INDEX

1. Shift2Rail and IP4 context
2. Project Overview
3. Interoperability Framework (IF)
4. Business Analytics (BA)
1. Shift2Rail and IP4 context
1. Shift2Rail and IP4 context

1.1. Shift2Rail initiative

Shift2Rail is the first European rail initiative to seek focused research and innovation (R&I) and market-driven solutions by accelerating the integration of new and advanced technologies into innovative rail product solutions.

Shift2Rail promotes the competitiveness of the European rail industry and meets changing EU transport needs. R&I carried out under this Horizon 2020 initiative develops the necessary technology to complete the Single European Railway Area (SERA).
1. Shift2Rail and IP4 context

1.2. IP4 overview and objectives

- Put the traveller back at the centre, ease access to rail, increasing its attractiveness
- Complete multimodal travel offer connecting the first and last mile to long distance journeys
- Give access to all multimodal travel services (shopping, ticketing, and tracking) through its travel-companion
- Build an open framework providing full interoperability whilst limiting impacts on existing systems
1.3. IP4 Technology Demonstrators

3 Research Areas
- Technical Framework
- Multimodal Travel Services
- Customer Experience Applications

7 TDs
- TD 4.1 - Interoperable Framework
- TD 4.2 - Travel Shopping
- TD 4.3 - Booking & Ticketing
- TD 4.4 - Trip Tracker
- TD 4.5 - Travel Companion
- TD 4.6 - Business Analytics
- TD 4.7 - Integration & Demonstration
1. CONNECTIVE in IP4 context

1.5. IP4 components overview

**Travel Companion**

**IP4 ecosystem**

- Unique ID
- Tickets stored in Virtual Wallet
- Services tailored to preferences
- Real time notifications
- Location Based Experiences

**Traveller services**

- Planning
- Shopping
- Ticketing
- Navigating
- Tracking
- After sales

**Logic and orchestration**

- Dialogues with each provider
- Integration of data
- Logic for added value services

**Transport providers’ functionalities**

- Clearing & Settlement
- Configuration of multimodal agreements
- Business Analytics

**Interoperability framework**

to interact with different interfaces and data models
2. Project Overview
CONNECTIVE: Connecting and Analyzing the Digital Transport Ecosystem
01/09/2017-31/06/2022

PARTNERS

Indra (coordinator)

HaCon
THALES
Network Rail
DIGINEXT
Ansaldo STS

Complementarity

Added value of Travel Experts and academia

START (Completed)
GoF4R (Completed)
sprint (started 2019)
The CONNECTIVE project will work towards the digital transformation of rail and all transport services, providing the framework, tools and technologies to allow data exchange among different actors of the transport ecosystem and facilitating interoperability among systems, but also the creation of added value services using all available information.
3. Interoperability Framework (IF)
Shopping, Booking & Ticketing, Trip Tracker components need to know for each TSP: end point, communication protocol, services provided, data model etc.
Approach

With Interoperability Framework...

Journey involves A-D-F
3. Interoperability Framework (IF)

Baseline

• CONNECTIVE-IF activities took as starting point the results of IT2Rail project. This included:
  • First approach to the IP4-IF definition and functionalities
  • First S2R-IP4 ontology
  • A set of software components (web services) to allow communication with a number of TSPs

• CONNECTIVE-IF initial activities were focused at covering ATT/COA needs to communicate orchestrators and TSP and provide multimodal services.
Work Streams

- Connect and allow exchanges among heterogeneous systems that use different interfaces:
  - semantic approach based on **ontologies**
  - Need of **conversion** among interfaces
  - Need to manage **communications**: urls, endpoints, certificates ...

- Provide an access point for TSP to **register their services** in the ecosystem, making them available for the IP4 applications.
  - Make the services available for orchestrators
  - Extra functionalities provided through the same portal: creation of business rules, view transactions etc

- Provide generic **components (web services)** to simplify the operation of the applications, allowing them to select the relevant providers and data
Work Streams

- Evolution of the S2R-IP4 ontology
  - Start with IT2Rail ontology
  - Being reviewed to include concepts from existing standards
  - Separate “monolithic” ontology into modules.

**Future IP4 ontology**

- Transmodel NETEX + others (GTFS)
- TRIAS + others (SIRI)
- FSM + others (TAP TSI, Transmodel)
- Others

- Infrastructure static data
- Real Time data
- Ticketing and services
- Others

Ontologies
3. Interoperability Framework (IF)

Work Streams

Describe ontologies/concepts, that need to be “mapped” with IP4 concepts

- Cover multimoda, not only rail
- No changes in data structures or communications protocols of the systems.
- No need to adapt interfaces to a specific standard, although the use of a standard could simplify the process of joining the ecosystem

Interoperability Framework

- Travel episode
- Train section
- Ticket
- Leg
- Wagon
- Billet

Ontologies

Describe services, end-point, web service/API, communications

TSP concepts

Ontologies

Interface

- Booking
- Issuing tickets
- Ancillary services
Work Streams

Shopping: need TSP information to build a trip

Ontologies A

Ontologies IP4

semantic broker

Ontologies IP4

Ontologies B

Assets, data available or linked

TSP Mappings
Other data

Example: TSP resolver

Shopping: Which TSP works in this area?

Converters

Brokers

Resolvers
Work Streams

• Provide TSPs with a web portal that they could use to:
  • register and describe their services, to make them available for multimodal shopping/booking/etc applications
  • Access extra functionalities provided by IP4 ecosystem (such as transactions information)
Work Streams

• Registration of services: includes network data, end points, interfaces information etc needed to interoperate with the service
Work Streams

- Additional functionalities: *creation of Multimodal agreements*:

- Allow to configure tariffs, specially multimodal agreements, specify the conditions and the benefits for the user and the revenue split among TSPs.

- “translates” to a technical level the rules, and feeds other IP4 components involved in shopping and clearing processes.

- Will be evolved to create Mobility Packages, including MaaS.
Work Streams

• Additional functionalities: **visualize status of transactions**

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**Operator Portal**

- Connected to **issuing and clearing flows**
- Shows each transaction and associated price
- Shows **status** of each transaction: Authorized, Confirmed (paid), Partial/total refund, Failed
- Each Operator logged can consult its own transactions. Admin to consult all
- Configure and download reports
4. Business Analytics (BA)
Overview

Take advantage of the data existing/generated in the ecosystem and provide useful information for travelers and TSP.

- Operational data coming from TSP’s systems
- S2R applications data
- Data coming from travelers
- Other external data: open data, social network data ....

DATA

- Anonymization techniques to guarantee privacy and confidentiality
- Consideration of GDPR

MANAGEMENT

- Develop descriptive, predictive and prescriptive analytics

ANALYTICS

- Interactive and dynamic visualization capabilities

VISUALIZATION

CONNECTIVE presentation
Business Analytics at three levels:

I. **Descriptive Analysis**
   - Use data aggregation and data mining to provide insight into the past and answer: “What has happened?”

II. **Predictive Analysis**
   - Use statistical models and forecasts techniques to understand the future and answer: “What could happen?”

III. **Prescriptive Analysis**
   - Use optimization and simulation algorithms to advice on possible outcomes and answer: “What should we do?”

Descriptive Analytics that helps you understand how things are going.
Predictive Analytics that helps you forecast future performance and results.
Prescriptive Analytics that suggest a prescribed next step or action.
4. Business Analytics (BA)

Examples of Analytics

**Assets management**
- Monitoring stations; optimize maintenance; optimize passenger flow
- Optimize revenue collection
- Fraud control
- Characterize problems/incidences and impact depending on type of day

**Demand management**
- Mobility patterns, demand prediction, OD Matrix
- Correlate demand and day type, events, weather, etc.
- What-If analysis, support to the deployment of strategies and offer-demand adjustment
- Control passenger entrance at stations

**Passenger & Services Management**
- Patterns of transport usage depending on sociodemographic profiles
- Business KPI: cost and revenues
- Loyalty programs, ancillary services, preferred bookings, etc.

**Multimodal**
- Combining data from different TSP, users and IP4 services:
  - Travel patterns: preferred multimodal itineraries, etc.
  - Multimodal KPIs
  - Resource management depending on other modes

Business Data Analytics

CONNECTIVE presentation
**4. Business Analytics (BA)**

**Examples of Use Cases: Analytics on Ticketing and service performance**

**Objectives**
- Use available information from ticketing equipment on board and in stations (vending machines, access gates), which could be useful to:
  - Enhance operators performance and maintenance
  - Allow users to know in advance the situation of the equipment in the stations as well as peak times

**Analytics**
- Total sales, sales per hour, sales per location, average of sales.
- Validation per line, validation per profile, validation per equipment.
- Demand prediction by line, stop, at peak hour
- Total benefits, Payed transactions, number of cards on the black list, Transaction per minutes.
- Delay time for each stop, occupation per service, occupation per service and per stop place.
- Alarms and failures patterns
- Prediction of delays

**Data available**
Databases of urban operator:
- Operation Assistance Services (OAS) and Automatic Vehicle Location (AVL)
- On board/ on station equipments:
  - Sales
  - Validations
  - Alarms
Examples of Use Cases: Crowd management in stations

Objectives

- Infrastructure design
- Offline analysis: Evaluate and enrich evacuating existing scenarios and train operators
- Online analysis: Forecasting analysis
- Online analysis: What-if analysis

Data available

Warsaw West station
- Real situation analyses
- Sensors installation inside the station allowing simulation model recalibration
  - Video Analytics
- Creation of virtual sensor data based on the simulated data

Technical details

- Analytics:
  - Machine Learning (virtual sensors and labelled data)+Transfer learning (real data and unlabelled or partially labelled data)
  - Data imputation algorithms
  - Predictive Analytics: short and medium terms predictions
  - Prescriptive Analytics: What-if analysis

- Visualization:
  - Visualizing simulation, KPIs
THANKS FOR YOUR ATTENTION

@ https://shift2rail.org/ip4/connective/

@S2R_CONNECTIVE