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1) The User-centric experience
2) Ticketing : the disruptive concepts
3) Interoperability Challenge
4) Collaboration and System Modeling Challenge

IT2Rail Mid-Term Conference 17/11/2016

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The User-centric experience

Nora Winninger (SNCF)
Leyre Merle (INDRA)
Petr Buchníček (OLTIS Group)
Bruno Rouchouze (Gemalto)

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An extension of the citizens work and leisure environment

User centric

My trips

My alerts

My tickets

My preferences

My navigation guide

My happenings

My ID

My stats

User

Empowered by his device

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User-centric travel

- In the current environment organizing a European-wide travel arrangement a Customer needs to identify suitable Travel Service Providers
- A Customer has multiple accounts and credentials, and/or dedicated ‘apps’, to interact with each of multiple Travel Service Provider they need to complete a European-wide
- A Travel Companion gives the Customer a single application to interact wtih the entire Travel and Transportation network, and to securely store all of her travel-related documents.

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Before IT2RAIL

User centric

User

TSP 1

TSP 2

TSP 3

TSP 4

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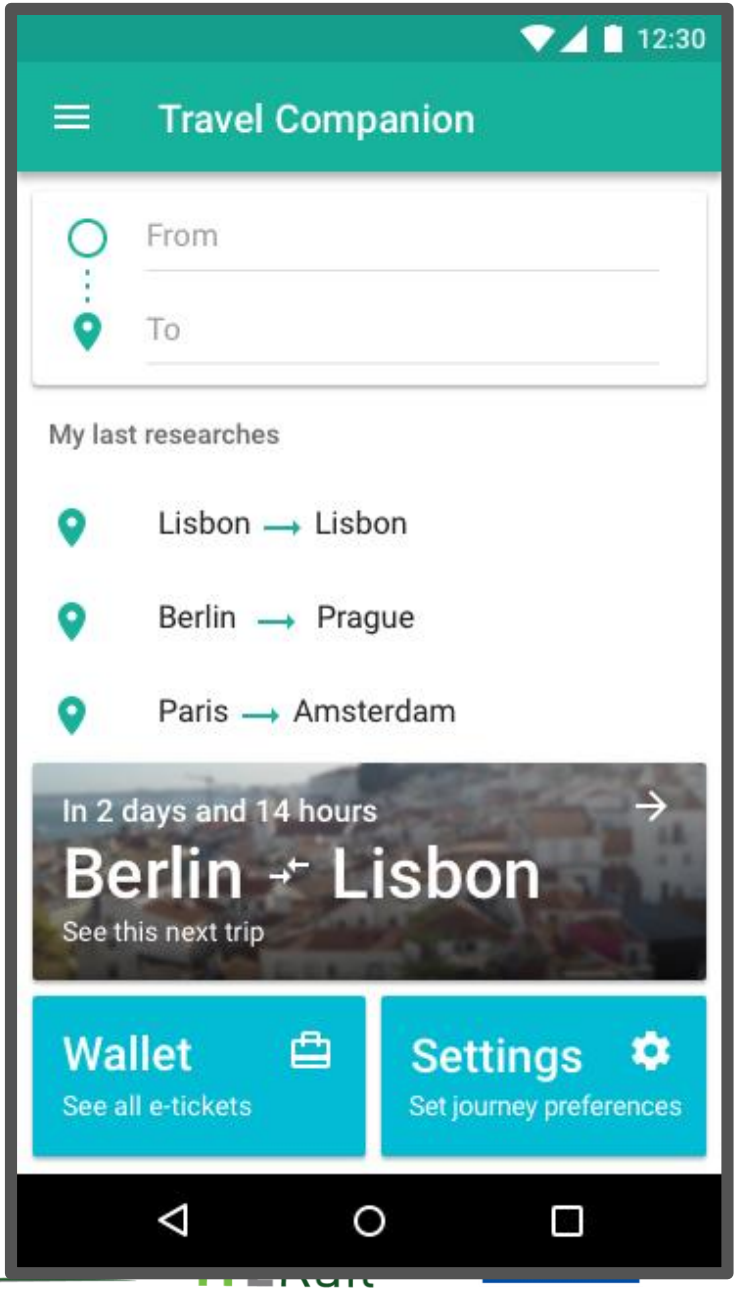
With IT2RAIL

Cloud

User

Empowered by his device



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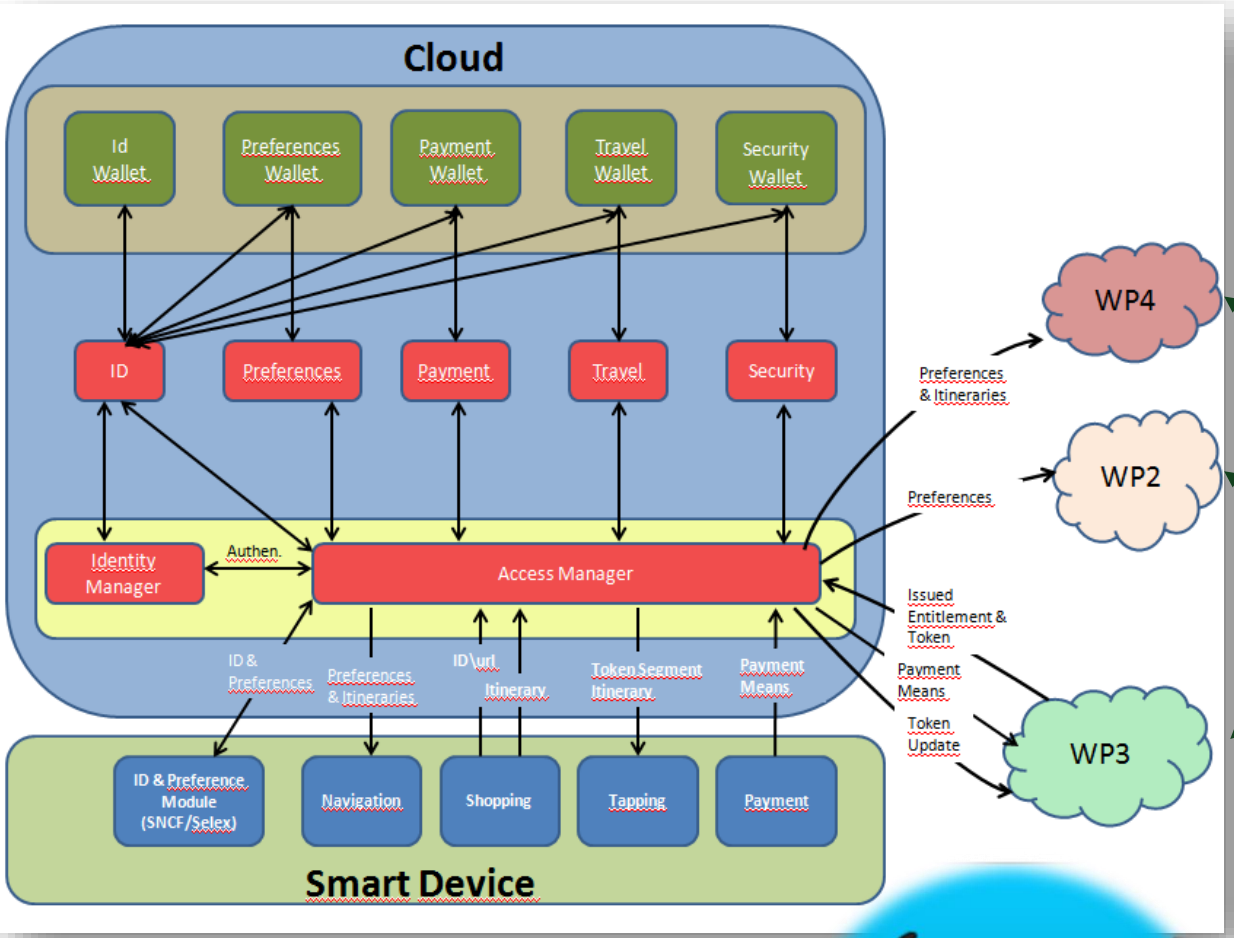
User centric



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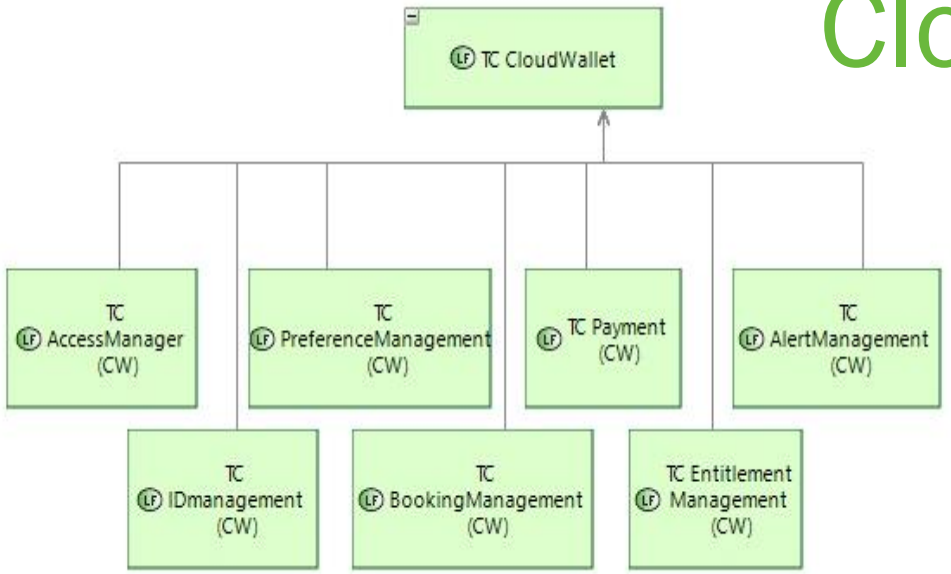
Cloud wallet functions



- ***AccessManager*** which controls who can or cannot access the personal information of the user;
- ***IDManagement***, which manages and stores the ID of the user, and grants the authorization to access the personal information of the user;
- ***PreferenceManagement*** which stores and manages the preferences of the user, and provides access to them;
- ***BookingManagement***, which stores and manages the information concerning the itineraries booked by the user;
- ***Payment*** which manages the information for the payment of services;
- ***EntitlementManagement,*** which stores and manages the entitlements and tokens of the trips of the user;
- ***AlertManagement*** which receives the messages concerning the trips that the user asks to track (e.g., those about disruptions affecting the trips of the user), and allows the traveller to be informed of them.

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State-of-the-art

Currently, there is a number of limitations...

- Passengers have limited amount of information regarding their travel plans (accommodation, weather condition, disruptions, etc.) before a journey starts
- Journey planners are searching for the optimal connection based on planned timetables
- Passengers are not provided with actual information in case of sudden traffic irregularities
- Passengers often have no tool to reschedule the travel plan in response to the current situation in which they found themselves
- Lots of wrong decisions are made due to insufficient amount of information

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TT objectives

The goal of WP4

- Monitoring of unforseen irregularities in transport
- Responding to such anomalies, incl. suggestions of alternative solutions

The main objectives of Trip Tracker

- Listen to the on-line information on traffic irregularities (real-time data)
- Alert Travellers on all relevant events concerning their planned journey
- Propose alternative solutions in reaction to such exceptions

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TT objectives

A new set of functions (Trip Tracker) shall allow users to cope better with travel disruptions

- Accessing passenger‘s actual position
- Monitoring of unforseen irregularities
- Identification of relevant events affecting passenger´s travel plan
- Matching these events with retrieved user preferences and itineraries (CEP)

- Automated alerting on disruptions or other travel conflicts
- Building of suitable alternatives to travel plan
- Invoking of re-accommodation services

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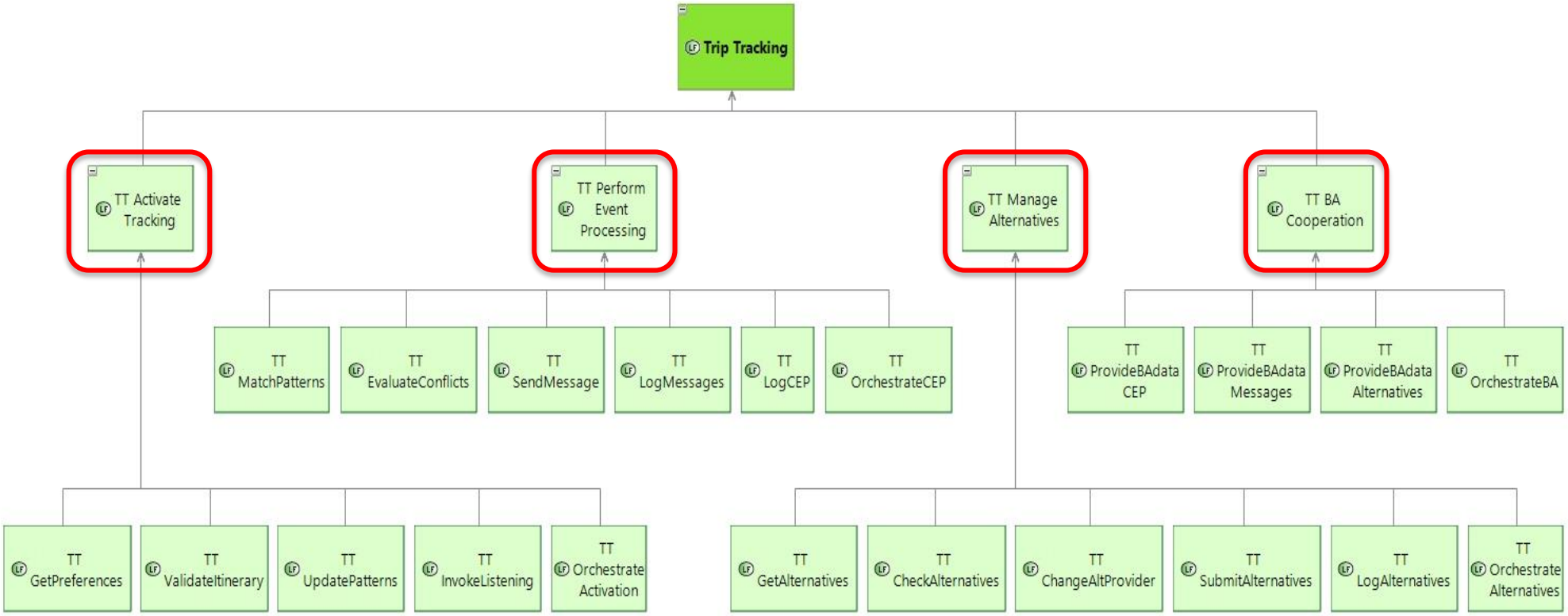
TT functions



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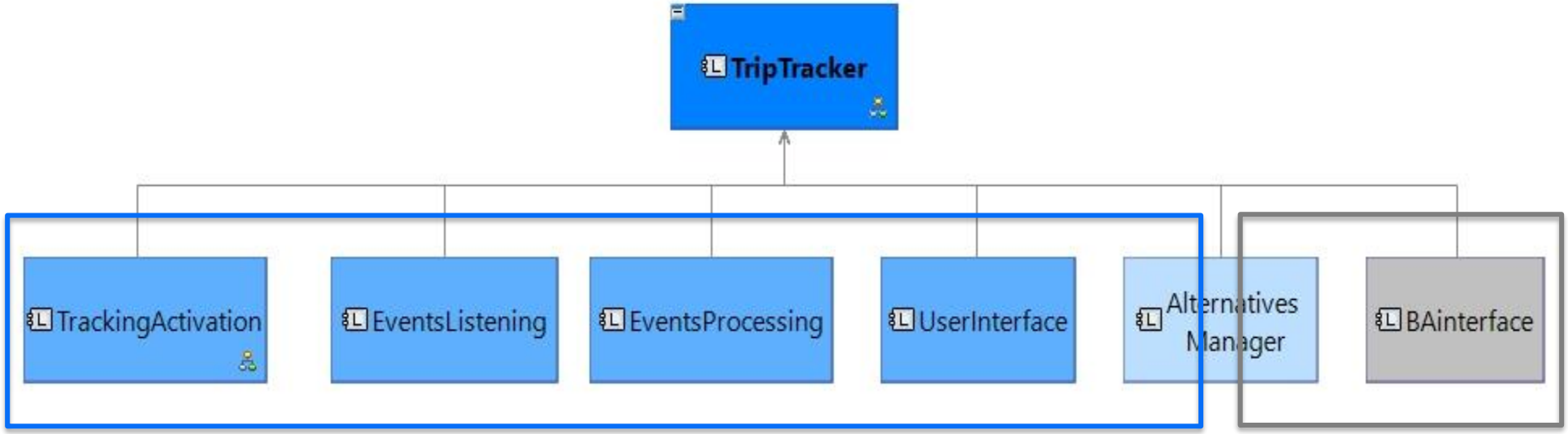
TT components



A-REL **F-REL**

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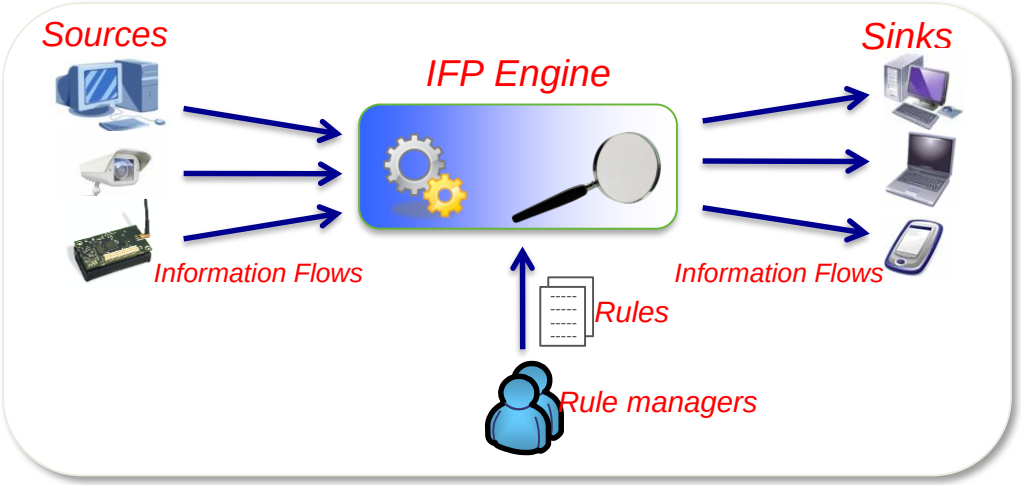
Complex Event Processing (CEP)

Information Flow Processing

- The IFP engine processes incoming flows of information according to a set of processing rules (processing is “on line”)
- Sources produce the incoming information flows, sinks consume the results of processing, rule managers add or remove rules
- Information flows are composed of information items
- Processing involve filtering, combining, and aggregating flows, item by item as they enter the engine



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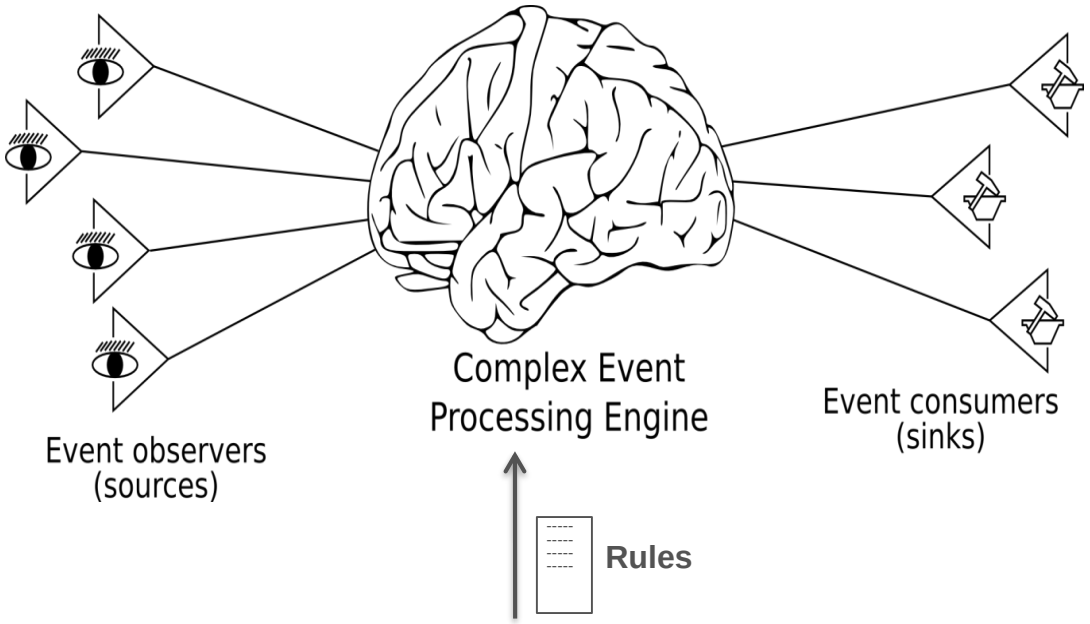
Complex Event Processing (CEP)

- CEP systems adds the ability to deploy ***rules*** that describe how composite events can be generated from primitive (or composite) ones
- Typical CEP rules search for *sequences of events*
  - Raise C if A → B
- Time is a key aspect in CEP



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Conclusions

The challenges:

- Automation of alerting users in case of disruptive events
- Real-time evaluation of disruption impacts to planned journeys
- Providing users with suggested alternatives when necessary

The approach:

- Introduction of new technologies and solutions,
  e.g. orchestration of already existing „local“ trip tracking services

The goals:

- Qualitative growth of services provided in public transport
- Increase of the railway transport attractiveness => the overall public transport becomes more attractive

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E-passport concepts

- It is planned to store some data inside the traveller biometric Passport. These data will be stored inside the NFC chip of the passport, through the application.

- *Travel Companion needs* an internet connection to access data stored into the cloud

- ePassport/LDS2 could also be used as a backup of the *Travel Companion* when internet connection is down

- ePassport/LDS2 stores the key data (trip data) linked with the current citizen' trip, as a mirror of the ones stored into the cloud

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E-passport technology

- **LDS2' management**
  - About LDS2
    - a specific memory zone into the chip of the ePassport
    - access (read/write/delete) **standardized by ICAO**
  - LDS2 will store the travel companion data as a mirror of the ones stored into the cloud. This will guarantee a full interoperability at worldwide level for all travelers

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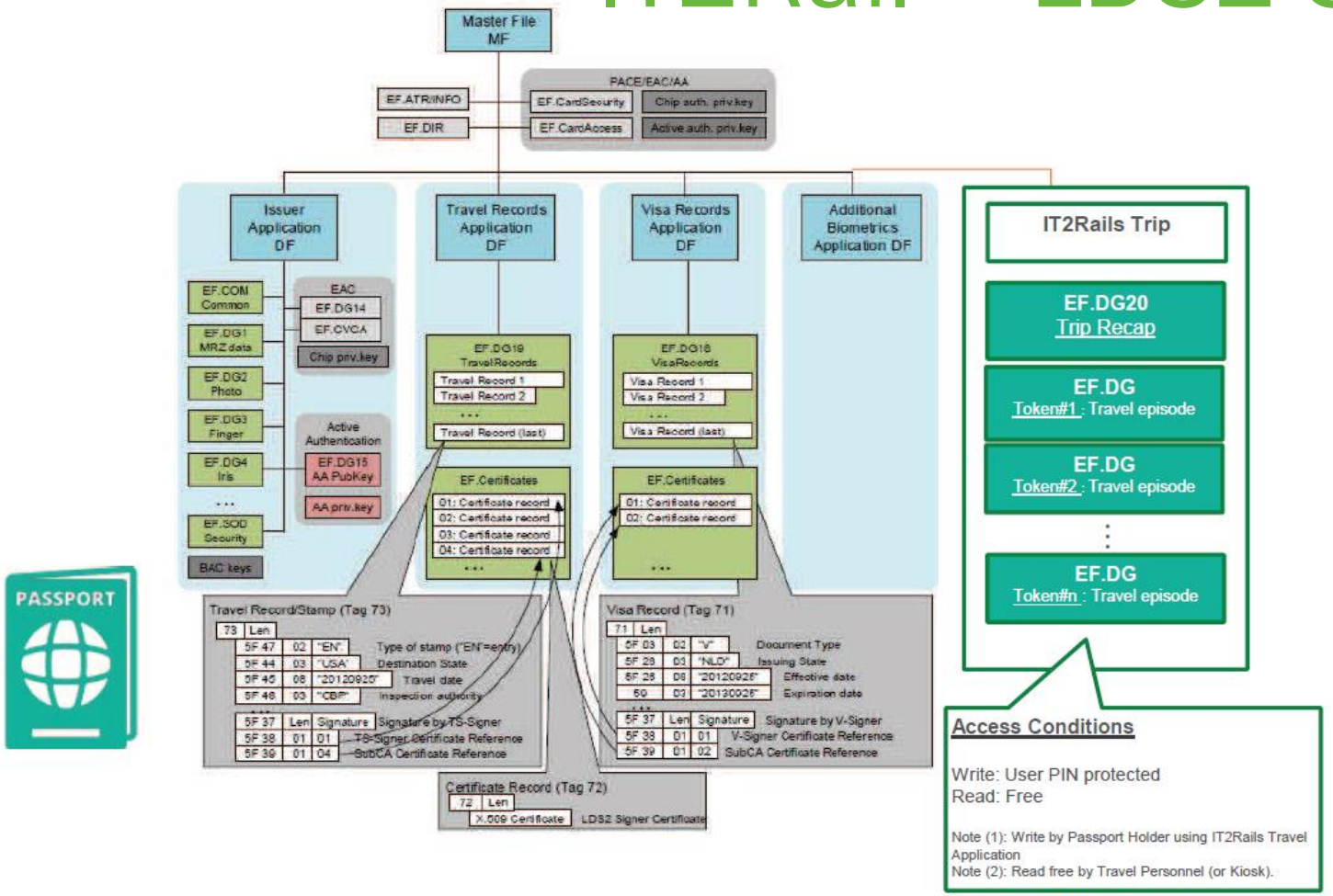
IT2Rail – LDS2 Structure



Approx 60kb of data available.

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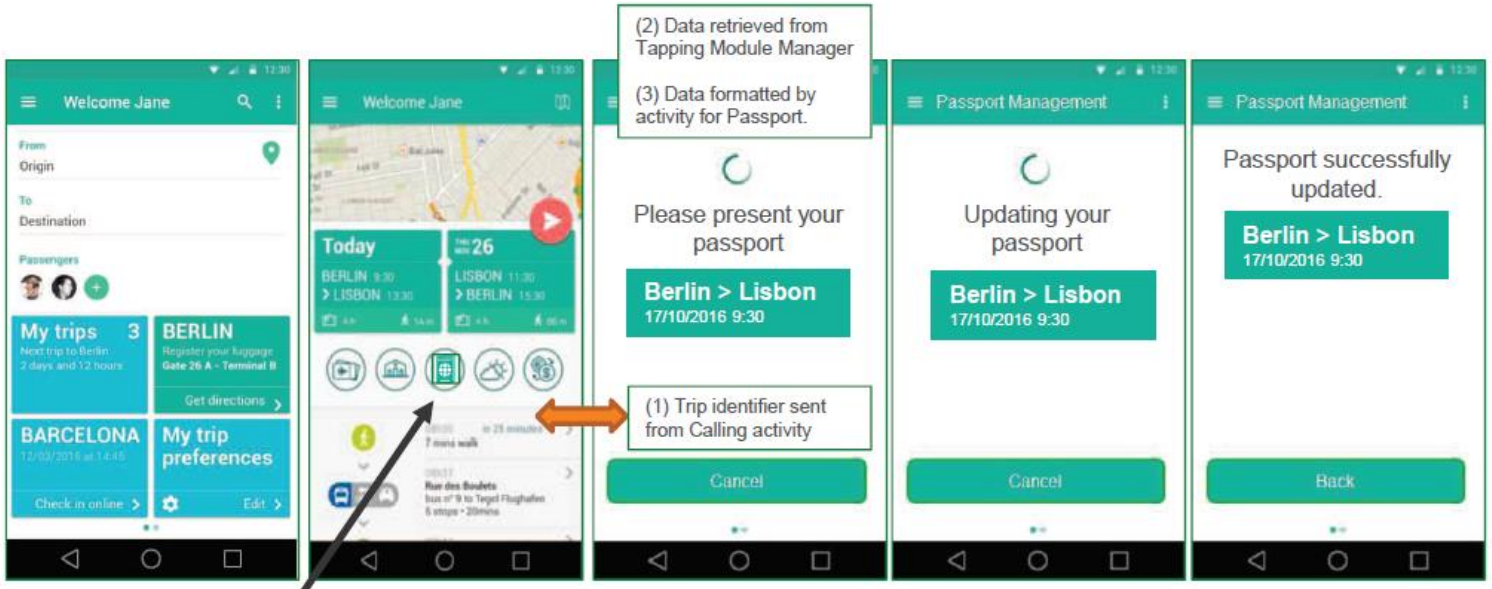
IT2Rail User story – Passport update



1 – User opens his IT2Rails travel application on his Smart Device

2 – User selects or registers a trip

3 – In the trip details, user can backup the trip to his passport document

4 – Trip Content is sent to the Passport Update activity though intent using bundle/extras.

5 – User is asked to present his passport document.

6 – Passport Activity encodes the Trip Recap and different entitlements in the Passport

7 – Activity finishes. User goes back to the original calling activity.

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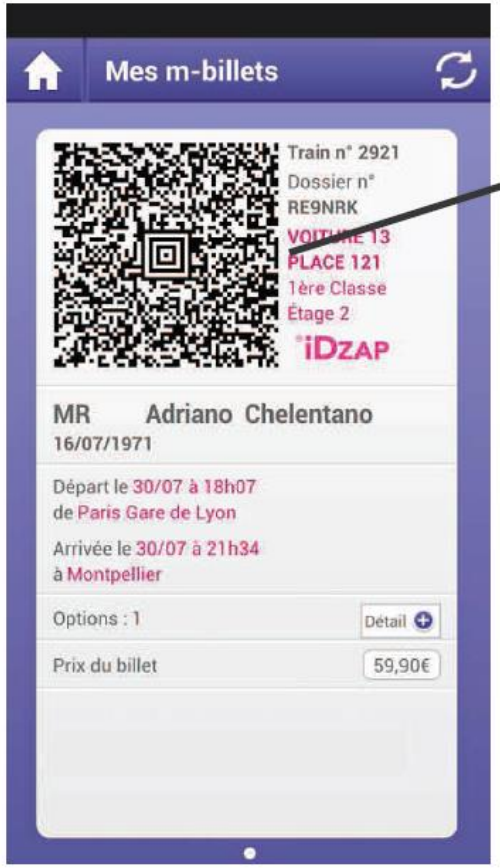
IT2Rail – Sample Data



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kLY62oEve+VR7uibmYXUbbx4wKGC3Jxi0jyH3ki1rXRjzk7U0vh3po7m
4mPfBs7gdjoUSeHlxwdlyhEY2t

~200 bytes

M1YOUNG/DANIEL EEMVK6CCLGWBCNEZY8571
254F5A 500 10A1385798218

~70 bytes

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Ticketing : the disruptive concepts

Edouard Carpentier de Changy (THALES)

Nicolas Generali (SNCF)

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Ticketing challenges

- Major enabler of multi modal transportation.
- Yield the best possible transport solution to the traveller
- Integrate specificities of each ticketing systems

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Ticketing interoperability drawbacks

- Ticketing equipment : standardization, certification.
- Infrastructure : adaptation or unification
- The higher the scale, the higher the cost

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IT2Rail ticketing challenges

- Keep legacy equipment
- Keep existing infrastructure.
- Scale horizontally
- Near zero cost of acquisition for small operators

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IT2Rail ticketing solution

- Entitlement
  - Decouple user's "contract" from the "ticket"
- Token
  - Decouple user's "travelling means" from the Entitlement
- Embodiment
  - Generate a physical version of the Token

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IT2Rail concept: Entitlement

- Representation of the contract
- Right & duties of the traveller
- List the fare products
- Provides all information on every operation related to the “contract”

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IT2Rail concept: Token

- Translation of the Entitlement in the existing infrastructure
- Token payload is specific to each operator
- Meta-data is interoperable through systems

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IT2Rail concept: Embodiment

- Physical object that supports the Token
- Contactless Card, Magnetic ticket, QRCode, NFC mobile-ticket

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IT2Rail disruptive concepts: Conclusion

- Allow existing systems to remain fully functional
- Scale horizontally and allows small actors to participate
- IT2Rail adoption is driven by market forces only

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THE NFC ENGINE PROPOSED BY SNCF FOR IT2RAIL:
NFC BOX

What is NFC BOX? The SNCF NFC BOX is a system composed by a ticketing engine and a mobile API that will allows the generation and storage of NFC dematerialized tickets in Secure elements based on the Calypso Standard.

To do this, it offers a level of abstraction that makes it easy to implement

The release proposed for IT2RAIl POC will generateFrench regional train ticket based on international interoperable Calypso Application Triangle 2 and the the Mobile API will be integrated in the IT2RAIL SNCF tapping module that is already planned.
But NFC BOX is destined to decline all type of Calypso ticketing applications: Triangle 2, Navigo, Mobib, Lisboa app...

The goal in the future is to adress any types of secure element in smartphones:

This system will be able to store NFC token in the SIM cards of any french Mobile operator, and could also ready to connect in the future with other european Mobile operators but also the NFC embedded secure elements of all Samsung and Apple devices in the world

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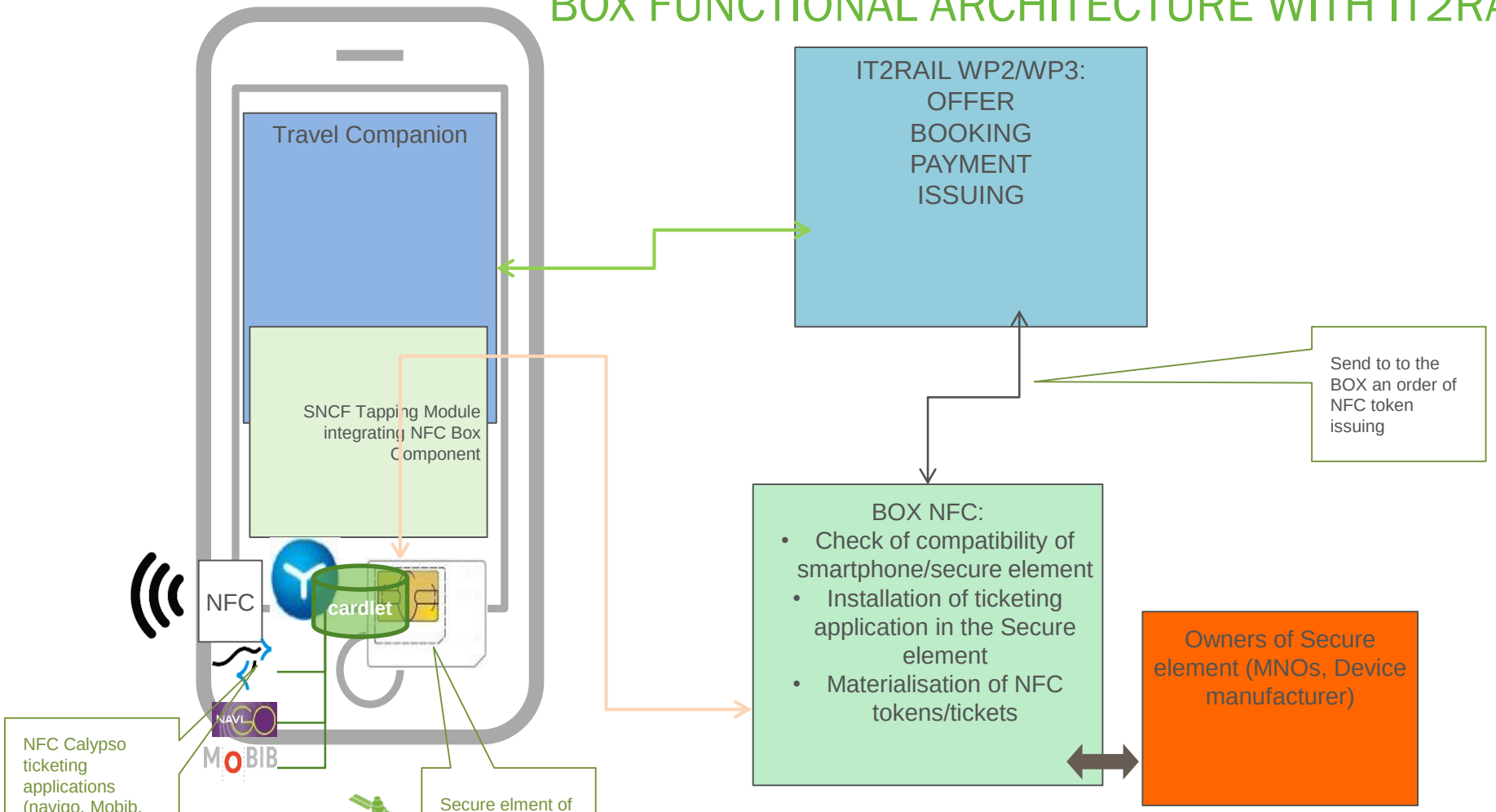
BOX FUNCTIONAL ARCHITECTURE WITH IT2RAIL



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Meeting the Interoperability Challenge

Riccardo Santoro (Trenitalia)

Alessio Carenini (CEFRIEL)

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WP1 Components

- Ontology Repository
- Semantic Web Service Registry
- Data/Service descriptor annotator
- Automated Data/Service discovery
- Automated Data mappings

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WP1 functional deliverables

- Locations Resolver (C-REL)
- Travel Expert Resolver (C-REL)
- Location Identification (C-REL)
- Travel Expert Broker (A-REL)
- Events Source Resolver (A-REL)
- Booking Orchestration Resolver (F-REL)
- Payment Processor Resolver (F-REL)

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Interoperability Framework in practice

- We represent domain knowledge formally with axioms expressed in a variation of the Description Logic language SHIF(D), expressed in the machine-readable language OWL-DL, augmented with logical expressions in the SWRL Language.
- Such representation is the shared IT2Rail *Ontology,* stored in the Interoperability Framework's Ontology Repository, used to validate the consistency of the domain knowledge and automatically compute inferences using 'reasoner' software that processes the axioms

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Formalization of the domain

- Concepts:
  - **Train – Wagon – Seat – RailRoute - Passenger**
- Quantifiers
  - some, only
- Properties (relations between concepts):
  - **A Passenger physically-occupies some Seat**
  - **A Wagon has Seats**
  - **A Train has Wagon**
  - **A Train operates-on only RailRoute**
- Axioms (“true” statements of the domain):

***If p* is a Passenger , *p* physically-occupies Seat *x and p* physically-occupies Seat *y*, then** $x \equiv y$

- Inference (added by *machine*-reasoning, i.e *theorem*)
  - «Passenger physically-occupies at most one Seat in a given Wagon of a given Train that operates-on a specific RailRoute»

All concepts, properties and axioms are formally defined in a mathematical language and referred to from existing message definitions by means of annotations

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POJO semantic annotations

- We can
  - Convert JSON or XML to POJO and vice-versa
  - Convert POJO to RDF triples and vice-versa
  - Create *new* POJOs from constructed/inferred triples
  - Therefore we can:
    - convert (almost) any syntax into any syntax
    - Store triples from data in (almost) any format / anywhere
    - Generate JSON and XML schemas from the ontology (stored as triples)

- The «common language» of interoperability is the *ontology* and is used in *annotations*

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POJO *new* semantic annotations

```
@Entity
@NamedGraph(type =NamedGraph.NamedGraphType.Static)
@Namespaces({"fares","http://www.it2rail.org/ontology/fares#",
             "it2rail","http://www.it2rail.org/ontology#"})
@RdfsClass("fares:Fare")
public class ParentEntity {

    @RdfProperty("it2rail:hasName")
    String fareName;

    @RdfContainingEntity(entity = CalculatedFare.class,
                         entityId = EntityId.AUTO_GENERATED,
                         relationPrefix ="it2rail:has")
    @RdfProperty("fares:hasFareAmount")
    float fareAmount;
}
```

Generated Triples
(persist)

<xxxxx> rdf:type <fares:Fare>
<xxxxx> it2rail:hasName «Name»^^xsd:String
<xxxxx> it2rail:hasCalculatedFare <yyyy>
<yyyy> fares:hasFareAmount 388.34^^xsd:float

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POJO *new* semantic annotations

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                         entityId = EntityId.AUTO_GENERATED,
                         relationPrefix ="it2rail:has")
    @RdfProperty("fares:hasFareAmount")
    float fareAmount;
}
```

Generated SPARQL **Query** (find)

```
CONSTRUCT {
        ?s it2rail:hasName ?name;
         fares:hasFareAmount ?amount
}
WHERE {
        ?s it2rail:hasName ?name;
            it2rail:hasCalculatedFare ?calcFare.
        ?calcFare fares:hasFareAmount ?amount
 FILTER(?s = <xxxx>)
}
```

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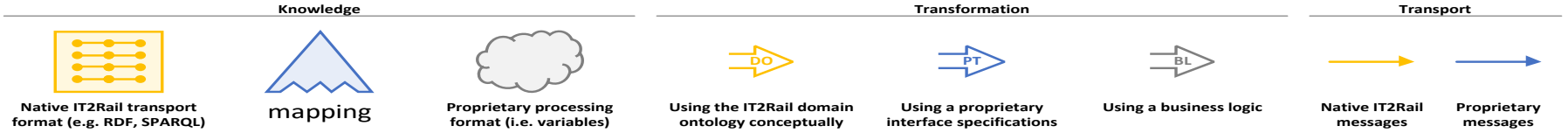
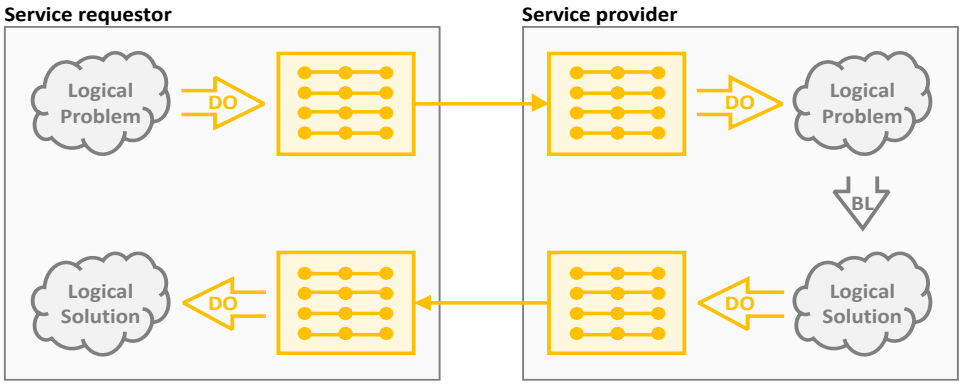
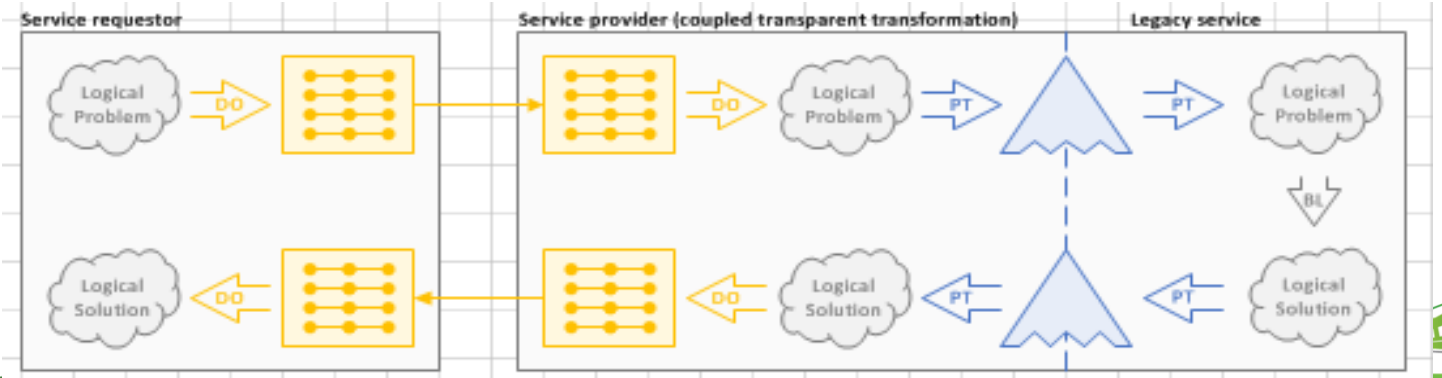
Deploy on your own architecture (some of many possibilities)





Peer-to-Peer native serialization of Native ontology XML/RDF, JSON, etc.



Peer-to-Peer with legacy service wrapped by semantic mapper deployed at provider side

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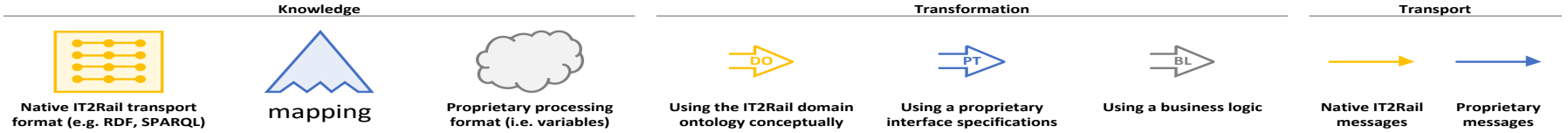
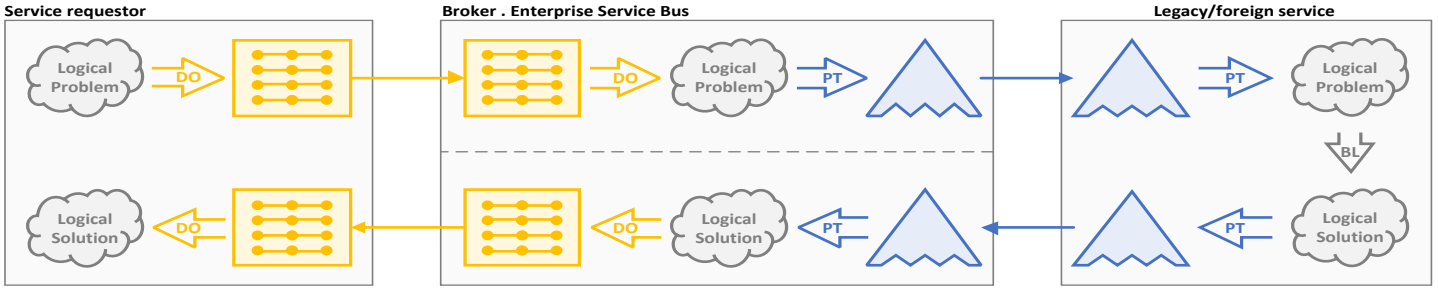
Deploy on your own architecture (some of many possibilities)





Enterprise service bus / broker scenario with semantic mappers deployed at broker and/or legacy service side

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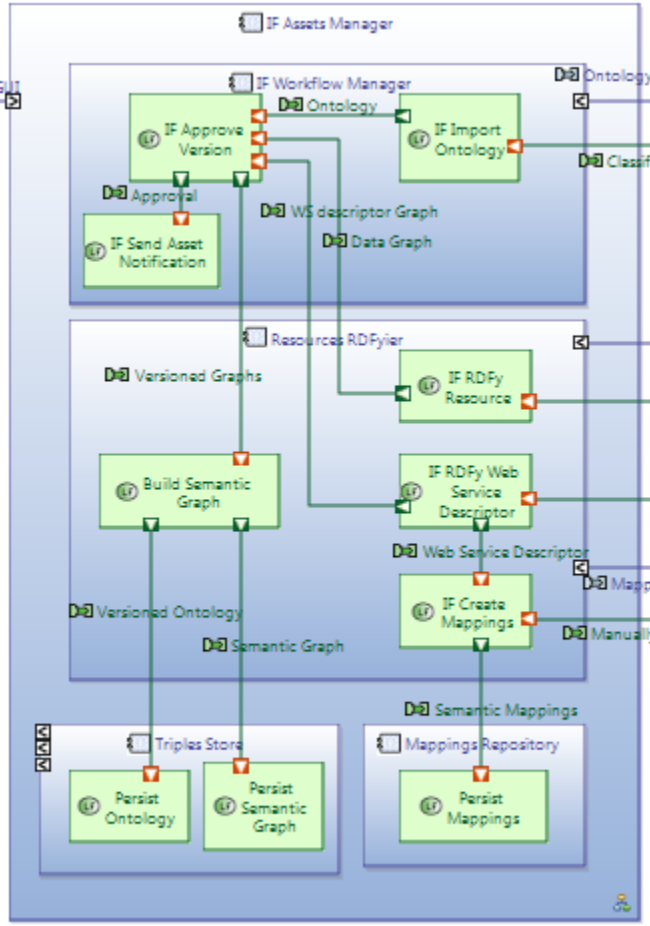
WP1 Assets Manager (ontology/service reg. repo)



Apache WSO2

Web Protegé

Empire/Pinto
RDF4J

GraphDB 7.x
Virtuoso 7.x

Wikidata
FactForge
VBB services
MERITS csv

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Asset Manager: Objectives

- Enable the **exchange of different asset types** (i.e., ontologies, data schemas, services) by means of a shared repository.
- Support the **cooperative editing process** of asset descriptions.
- Define and support the **lifecycle of an asset description** (i.e., reviews, versioning, approval, publication).

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Asset Manager: Main Features

Management Console

- A web application including a workflow process tool that supports the collaborative management of the published assets.

Publisher

- A web application through which owners/contributors make information about assets available to the community.

Store

- an structured web repository of digital assets accessible by any authorized actor.
- Ontology Repository and Semantic Web Service Registry are particular sections of the store containing ontology files and semantically annotated web service descriptions.

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Management Console

- Support the **definition of asset types** by using Configurable Governance Artifacts (RXT).

- Support the **definition of custom asset lifecycles** as finished state machines expressed using SCXML. Each lifecycle contains a set of states and the allowed transitions, plus additional constraints to be enforced while changing state and actions to be triggered upon successful state transition.

```
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IT2Rail

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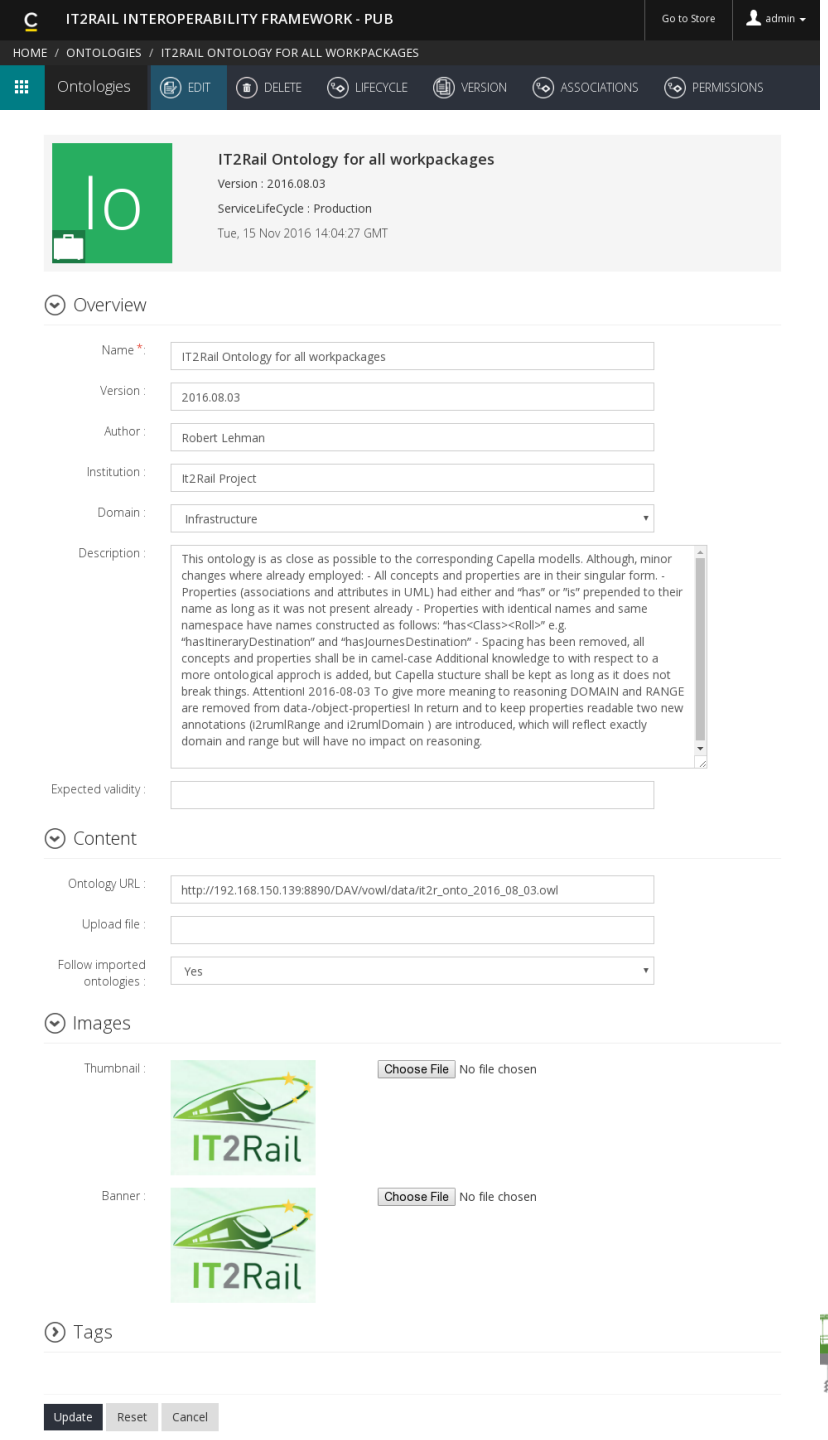

Publisher

- Once the asset type is defined, the Publisher web application allows authorized users to **add new assets** or to **modify existing ones**.

- The form-based interface for editing information about an asset is auto-generated from the asset type definition.

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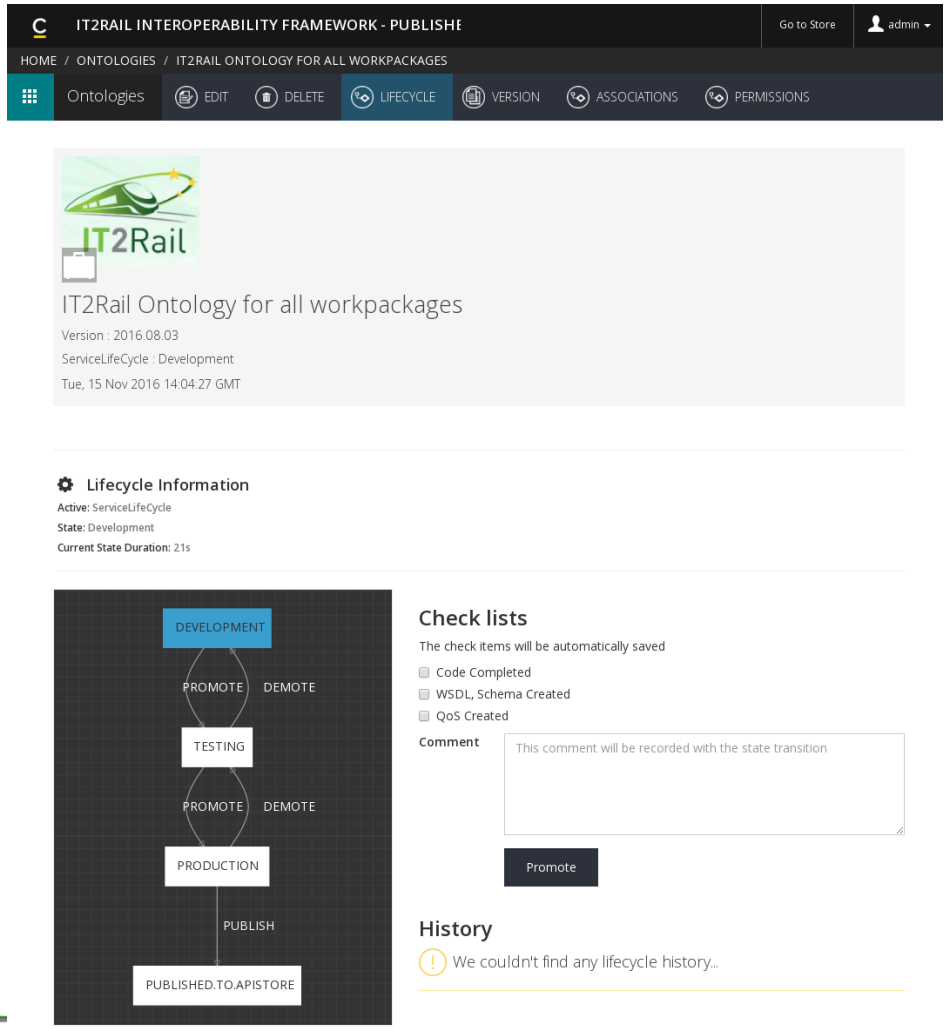
Publisher – Asset lifecycle

- The Publisher application allows the users to **modify the status of an asset**.

- Data coming from each asset is stored inside the database used by WSO2 as XML documents which are then converted into RDF and sent to the Triple Store upon successful publishing.



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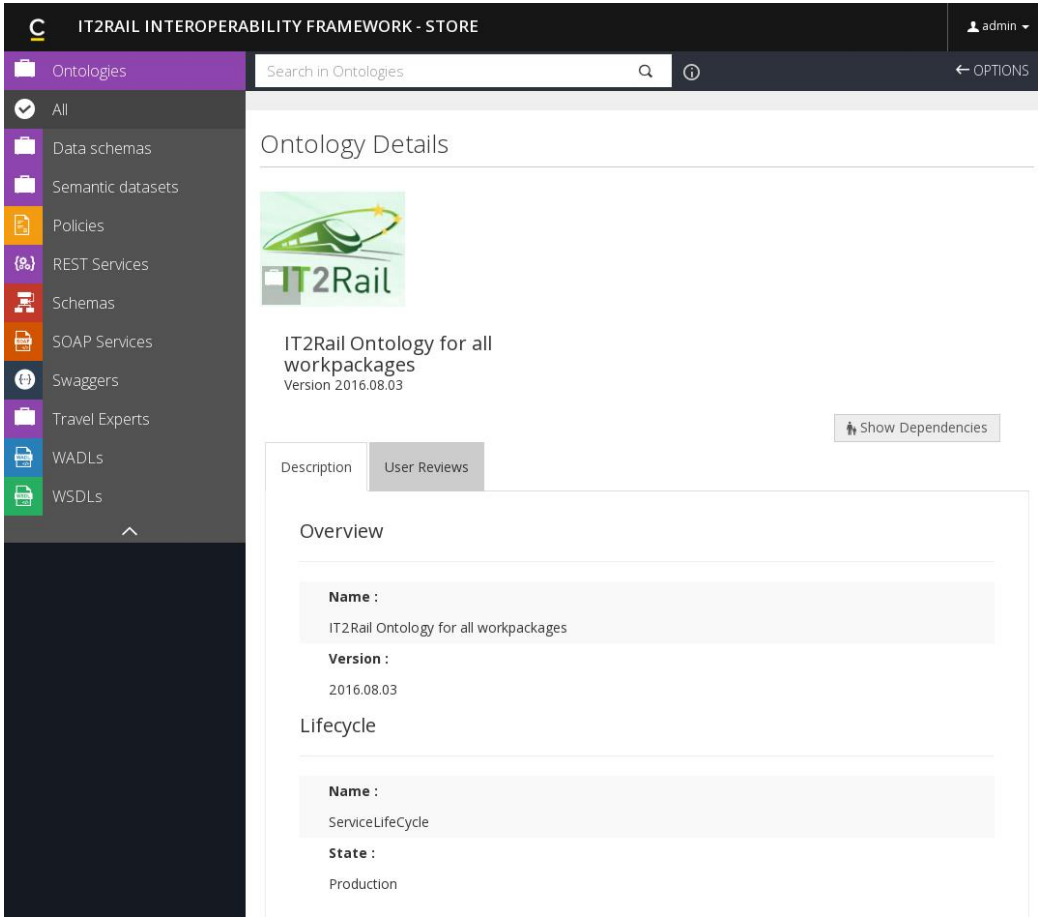
Store

- The store is the users' frontend for **accessing and searching existing assets** according to the defined authorization policy.

- The "User reviews" tab allows **inserting ratings and comments about assets**, therefore enabling the possibility of collecting hints to improve the content of the assets.



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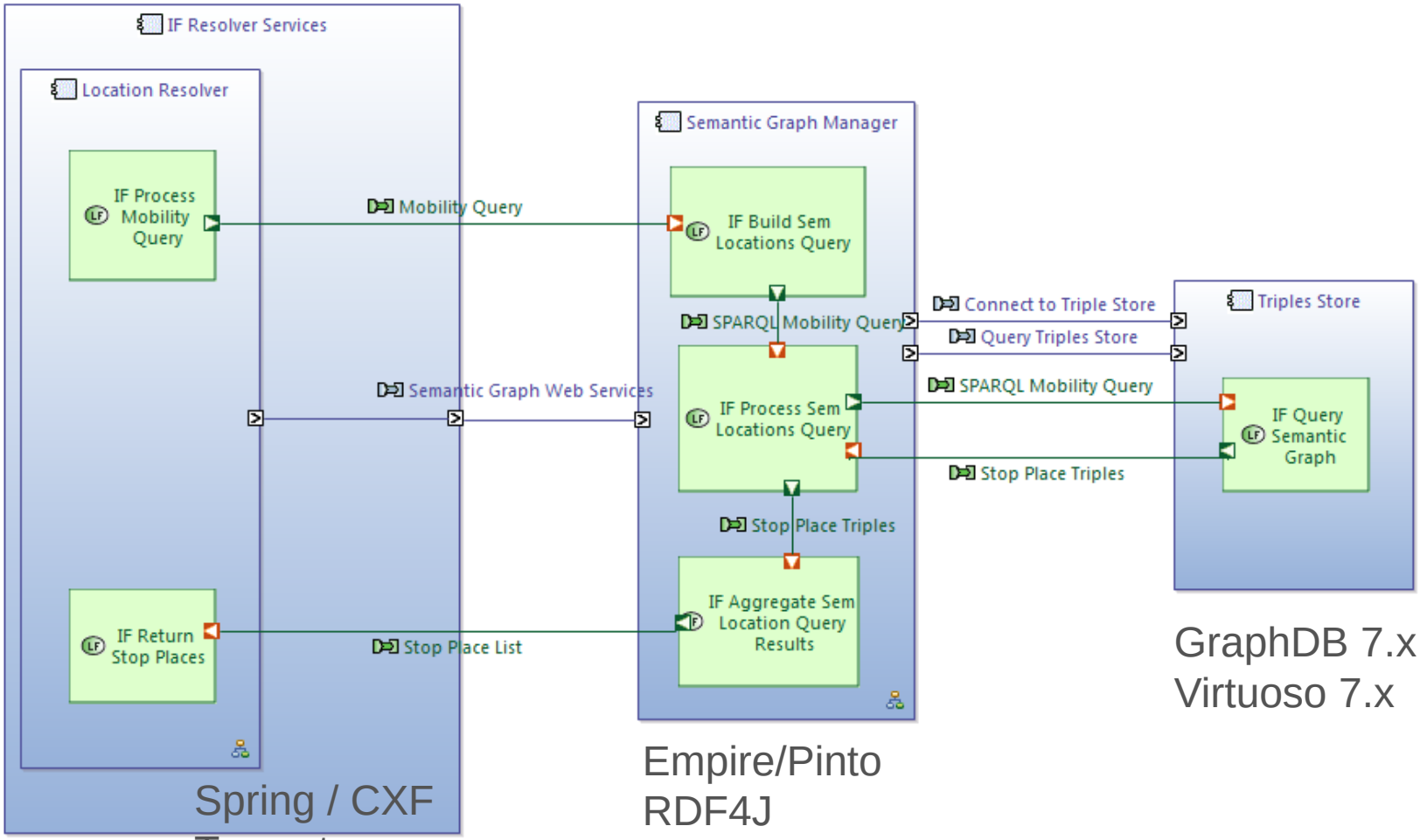
WP1 «generic» Resolver



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Triple Store

- Approximately 1.300.000 triples loaded from external sources (StopPlace, RouteLink, TravelExpert descriptors)
- Worked initially with Virtuoso open source 7.x
  - Buggy, especially for geospatial queries
  - Has «sponger» technology that could be used for data linking
- Switched to GraphDB free 7.x
  - Better integration with RDF4J framework
  - More features, including for inferencing
  - Much better «human» Workbench

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Semantic Web Registry

- Triple Store acting as Semantic Web Registry, e.g. triples describe Travel Expert service descriptors

SNCF

Source: http://it2rail.org/id/travelexpert/SNCF

subject | predicate | object | context | all | Explicit only

	subject	predicate	object
1	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasEndPoint	https://integration1.pao.vsct.fr/sales/searchSolutions
2	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasInputMessageMapper	http://192.168.150.139:8890/DAV/home/it2rail/PAO/offer_request.json
3	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasName	"PAO"^^xsd:string
4	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasOutputMessageMapper	http://192.168.150.139:8890/DAV/home/it2rail/PAO/offer_response.json
5	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasServiceCapabilities	"PAO Travel Expert Service"^^xsd:string
6	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasServiceCapabilities	"Requires authorization from SNCF, see documentation"^^xsd:string
7	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasServiceCapabilities	"Services SNCF network"^^xsd:string
8	http://it2rail.org/id/travelexpert/SNCF	it2rops:hasWebSite	http://en.voyages-sncf.com/en/
9	http://it2rail.org/id/travelexpert/SNCF	rdf:type	it2rops:TravelExpert
10	http://it2rail.org/id/travelexpert/SNCF	rdfs:seeAlso	http://192.168.150.139:8890/DAV/home/it2rail/PAO/PAO_MAU_PAO_GDS_V1-lt33_V0.2_extract.pdf

These hosted on Virtuoso Web Server

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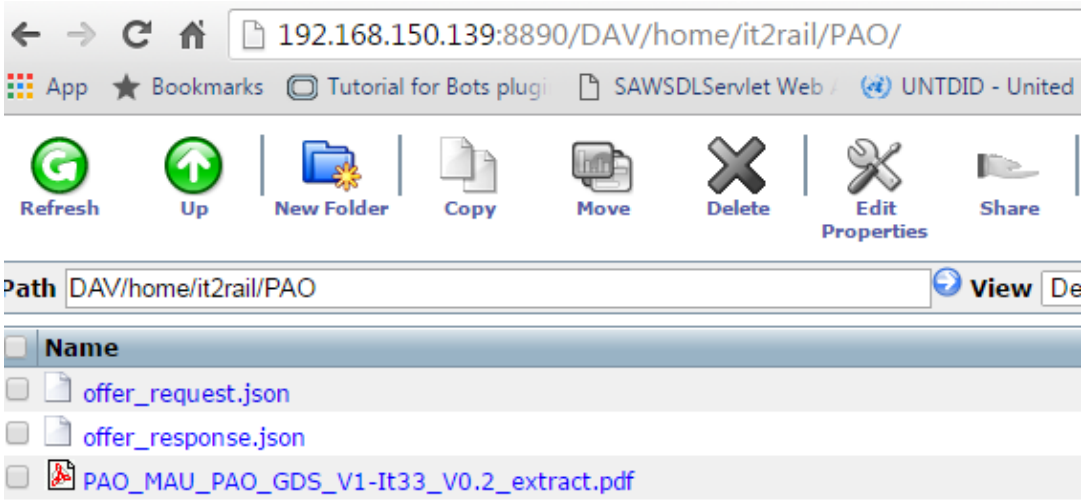
Virtuoso

- Still using Virtuoso as «auxiliary» web server to serve tools (e.g. ontology visualizer) and files (e.g. web service human documentation)
- Still investigating «sponger» technology



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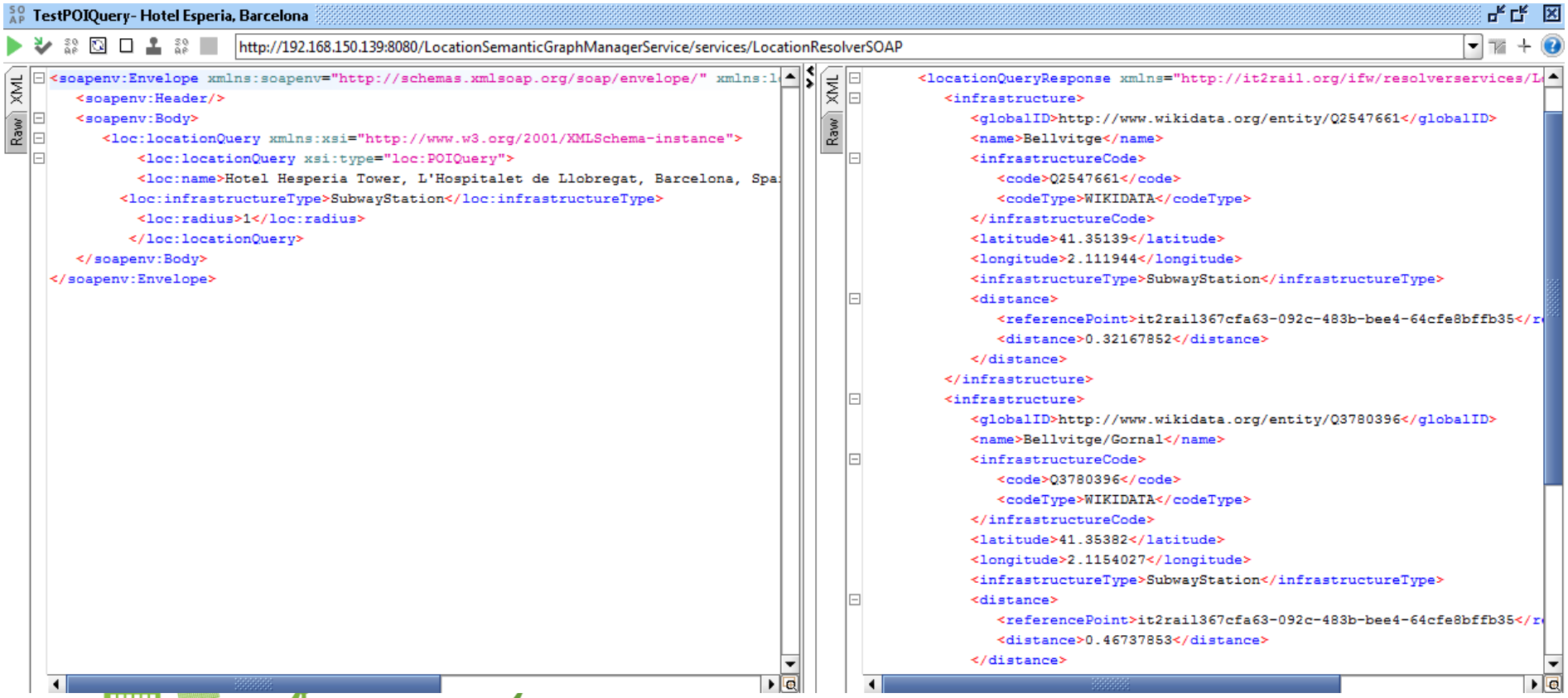
Location Resolver example



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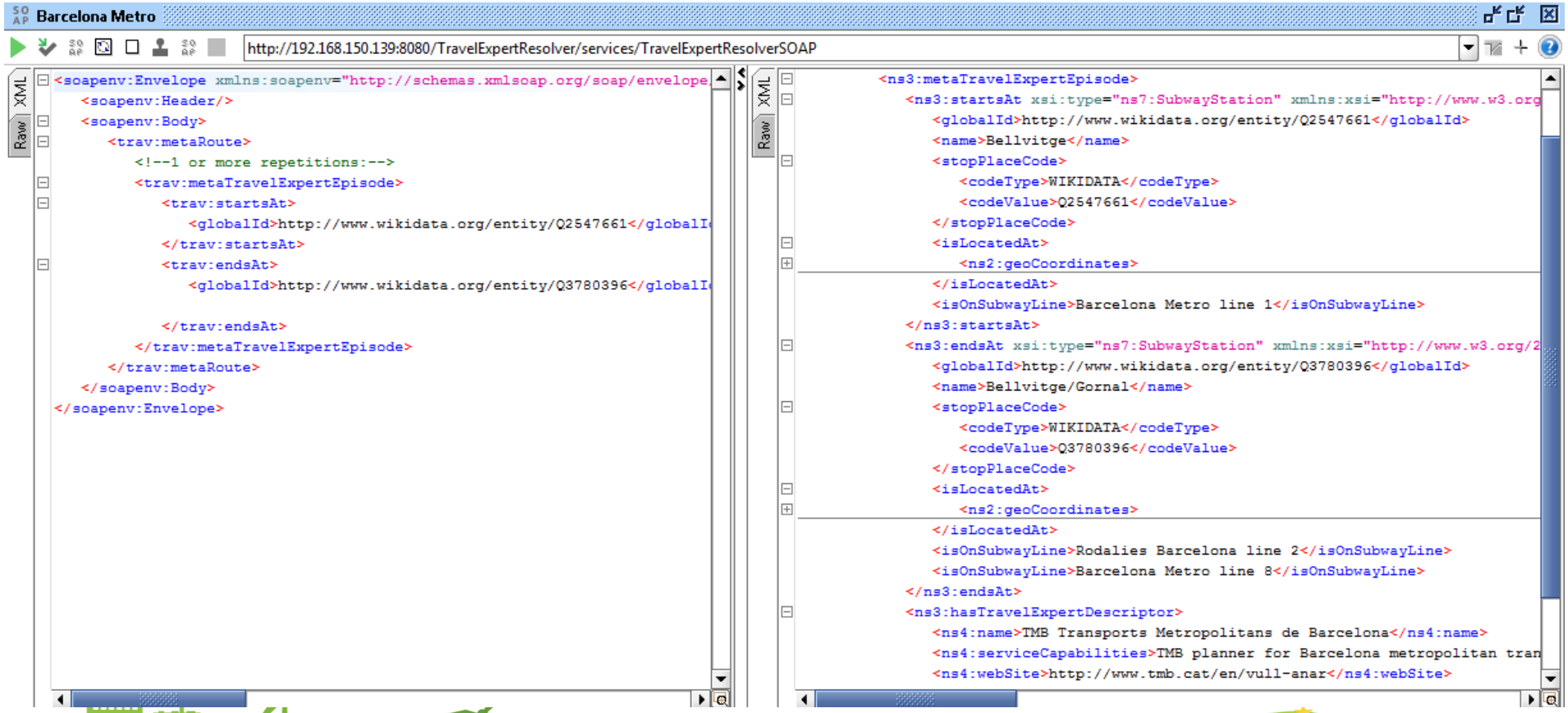
Travel Expert Resolver



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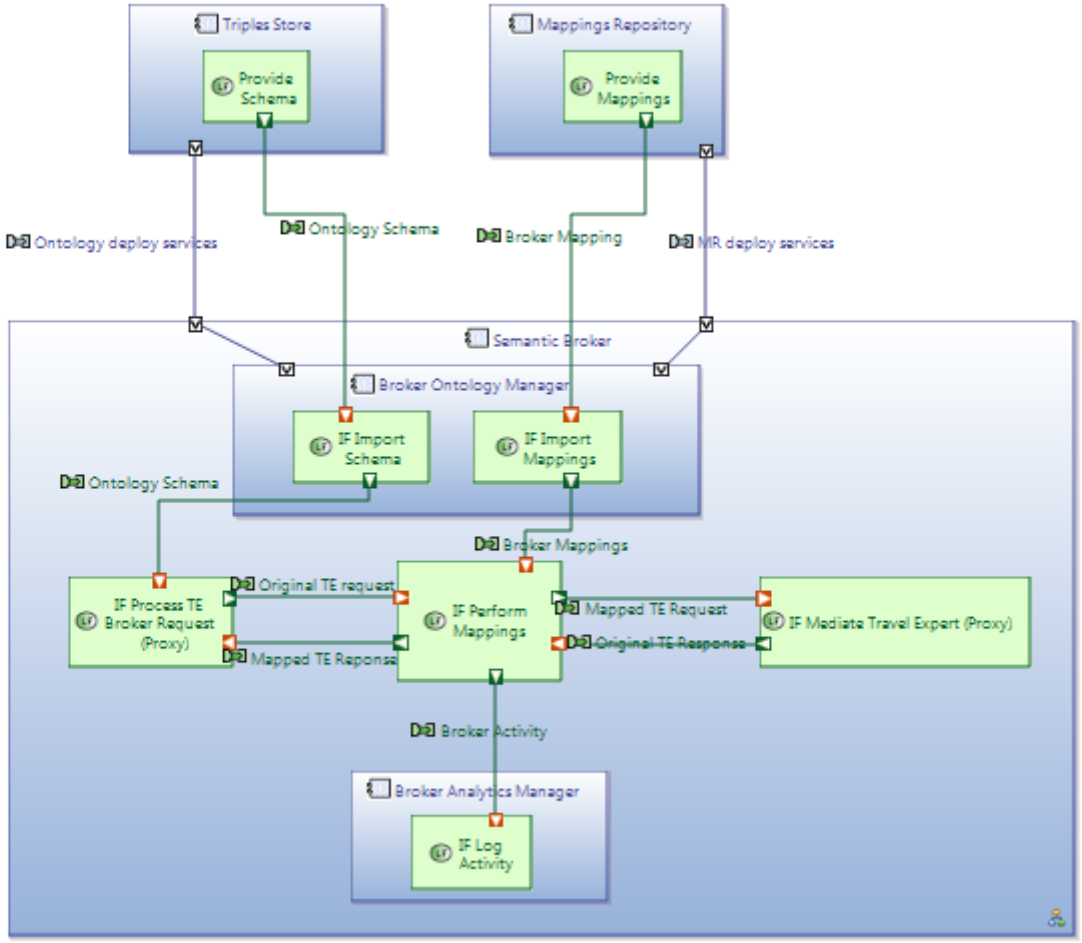
WP1 Semantic Broker (concept)



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FEEP IoT & Big Data Platform Sofia2

FEEP IoT & Big Data Platform Sofia2 is an interoperability platform that allows information exchange between different systems and devices. Thanks to its Big Data capabilities, it acts as a repository that allows advanced analytics, also in real time.

1. It acquires information in **real time** via the **senses** (sensors, machines, systems)
2. It **makes decisions** in real time based on the information received and prior knowledge
3. It stores all the information in its **short-term memory**
4. It consolidates relevant information acquired throughout the day in its **long-term memory**
5. It processes and relates the information in the two memories to learn and **act in a more intelligent manner next time**

Multi-device & Interoperable | **Integrated Security** | **Customizable & extensible** | **Holistic Viewer** | **Semantics**

Big Data | **Social Media** | **Predictive Analytics** | **Marketplace** | **Open Source & Commercial**

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Illustrative examples: Smart City of La Coruña

Project context / complexity

- **>20 projects** covering vertical services from different city areas: Mobility, Security, Environment, Water, Energy, Participation and Tourism.
- **Different player nature**: 3 Large Companies, 12 SMEs, 2 Research Centers, 2 Start-Ups, 1 University.
- **Open Data** services and **Cloud deployment**.

Project approach / technological solution

Sofia2 acts as the **brain of the city**, centralizing and storing information:

- **Real-time reactions** to events occurring in any domain/ location across the City
- **Data analytics over information of any domain**.
- Build a cross-domain and smart solutions where each vertical, instead of working independently, can take advantage of information from the rest of the solutions to provide a **better use of resources**

Project results

- The project has allowed **fostering innovation** across the whole city, creating new jobs, boosting the growth of the IT sector, **promoting new investments** and positioning the city as a **world-wide reference** in the Smart City domain
- Following are a few indicators quantifying the improvement in resource usage:
  - ✓ More efficient water management, optimizing its usage by 20%.
  - ✓ 25% water savings in park irrigation, by watering accordingly to weather and soil conditions.
  - ✓ 20% in energy saving in public buildings.
- Estimated impact of **10M€ savings per year**

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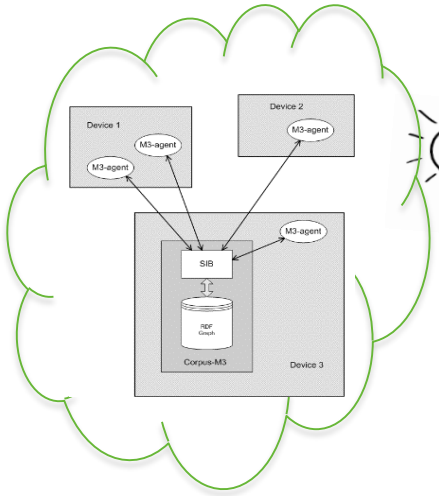
Sofia2 involvement in IT2Rail: WP1



Smart M3 Concept

Sofia 2

Interoperability Framework

Security

Adapt Protocols

Multiprotocol
(MQTT, WS, REST, WebSockets, JMS,…)

TRAVEL COMPANION

TRIP TRACKER

IT2RAIL APP N

IT2RAIL Legacy Systems

External systems

IT2Rail

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Sofia2 involvement in IT2Rail: WP6

WP2

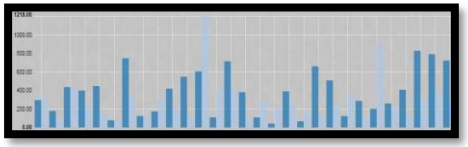
Data Flow from WP2

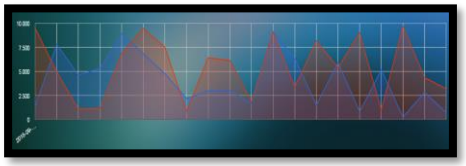
Sofia 2

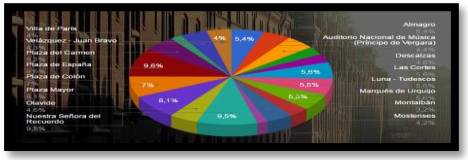
WP5

Data Flow from WP5

Key Performance Indicators production and visualization







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Big Question: should we use existing ontologies?

- Sounds reasonable (from an engineering p.o.v):
  - Helps with *linking*, including sem. annotated. web sites
  - Saves work
- But it may be *not* (from a logical formalization p.o.v)
  - An ontology is not just a set terms: it is a *theory*
  - Can we «inspect» it and conclude that *our* domain is a *model* of that particular theory?
  - This «inspection» is a lot of work
- Solution: *mappings* across ontologies

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Collaboration and System Modeling Challenges

Matteo Rossi

Politecnico di Milano

IT2Rail Mid-Term Conference 17/11/2016

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The Challenge(s)

- Project participants with different backgrounds
- Different views and perspectives on the IT2Rail system

$\Rightarrow$

- A shared understanding of the system is necessary

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The Key Ingredient

- Model-centric approach

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Capella key facts

- A modeler for Model-Driven Engineering (MDE)
- Domain-Specific Language (DSL) inspired by UML/SysML
  - with associated methodology Arcadia
- Open-source
  - Available from POLARSYS (an Eclipse Industry Working Group)
    - https://www.polarsys.org/capella
- Support available for partners

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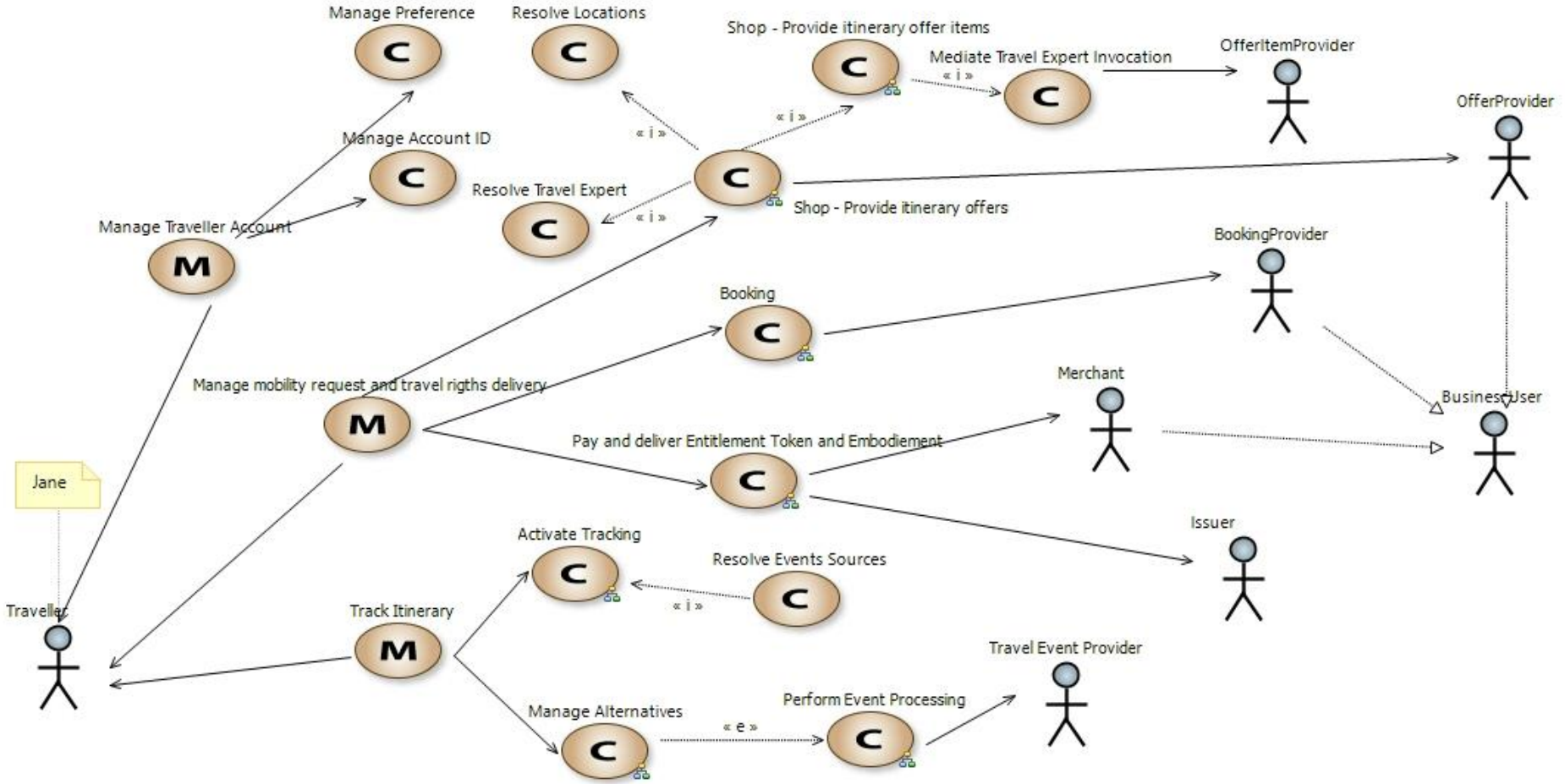
Capabilities (Use Cases)



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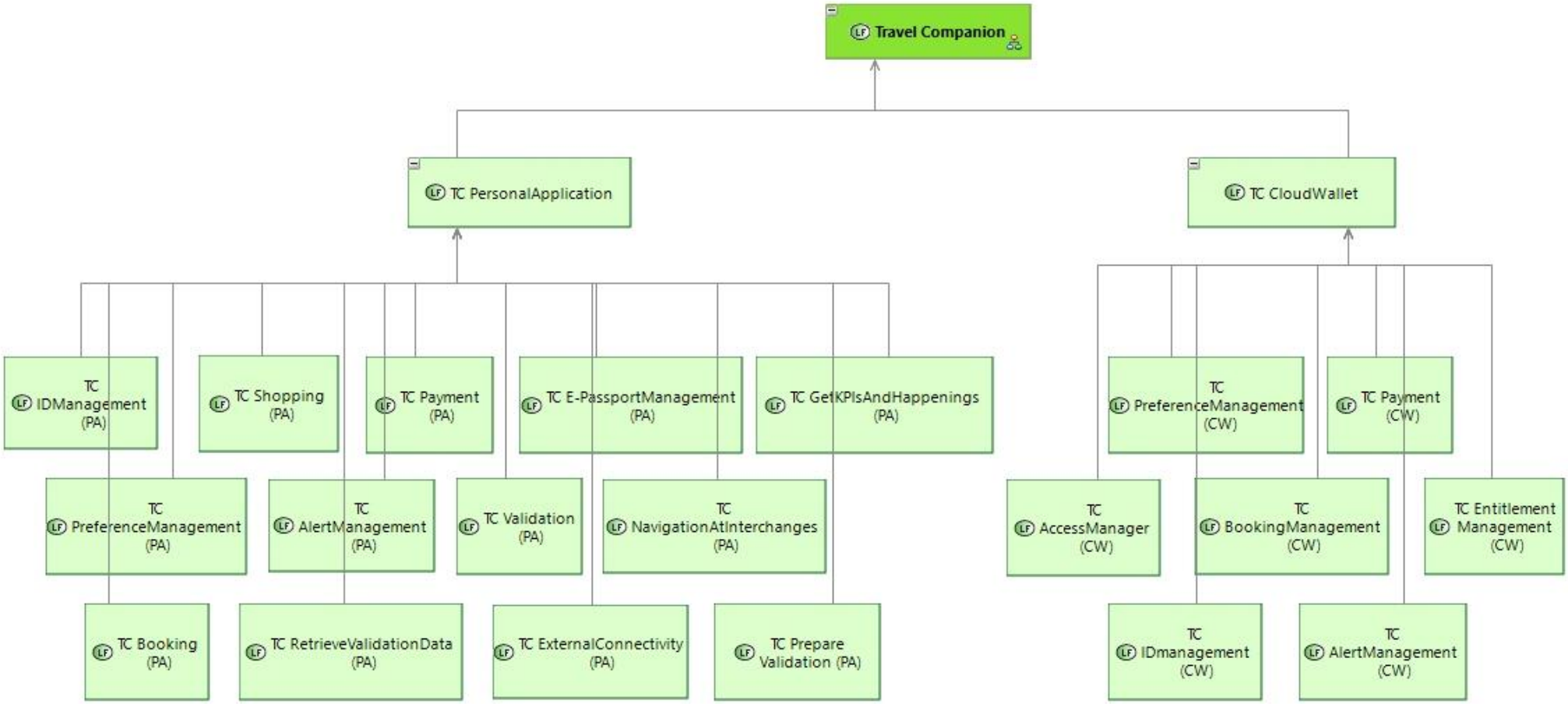
Functions



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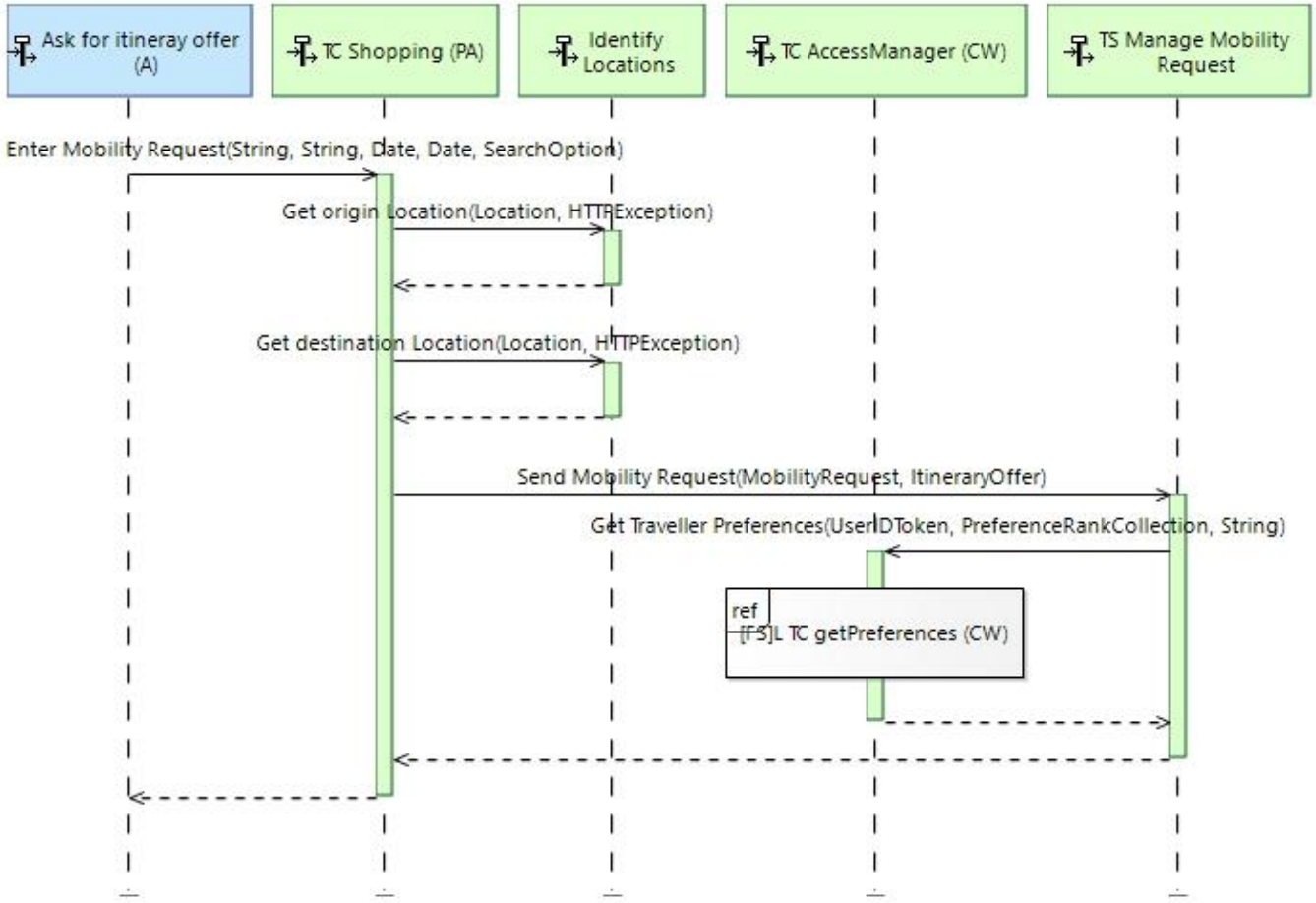
(Function) Scenarios



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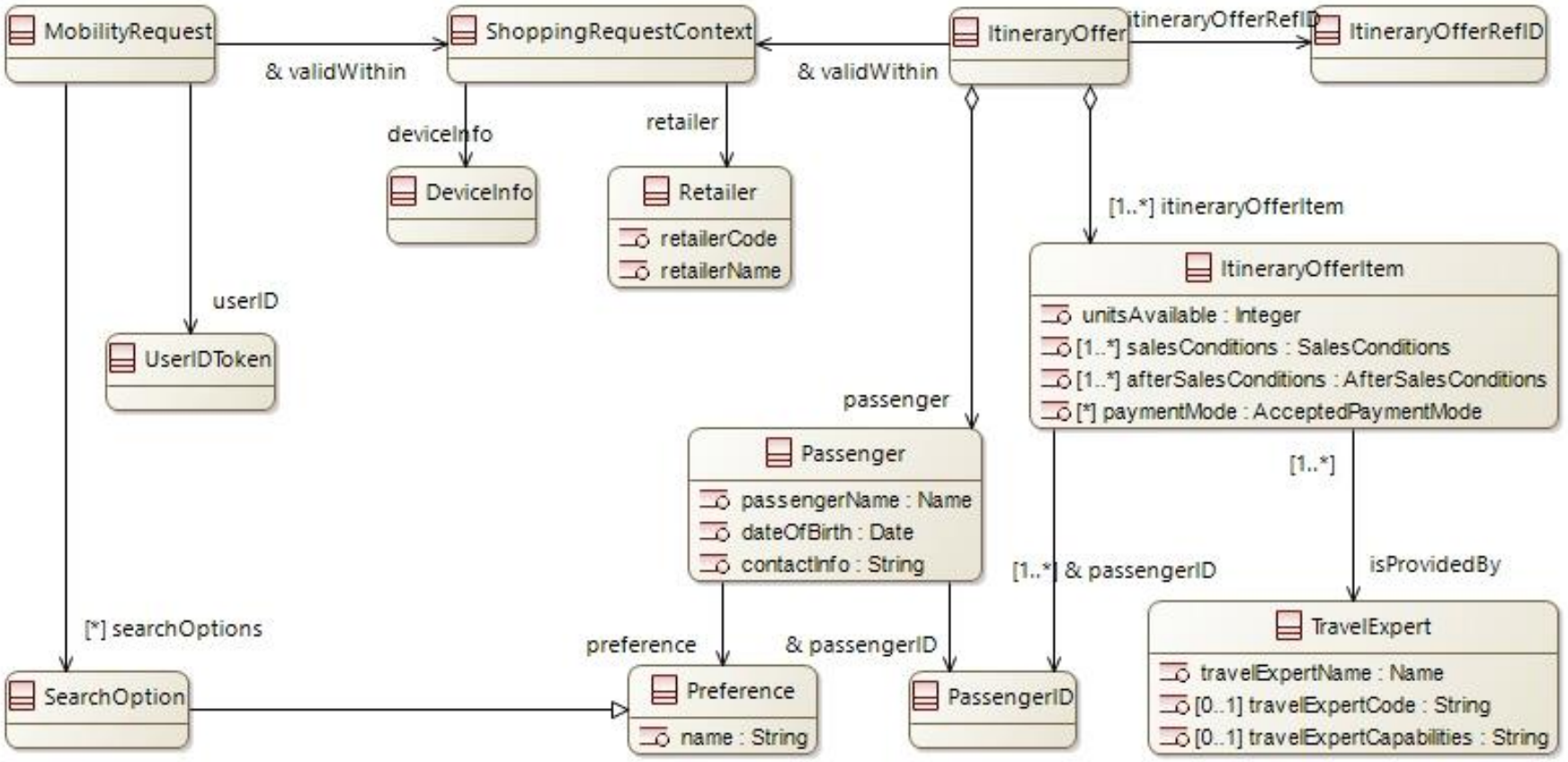
Data



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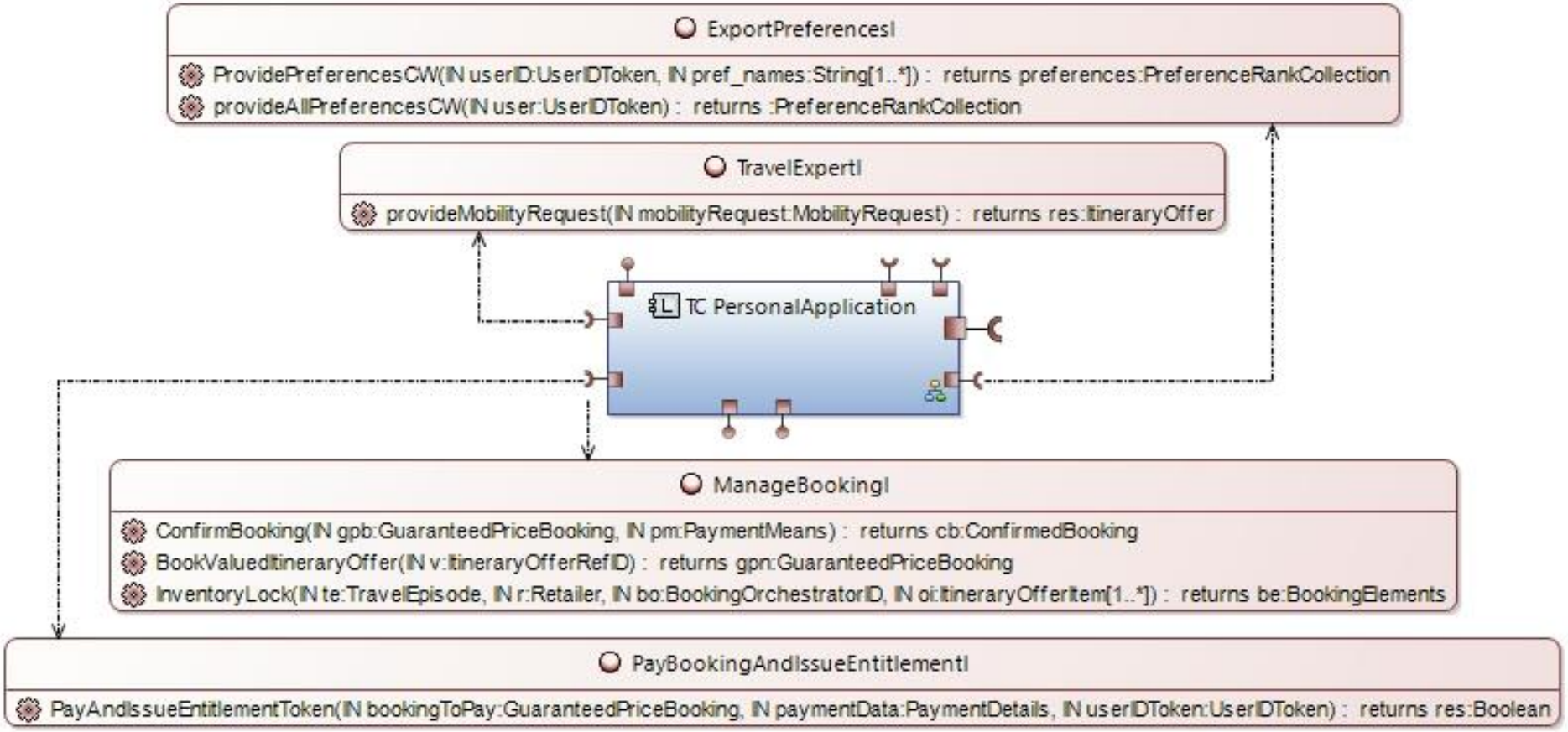
Operations and interfaces



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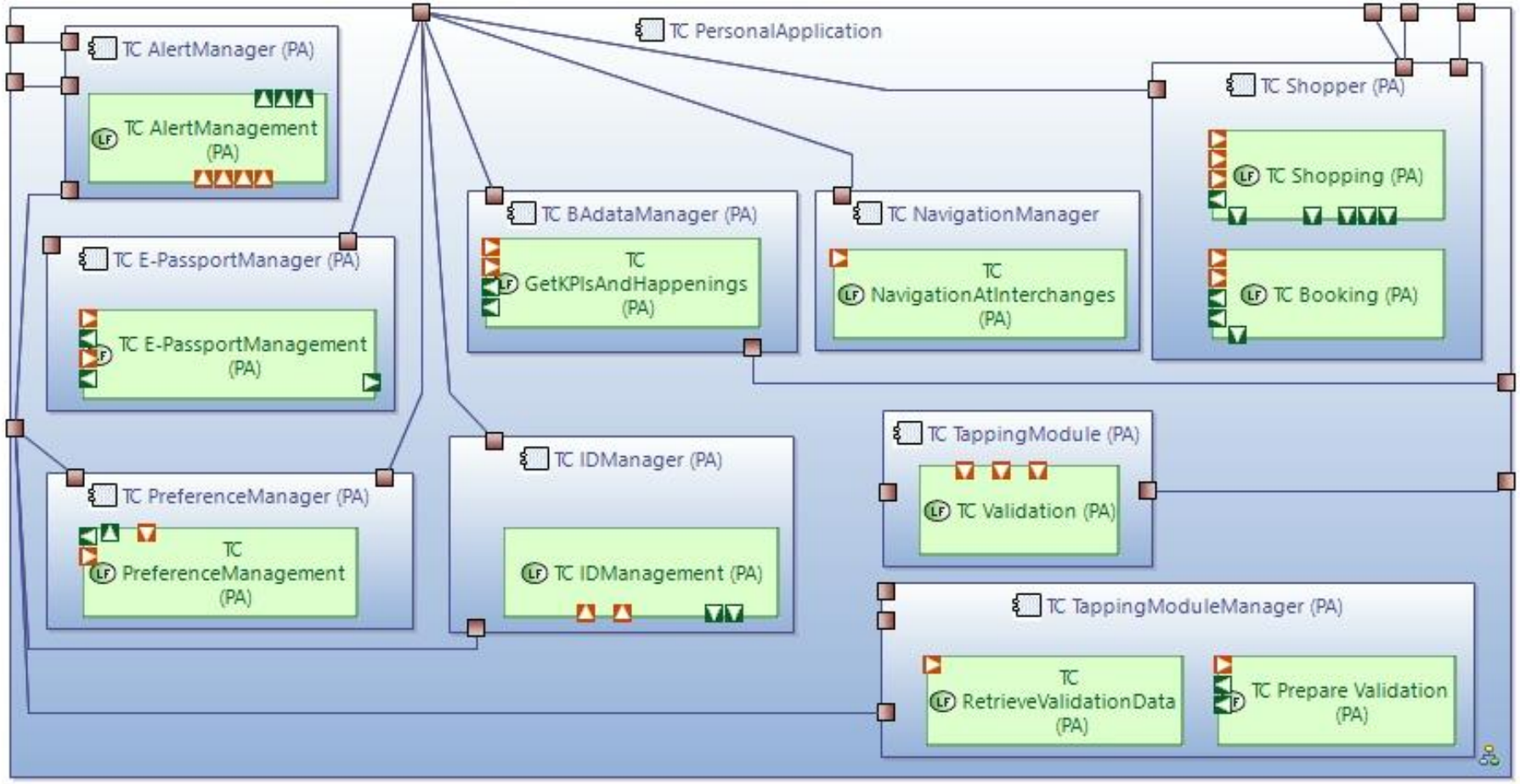
Modules



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Collaboration

- A unique, shared model
  - stored in an SVN repository for versioning and sharing
- Coordinated modifications to the model
  - Capella “merge” tool helps
- Mantis bug tracking tool for keeping track of issues and discussions

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Thank you for your kind attention!

IT2Rail Mid-Term Conference 17/11/2016

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IT2Rail

Digital

Multimodal

Ticketing

Tracking

Connectivity

Innovation

Open Interfaces

Web of Transportation

Shopping

Real time

Door to Door

Travel Companion

Seamless Travel

One-stop Shop

Business Analytics

Technical Enabler

Cloud

Re-accommodation

Attractive Railway Services

Interoperability

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