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GoF4R – Governance of the Interoperability Framework for Rail and Intermodal Mobility

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Abstract

In order to promote a modal shift towards green modes of transport such as rail, the intermodality between different transport modes should be improved. The development of multimodal travel information, planning and booking services and the interoperability between business applications is currently limited due to the fragmentation and incompatibility of interchange formats and protocols both within and across transport sectors as well as within the supply chain.

The aim of the GoF4R project is to overcome the obstacles currently impeding the development of market innovation by fostering a large acceptance of the ‘semantic web for transportation’. The establishment of good governance aims at securing the confidence of the industry to use the Interoperability Framework (IF) semantic technologies that will be established under the IP4 Innovation Programme of Shift2Rail ‘IT Solutions for Attractive Railway Services’. The objective of the Governance of the IF for Rail and Intermodal Mobility (GoF4R) project is to design a governance and management structure for the IF that will: i) create the right conditions to introduce seamless mobility services, ii) foster the development of multimodal travel services and iii) ensure its continued relevance for the future evolution of the Single European Transport Area. The governance models proposed in GoF4R will serve the interests of the European travellers by fostering the 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 transport arena by removing technological, administrative and economic boundaries.

The objectives will be achieved through a partnership of specialist participants including research institutions, a major European rail operator, 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, contributing to the achievement of a distributed semantic ‘web of transport’ integrating the TAP-TSI specifications as one of its elements.

Keywords: Governance; Interoperability Framework; S2R; Semantic Web; Mobility Services; TAP TSI; IT2Rail; IP4; multi-modal marketplace; semantic web of transportation; travel companion; sustainability.

1. Introduction

1.1. GoF4R and the Need for Interoperability Framework Governance

The **G**overnance of the Interoperability Framework for **R**ail and Intermodal Mobility (**GoF4R**) project will define sustainable governance rules and processes for the Interoperability Framework (IF) Technology Assets. The IF Assets, under development within the Shift2Rail framework, comprise semantic web technologies and tools that will allow data exchange amongst different actors of the transport ecosystem. As shown in the figure below, these assets provide the necessary mechanisms that data consumers can apply to overcome the complexity of exchanging varied data formats and non-integrated services, thereby facilitating interoperability across disparate systems.

The IF, if widely adopted, will facilitate the development of value added services for achieving a seamless multimodal door-to-door travel experience for the European citizen. The underlying Assets will enable developers to provide seamless mobility services, foster the development of multi-modal travel services and help to overcome the obstacles currently impeding market innovation. Such governance can lead to a large acceptance of the semantic web for transportation.

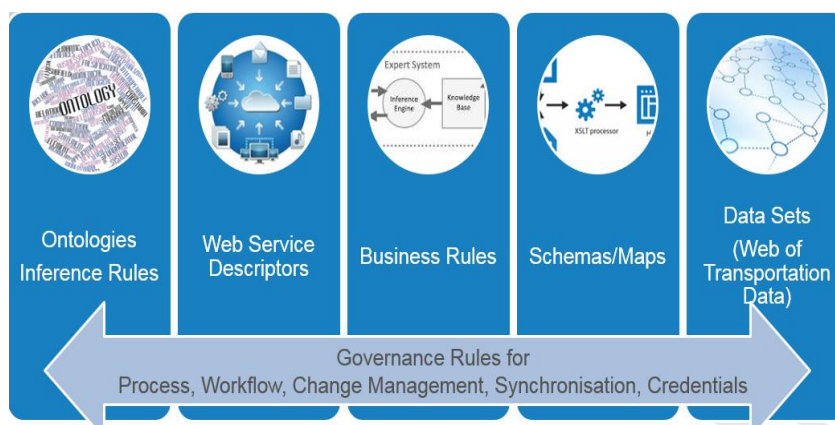


Fig. 1 The IF Technology Assets

An effective governance structure is necessary to assure that the technical interoperability components of the IF can be deployed effectively and cost-efficiently by market actors to create service offerings that substantially improve mobility. To assure uptake of the IF, the governance must create confidence amongst market actors by assuring stability and by providing free, non-discriminatory access to the IF Assets.

The underlying IF semantic technologies and standards as developed in IP4 will address fundamental obstacles to interoperability by overcoming incompatibility. These technologies, if widely adopted will be able to:

- lower the cost of accessing data that is openly discoverable
- favour higher quality and availability of 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 by removing ICT system incompatibility, e.g. enabling market players and new entrants' capabilities, thereby reducing the cost and time-to-market for the ICT integration.

1.2. The GoF4R Challenge:

The IF technologies and standards are not sufficient to ensure interoperability unless they are integrated by service providers for the development of new service solutions. The establishment of good governance, in and of itself, will not assure market uptake of the IF components – that is left to market forces to decide. Good governance will, however, define the processes and environment to best promote the use of the IF components and secure the confidence for service providers to deploy them. Therefore, GoF4R will address only those rules and processes related to the base IF Assets. Development and implementation of eventual services will be left to market forces. However, the project will provide guidance to future service providers to make sure that certain framework

conditions shall be respected regarding Data Privacy, Intellectual Property, Regulation, etc.

To be effective, the IF governance framework must match the technology and address only those obstacles that are within its authority. The rationale behind GoF4R is to develop a lean framework based on a full analysis of **how** this technology will be used and by **whom**. It is essential that the governance framework does not include new mandatory requirements that could hinder the expected market uptake of the IF components. Governance requirements such as privacy, copyright, accessibility and open data will be considered in the analysis with attention to making the IF components available and easy to deploy. GoF4R will aid in the development of this semantic web of transportation through non-technology measures by fostering cooperation between stakeholders of all transport modes (air, rail –main and regional-, coach and urban.) The IF components as supported by strong governance will provide a breakthrough for European travelers and stakeholders to create new business opportunities for improved mobility and travel related services. The governance model and processes, as proposed, will create the environment for potential market uptake well beyond the lifecycle of the SHIFT2RAIL project.

Therefore, a critical analysis of the framework conditions (at all stages in the value chain) is being undertaken. It includes analysis on users' needs and behaviour, related regulation, voluntary initiatives and exploitation of market forces. The work is undertaken based on both qualitative and quantitative evidence generated in the project, supported by appropriate surveys, interviews and others. This analysis will lead to the best possible governance model and its wide acceptance by transport stakeholders by specifically addressing the following:

- structure and dynamics of the market for multi-modal mobility services analysed from both the passenger and other stakeholders' perspectives;
- regulatory framework and voluntary cooperation for mobility services and related technology specifications at the European, National and Local administration level – it includes initiatives, e.g. the STA (Smart Ticketing Alliance) and even worldwide initiatives (e.g. W3C);
- market and maturity of semantic web technologies, including related professional services;
- discovery and definition of processes, procedures, policies and guidelines for a large IF acceptance also based on an analysis of best practices and lessons learned;
- a set of KPIs to monitor the status and evolution of the IF acceptance.

The above will allow GoF4R to define a credible roadmap for a sustainable, low-barrier governance structure and rules that can secure confidence in the industry for the use of the IF and promote large-scale adoption.

2. A model of the market for customer-centric mobility services

The transport network ecosystem incorporates user behaviours, technology and operational processes that need a new customer centric approach to embrace the concept of 'mobility as a service' (MaaS). To implement effective user behavioural change for MaaS pre-emptive, real-time and disruptive journey choices requires a clear understanding of the demands the consumer (individual user) has for various products within the travel companion (TC). It is also important to recognise the implications MaaS has for the IF and ultimately for its governance. A model of the market for customer -centric MaaS offers a means of establishing how a TC can support end to end (E2E) journeys. The initial step in this work is to deconstruct the TC into its consumer orientated capabilities and interaction points. Analysis of the separate elements and their interactions will enable the constraints, barriers, incentives and needs to be identified and shape the recommendations to achieve optimal use of the TC. In turn, this will enable the definition of recommendations for large adoption by the consumer of the TC approach.

These recommendations provide a basis to deduce the requirements the consumer has for the IF and its governance which would benefit from an understanding of the travel choice psychology and socio behaviours that determine their travel decisions. To elicit these details an expert workshop within S2Rail IP4 members and supported by desk top study has been planned to validate the interaction points' assumptions in terms of factors that can influence customers' behaviour (e.g. constraints, barriers, incentives, and needs) to ensure the large consumer uptake across European countries. The scope of the workshop captures the ethnographic differences between market conditions and cultures.

The scope of the consumer interactions points includes user identity, preferences, planning, buying, receiving travel entitlement authentication, journey information, disruption updates, re-routing, post trip data analytical information. These factors can influence (positively or negatively) the adoption of new digital technologies by consumers and a literature review e.g. Davis, 1989; Venkatesh, et al. 2003; Venkatesh, et al. 2012; Wang, et al,

2013; Pura, 2005; Slade et al. 2015) offers a consolidated broad generic synthesis of differing models coexisting within a diversified range of factors. However, these do present common themes around; *performance expectancy* the degree to which using a technology will provide benefits to consumers in performing certain activities (e.g. perceived usefulness); *effort expectancy*, the degree of ease associated with consumers' use of technology (e.g. ease of use); *social influence*, the extent to which consumers perceive that important others (e.g. family and friends) believe they should use a particular technology; *compatibility with current resources*, knowledge and surrounding environment, consumer perceptions of the resources and support available to perform a behaviour; *habit*, the extent which people tend to perform behaviours automatically because of learning; *hedonic motivation*, fun or pleasure derived from using a technology; *monetary value*, value derived from task fulfilment. Monetary benefit or superiority compared with the alternatives; *perceived risk*, the perception of safety and security in providing information; *trust*, the trustworthiness of the provider (keep promised, keep consumer interests in mind).

Based on the outcomes of the workshop and interaction points, low fidelity prototyping will allow the structured development of the consumer demands. These will be validated by a targeted survey of consumer experience and interviews.

Technology is converging and as new products and systems are placed into the market this creates an increasing level of data interconnectivity for the TC functions and services and consequently the sharing of information about users and their locations. This raises several issues for transport actors of all transport modes with different roles in the passenger transport chain. What information is being shared? Who is legally responsible for the information that is shared? Given the actors have different perspectives and responsibilities, how is the process regulated? To promote market commercialisation these questions, need to be resolved so as to address the IF and other S2R solutions.

The availability of the TC data is critical for developing business model applications and service operations. To boost pan European take-up operators will benefit from a better understanding of the complete E2E data links. This work will seek to clarify the current European situation and expectations by identifying operator and public authority major use cases and market actors of IF. With the impact of General Data Protection Regulation and increasing impact of individual and organisation level data ownership it is important to identify clear possible requirements for the governance and management structure of the IF.

3. Governance and management structure requirements

“New technologies often allow novel communication means, where the causality, responsibility, speed of access, and distribution policies are widely different from those available in non-Internet communication. **A mismatch of governance and actual usage often leads to mandated requirements which cannot be easily and consistently interpreted.**”*

GoF4R aims to define a minimal governance structure that will not become an obstacle to adoption through compliance with unnecessary obligations that add to the overall cost of supplying new, customer-centric mobility services. The project employs both qualitative and quantitative modelling to identify market incentives for the adoption of the IF Assets, as well as analysing the conditions and factors for which market forces may not be sufficient to promote adoption. Accurate identification of the latter is critical in order to design a governance and management structure that can leverage the positive incentives generated by market forces while respecting the regulatory framework. Additionally, GoF4R addresses complementary correction or mitigation actions where these forces are insufficient or negative.

This concept is applied to the development of a management structure and specialised processes specifically designed to minimize the cost to the users in Actors in the supply chain for the adoption and the transition to the IF Assets technology. It will furthermore provide guidance and support to make the most efficient use of the Assets following the principles of open access and use of non-proprietary standards/architectures.

The application of this concept shall be facilitated by the design of the Interoperability Framework (and Travel

* Larry Masinter, W3C Editor's Draft (<https://www.w3.org/2001/tag/doc/governanceFramework-2012-07-19.html>)

Companion) within both the Shift2Rail and the Multi Annual Program for IP4 (IT2Rail “lighthouse” project.) By working closely with the IP4 stakeholders, the alignment and respect of those design principles is ensured. Indeed the Interoperability Framework requires a minimum of governance effort and allows its exploitation by any Agent in the supply chain without the need for a centralized coordination of roadmaps, centralized architectures or components. The governance has to consider the following principles:

1. The domain’s “knowledge” (i.e. concepts, relations, assumptions, constraints) are expressed formally and explicitly in an “ontology” as logical axioms in a machine-readable existing standard language and can be shared and distributed over networks with existing serialization and communication protocols, as opposed to the existing heterogeneity of syntactical representations in different formats.
2. The logical axioms expressed in the machine-readable language can be processed by machines using existing standard and open source ‘reasoners’ that operate on the ontology. As an example, logical equivalence relationships can be described in the ontology to state that an object’s instance is a particular syntactical representation of the same object described in another representation, including a ‘legacy’ or ‘regulation’ of such representation. Automated processing of the logical axioms in a reasoner can then automatically produce conversion between different representations, or ‘formats’ of the same object instance or concept. This eliminates the need for governance imposing data format standards and for Actors refactoring their systems to the common format, while allowing existing differing standards to interoperate.
3. Open Linked Data principles are adopted, whereby every datum is uniquely identified by an URI that can be automatically used on the HTTP protocol and linked to other such data across the World Wide Web. This makes the physical location of the data irrelevant as standard software, including web browsers, open source or commercial linked data software can transverse the links across the web and reach the data wherever they are located, providing a ‘web of transport data’ abstraction to applications. This eliminates the need for centralized data stores or hubs and for dedicated data-exchange protocols to and from the data hubs. Legacy data stored at existing repositories can be converted into linked data through automated procedures supported by open source or commercial tools and thus extend the ‘web of transport’ data.
4. Service and procedure descriptors are also represented using the principles described above. They can therefore be discovered and bound to calling applications through automated procedures, again eliminating the need for centralized service hubs or transactional specifications
5. Finally, since the technology is based on existing open interoperable standards, multiple concurrent implementations and deployment on multiple architectures are possible with their own legitimacy, there is no prerequisite for governance of a common or a centralized architecture.

GoF4R does not focus on a governance structure designed *to ensure interoperability*, but on a governance structure that is designed to facilitate the adoption and sustainability *of the Shift2Rail IP4 Interoperability Framework Assets* which, by design, ensures interoperability.

Specific governance actions and processes will be developed under this concept for the management of the Interoperability Framework and its components (i.e., shared ontology, semantic web service registry, automated converter libraries), for the administration of the specifications and for training services. Governance actions will be additionally designed for coordination activities with standardization and specifications bodies, with the purpose of ensuring the continued availability.

Non-technical compatibility factors related to the fragmentation of regulatory regimes across modes of transportation and/or jurisdictions (data privacy and security, customer protection, liabilities and obligations associated with delays, cancellations or denied boarding, contractual relations between Actors) must also be taken into account. The compatibility factors also relate to the customer centric MaaS reflecting the need to integrate with current systems and also future exploitation of new data sets in a controlled and unified pan European framework. The key TC data elements for success are fundamentally built of a ‘single source of truth’, integration to existing systems choices and services, which link to big data analytics and operational performance, and ultimately to external data services such as ticketing and payment. These elements require analysing potential specifications to be recommended.

As a complement to the design of the actions and processes for governance of the technology, the project will generate a set of recommendations on these issues for further actions by other stakeholders, including public

agencies, targeting increased voluntary cooperation between travel operators and competent authorities.

4. Overall methodology

The project will generate a governance and management structure designed on the basis of quantitative evidence on the structure and dynamics of the market for customer-centric mobility services. From market observation, the project will derive the economic incentives obtained by introducing the IF and TC technologies. These studies will be in their turn based on economic models of “network industries” that will constitute the theoretical foundation of the work and which have been successfully applied over the years in other industries, e.g. the computer or media industries, particularly with the widespread adoption of the internet and the World Wide Web as a fundamental infrastructure of the economy.

Dedicated activities detailed in section 3.1.1 “Overall structure of the work plan” will be conducted to collect and normalise actual data to provide quantitative inputs to the network industry models, in order to generate a fact-based foundation of the design of the governance and management structure of the technology. The collection of data will be conducted through the design and administration of specific questionnaires to complement existing data sets from a variety of sources, including those maintained by participants in the GoF4R project such as UIC, EPF, UITP and UNIFE as part of their institutional mission. Data analysis and normalisation will be the object of dedicated workshops with major stakeholders and specialists. The models and their associated data will be published and made available electronically, and will constitute an integral part of the published deliverables.

Workshops will be conducted with existing governance or standardisation bodies to identify and avoid possible overlaps, interference or duplication of governance actions or entities, and to design collaboration processes to leverage complementarities and synergies between these entities and the governance and management of the IF.

The project shall also learn from IT2Rail Proofs of Concept and build upon the IT2Rail release - as the first of 4 releases iteratively produced by 2022 - for making recommendations for the future IP4 demonstrator ITD4-7.

5. Expected impacts

GoF4R will induce a snow-ball effect of market uptake, as retailers and transport undertakings realise that “membership” will allow unlocking and exploitation of a much larger consumer demand than was previously possible.

By supporting full semantic interoperability of interchangeable and loosely coupled tools, data and services within a distributed “web of transportation”, multiple concurrent implementations can be developed independently by specialist suppliers and co-exist competitively.

Thanks to the connection between the preferences and the geo-localisation of the person, many innovative IT solutions can be developed covering all aspects of social life (culture, merchandising, etc.).

The market of transport services (shopping, ticketing but also services related to guidance) will be opened thanks to the IF. The heterogeneity of the transport market will be masked by the IF technology decreasing the investment costs for advanced IT solutions, and opening up a new competitive market of both mobility services and specialist technology providers.

The main benefits that the IF will bring include:

- 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.

These benefits will materialise in the following ways:

Cost reduction:

Enhanced interoperability will allow the reduction costs entailed by the following activities:

- data exchange between current systems with new ones;
- acquisition of Customer experience systems by railways operators;
- railway product distribution to final customers via third parties.

Besides, it might even help take the current TAP TSI to a higher technical and functional level, fully in line with the principles of European law-making (“New Approach”, 1985). By applying the technology of the IF Assets, no fixed data formats would need to be enforced by law in order to ensure interoperability. The ensuing cost reduction would apply to administrative burdens (the cost of continually updating the TSI annexes), and to consequential hardware and software redesigns as well.

Increased revenues:

Creating new value chains; generating additional revenue to Retailers and Railway Operators from richer product offerings and smart services to Customers.

Increased Agility:

Agility (in the IT sense) will be increased by virtue of the flexibility of the framework. The consequence will be a reduced time-to-market of advanced Customer experience applications.

Better Experience for Customers:

Integrating fragmented platforms and systems will contribute to more attractive a Rail System, as Customers enjoy continuous access to their personalised journey information systems; passengers treat their journey as a seamless extension of their working or leisure environment, whatever the mode. Besides, by aggregating suppliers’ systems to the offering, market of specialist suppliers of products and services will be encouraged to be compliant with the IF specification, thus putting additional downwards pressure on the cost of interoperability for Customer experience system developers.

Benefits from cooperation between stakeholders:

- Exploitation strategy is for assuring interests of the Rail/Public Transport industry, stakeholders and European travellers, as base for potential market uptake beyond the project itself.
- Opportunities and barriers results will be analysed as impacts for the whole IP4 project, in a go to market approach that will lead all partners to a successful exploitation process, clearly addressing purpose, audience, message and method.

As services providers and operators get better and more correlated feedback from the ecosystem, including from the travellers themselves, they will be in an optimal position to propose new services and adaptations of current offers to better suit travellers’ needs. Complete understanding of their users’ typology, preferences, payment patterns, etc., will allow the transit agencies to offer innovative transport products better matched with demand.

Through the emergence of cooperation (cooperation and competition) schemes, operators and services providers will provide data which will gain in value through their correlation and enrichment with the rest of the ecosystem analysis.

Federate a community around the innovation concepts of IP4:

A key objective is to ensure the appropriate dissemination of key concepts, progress and communication strategy within the S2R community and toward the global ecosystem and future users of IP4. Participant of the IP4 TDs will therefore play the role of the IP4 ambassador toward the EC organisation and any other key stakeholder’s communities such as TAP-TSI, Full Service Model (FSM), Smart Ticketing Alliance (STA) and any other connected initiatives.

6. GoF4R Themes and Corresponding Work Packages

As seen in Figure 2, the technical Work Packages were carefully conceived to address the following themes that are essential to create confidence amongst market actors to use the IF Assets, by assuring stability and by providing free, non-discriminatory access.

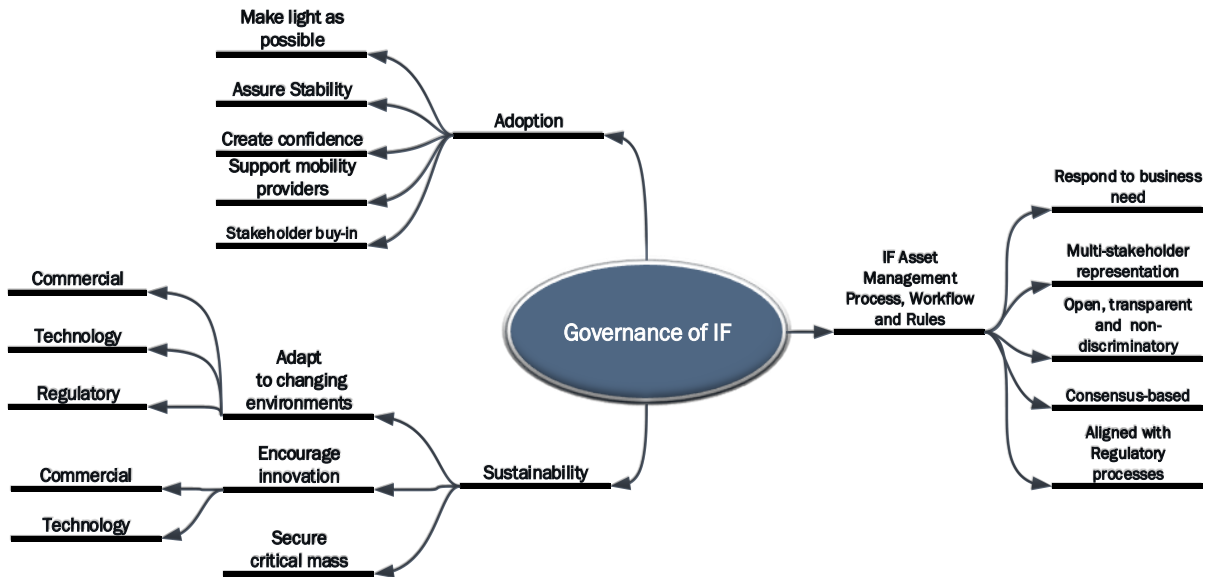


Fig. 2 GoF4R Themes

These themes are described below:

a. Fostering large-scale adoption of the IF Assets by the stakeholders

One of the most important factors for take-up of the IF is to assure that there is a sufficient critical mass of users. This means that different user's needs must be identified and met in order to effectively foster Stakeholder buy-in. Taking a page from the success of similar (albeit larger-scale) governance entities such as W3C or UNECE, it is shown that these organisations provide the stability and transparency needed to service myriad stakeholders – without the risk of sectoral dominance from any specific sectoral interest.

b. Creating a sustainable governance that can adapt to changing environments

It is essential that the Governance structure can stay relevant where the technology, commercial and regulatory environments are in constant evolution. It must be agile enough to adapt to these changing environments while encouraging innovation in both the technical and commercial environments.

In order to address these two themes, the following Work Packages concentrate on the identification of Stakeholder needs, critical factors for adoption and future evolutions that will impact sustainability:

- **Work Package 2** has two specific objectives: 1) to analyse the market actors' interests in the interoperability framework and 2) analyse the travellers demand for the travel companion.
- **Work Package 3** specifically addresses the Regulatory Environment(s) that either influence directly or impact the IF Assets. This includes the identification of Regulations and Regulatory bodies (both European and National) that will interact with the Assets. It also addresses industry initiatives developing specifications that touch the Assets. Particular attention is given to issues such as Data Privacy, TAF-TAP data requirements, Intellectual Property rights and various standards that will be by the IF. The Regulatory Environment (including Standards) is always changing, so special attention will be paid to evolutionary trends that must be taken into account in order to assure the relevance of Governance well into the future.

- **Work Package 4** addresses the technology market in the field of semantic interoperability solutions, in order to understand the feasibility of a large-scale adoption of such solutions within the transport domain as enabled by the Interoperability Framework. It specifically addresses the specific conditions to adoption in the transport domain, both in terms of costs of switching to semantic solutions, resistance to invest in different standards and available supply market. Furthermore, it evaluates the supply market in terms of skills and professional services, to understand the potential difficulties to ensure the evolution and maintenance of semantic solutions.

c. Creation of IF Management Processes, Workflow and Rules

This theme specifically defines how the governance entity is managed and how change management is implemented for the IF Assets. All change management decisions should be based on Business (or Regulatory) need and approved in an open, transparent and non-discriminatory manner. It is crucial that the Governance involves multi-stakeholder representation to avoid that any one sector may impose proprietary solutions on the Stakeholder base. Only in this manner, can the Governance stay relevant in the future and assure the engagement of its user-base.

- **Work Package 5** will design the management structure, i.e. the assignment of activities in the processes to roles, their corresponding rights and obligations, and their relationship with established related governance structures such as Standardisation Organizations, Public Agencies, Industry Platforms or Consortia. The design will be based on qualitative and quantitative evidence on:
 - the structure and dynamics of the market for multi-modal mobility services (WP2);
 - the regulatory framework for mobility services and related technology standards at the European, National and Local administration's level (WP3);
 - the market and maturity of Semantic Web technologies for interoperability (WP4).

The Work Package Organisation is shown in Figure 3 below.

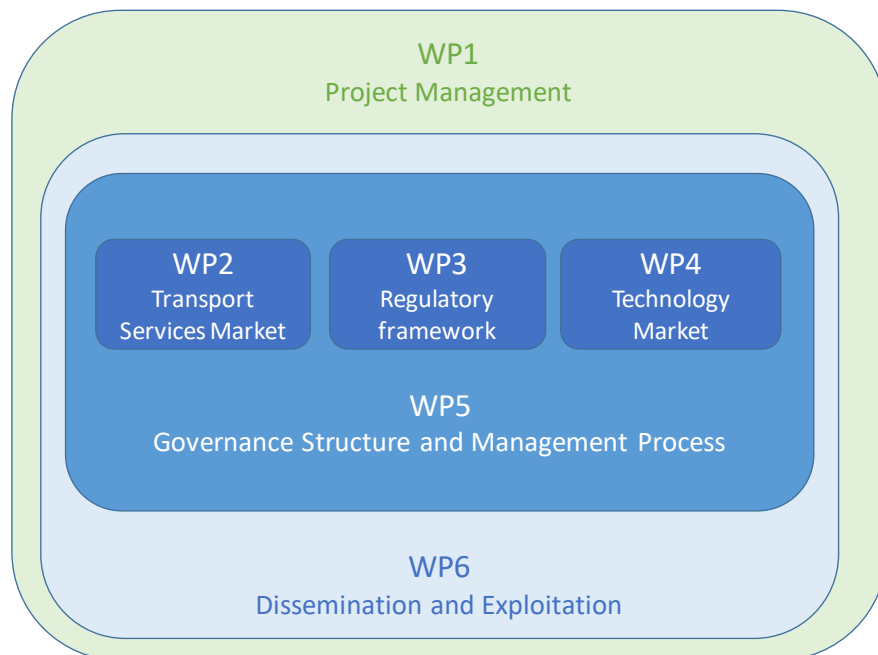


Fig. 3 Work Package Organisation

7. Conclusion

GoF4R's ultimate goal is to design an efficient governance and management structure for the IF technology promoting its adoption and sustainability through leveraging contributing regulation, exploiting market forces, and providing adequate complementary specialised measures to compensate for market failures. The design of the governance is based on qualitative and quantitative evidence on:

- the structure and dynamics of the market for multi-modal mobility services;
- the regulatory framework for mobility services and related technology standards at the European, National and Local administration level;
- the market and maturity of Semantic Web technologies for interoperability.

It is a GoF4R mission to provide recommendations on additional actions and measures to address non-interoperability technology related factors that may limit adoption and sustainability and are outside of the scope or the powers of the IF technology governance. To this purpose, it is necessary to achieve some specific objectives. First of all, it is essential to develop a set of use cases identifying the actors in the supply chain and describing their interactions with the governance structure in the adoption and maintenance of the technical tools (e.g. ontology repository, semantic web data and service registry, libraries of specialised converters).

Governance processes - and supporting tools – are essential for the realisation, automated in part, of the use cases, including the administration of training, as well as the design of the management structure, i.e. the assignment of activities in the processes to roles, their corresponding rights and obligations, and their relationship with established related governance structures such as Standardisation Organisations, Public Agencies, Industry Platforms or Consortia.

The deployment of the governance structure and the supporting tools need to be synchronized with the related current European initiatives, such as the Single European Rail Area, Single European Mobility Area, and Roadmap for ICT Standardisation and Digital Single Area timelines.

Finally, a prioritised list of recommendations to all stakeholders of further actions or measures to address the minimisation of the non-technology related factors will be defined by GoF4R, to induce a domino effect of market uptake of the Interoperability Framework, as a fundamental enabler of new business opportunities for retailers and transport undertakings.

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