

# INFORMATION TECHNOLOGIES FOR SHIFT TO RAIL

## D6.2 – Business Analytics Specifications

Due date of deliverable: 31/10/2017

Actual submission date: 20/10/2017

Leader of this Deliverable: LEONARDO

Reviewed: Y

Document status		
Revision	Date	Description
1.0	15/04/2016	C-REL version
2.0	30/11/2016	A-REL version
2.1	31/05/2017	F-REL version
3	20/10/2017	Final version after TMT approval

Project funded from the European Union's Horizon 2020 research and innovation programme		
Dissemination Level		
PU	Public	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Start date of project: 01/05/2015

Duration: 36 months

## EXECUTIVE SUMMARY

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This document describes the specifications of the Business Analytics of the IT<sup>2</sup>RAIL platform.

It includes:

- Operational aspects
- Functional aspects
- Capabilities (sequence diagrams)
- Exchanges (data model and interfaces)
- Technical architecture

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IT<sup>2</sup>RAILs

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## 1. INTRODUCTION

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This document describes the specifications and requirements of the IT<sup>2</sup>RAIL Business Analytics.

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## 2. OPERATIONAL ASPECTS

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This chapter describes the operational aspects related to the IT<sup>2</sup>RAIL Business Analytics. The main goal is to enrich the IT<sup>2</sup>RAIL platform providing Travel & Transport Analytics. This IT<sup>2</sup>RAIL module combines data from various sources (internal and external) by correlating events, by transforming data into useful information and by computing a set of indicators in order to answer a set of analytical questions.

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### 2.1 PRINCIPLES

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The Interoperability Framework module along with the Business Analytics platform are the building blocks of the technical framework of the IT<sup>2</sup>RAIL platform. The Interoperability Framework guarantees technical interoperability of all multimodal services by insulating consumer applications from the task of locating, harmonising and understanding an open-ended world of data, events, and service resources, which are consequently made available 'as a service'.

The Business Analytics module allows the operators to adapt their transport environment and services with greater accuracy by listening to Travellers feedbacks, thus contributing to the ease and seamlessness of the Customer's travel experience. The Business Analytics Framework uses 'big data' technologies to access the 'web of transportation things' through the Interoperability framework module and to leverage the data published by the multimodal services to generate analytical insights, on demand tailored to multiple consumers.

## 2.2 SCOPE/PURPOSE

The Business Analytics module is focused on leveraging social, mobile, structured and unstructured data to obtain valuable, actionable insights that allow rail operators, product/service providers, Traveller/Transport Enterprises to make better decisions in order to increase quality of services and revenues, to better adapt their level of service to the passengers demand and to optimise their operations to bring and retain more people on the train-urban mobility.

More specifically the IT<sup>2</sup>RAIL Business Analytics aims to:

- measure Traveller experience indicators;
- monitor the performance of the transport systems or any part of them;
- identify trends, deviations or critical cases;
- inform Travellers on services feedbacks;
- suggest operative actions/changes to services.

The fundamental aspect of the Business Analytics is that it is expected to be very flexible, an IT<sup>2</sup>RAIL component that exposes a set of pre-defined indicators and reports by offering to transport and service operators the capability of defining and managing their own business analytics. A business user will be able to instruct the module to add, modify or delete both indicators (e.g. KPIs) and their related reports. Following this perspective, the main functionalities required to be offered by the Business Analytics module are the following ones:

- **Analysis:** users will be able to retrieve a number of different types of business analytics, to analyse transport service performances.
- **Reporting:** users will be able to visualise reports based on the business analytics.
- **Publication:** it will be possible to show reports to travellers.
- **Security:** all the operations will be performed only by authorised users.

The IT<sup>2</sup>RAIL Business Analytics includes components to detect statistic functions, such as patterns, correlations events being different services or transportation, blackheads, trends / demand service, users characterise, passenger flows, etc.

## 2.3 DESIGN DRIVERS

The IT<sup>2</sup>RAIL Business Analytics is envisaged to provide useful information to IT<sup>2</sup>RAIL users by exploiting data and information gathered by other work packages and data sources.

The following list describes the main principles that lead the design and the implementation of the IT<sup>2</sup>RAIL Business Analytics:

- **Data-driven approach:** this approach is based on analysing data shared by several systems, in particular for finding connections between the system state variables (input and output variables) without explicit knowledge of how the system status evolves. These methods represent large advances on conventional empirical modelling and include contributions from several fields such as Artificial Intelligence, Data Mining, Soft Computing, Business Intelligence and Machine Learning. Data-driven modelling is therefore focused on



such methods that can be used to determine the relationship between inputs and outputs using a training data set that is representative of the system behaviour. Once the model is trained, it can be tested using an independent data set to validate what the system learned during the previous stages.

- **Interoperability:** IT<sup>2</sup>RAIL modules are designed in order to build a self-consistent platform able to add ‘on-the-fly’ new components that enrich the abilities of the whole system. Designing a system with these features means to meet specific requirements in terms of interoperability, both syntactic and semantic. The former aims at allowing heterogeneous systems to communicate each other by exchanging information by means of specified data formats and communication protocols. The latter enables systems to automatically understand the information exchanged in terms of meaning in order to produce useful results for IT<sup>2</sup>RAIL users.
- **Open data:** modern systems have to be ready to include information collected not only from legacy systems but also from external data providers that may supply useful information in terms of open data. The latter refers to information that can be freely used, re-used and redistributed by anyone, subject only to the requirement to attribute and share alike. The IT<sup>2</sup>RAIL Business Analytics integrates information collected internally, within the IT<sup>2</sup>RAIL platform, and externally from systems that help to enrich computations carried out by this module.
- **Privacy:** the system must make every effort to store and process as little of personalised data as possible. Travellers’ data must be anonymised or pseudo-anonymised as early as possible in the workflow; the handling of any re-identifiable pieces of data must be justified by and balanced against the necessary functionality of the IT<sup>2</sup>RAIL Business Analytics. The processing of personal data will follow the key requirements of the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (“General Data Protection Regulation” or “GDPR”), including the availability to erase the personal data of a Traveller upon request.

## 2.4 ACTORS AND USE CASES

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### 2.4.1 Actors

This paragraph describes the main actors that use the IT<sup>2</sup>RAIL Business Analytics:

- **Traveller:** the generic IT<sup>2</sup>RAIL user who travels by using any transportation means. He/She uses his/her smart device in order to plan all activities for his/her travel.
- **Business User:** this user represents a generic employee who works for either a transport operator (operating local, national and European transport services) or a Service Provider (offering its ancillary services to traveller).

- **Data provider:** an organisation or a service that provides useful information regarding transport, travelling, ticketing.
- **Social network:** a platform that enables its users to share contents such as messages and photos that might contain important feedbacks on user experience or might help to report incidences on traveller' services.
- **Transport service operator:** an organisation that offers its facilities to IT<sup>2</sup>RAIL users. In the specific case of the Business Analytics module, this actor provides transport information that can be used for being analysed by the business users and travellers.

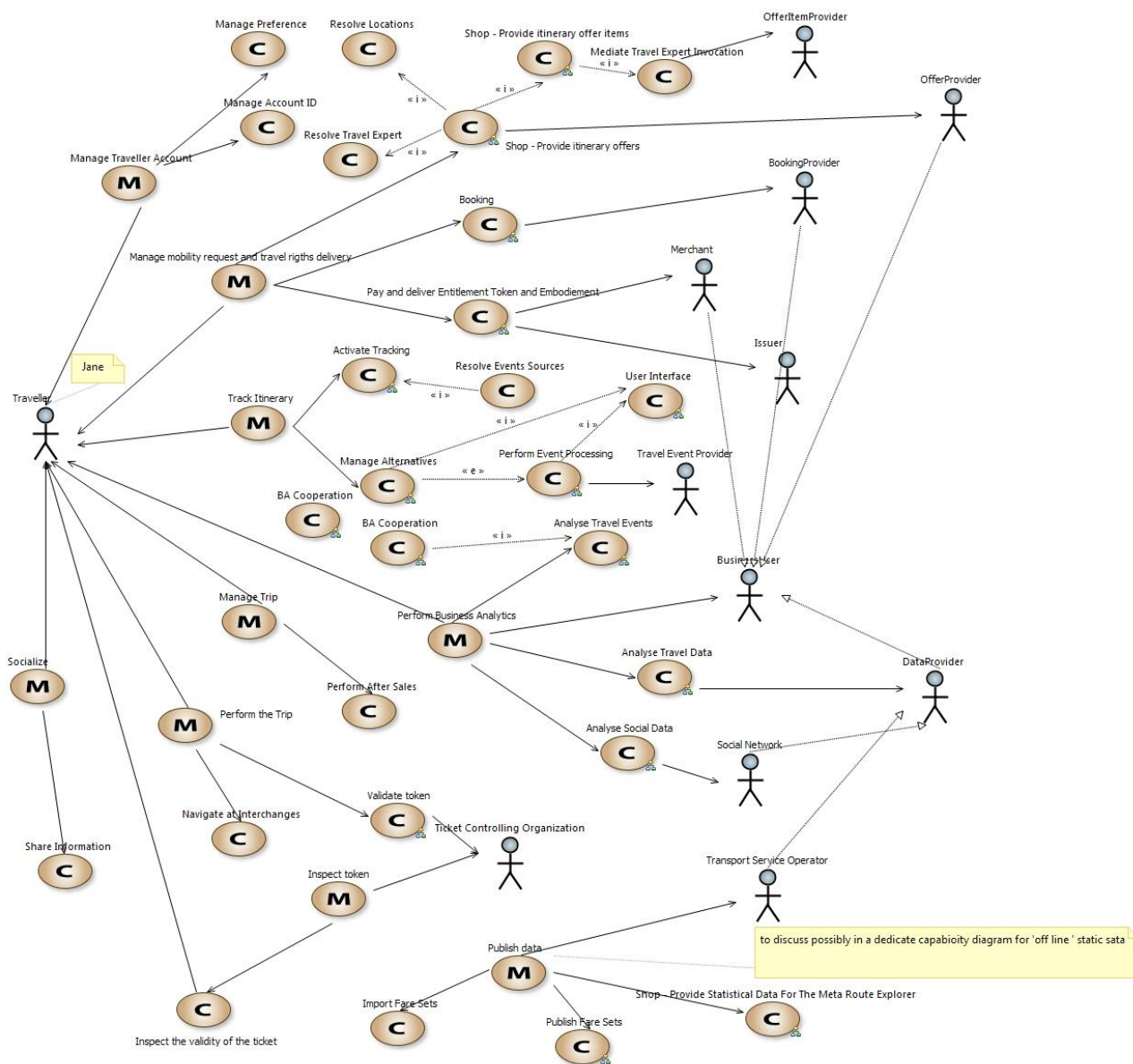


Figure 1: Actors and capabilities of IT<sup>2</sup>RAIL platform

These actors, together with their capabilities, are shown in *Error! Reference source not found.: Actors and capabilities of IT<sup>2</sup>RAIL platform* corresponding to **Model reference: “[MCB] Capabilities” diagram, SVN version 794.**

In addition to above actors, other IT<sup>2</sup>RAIL work packages are involved in the activities carried out by the Business Analytics module:

- **Interoperability Framework:** this module guarantees the technical interoperability of all multimodal services provided by the IT<sup>2</sup>RAIL platform. It provides all means and services descriptors for retrieving information such as events, master data (original TSP data) geographical locations needed by the Business Analytics to perform KPI computations.
- **Travel Companion:** this module represents the main component of the IT<sup>2</sup>RAIL platform as it allows travellers (passengers and customers) to plan their journey by choosing among a list of itineraries and offers. In the specific case of the Business Analytics, Travel Companion allows IT<sup>2</sup>RAIL users to visualise indexes and KPIs computed on travel and transport information as well as to provide feedbacks on their travel experience.
- **Travel Shopping:** this module manages and aggregates distributed travel shopping data and offers to the Business Analytics module relevant information regarding the results of mobility queries issued by the IT<sup>2</sup>RAIL users.
- **Trip Tracking:** this module tracks events such as disruptions and delays and sends information to the Business Analytics to compute statistics on messages and alternatives offered to the IT<sup>2</sup>RAIL users.

## 2.4.2 Context

The Business Analytics platform comes into play in various IT<sup>2</sup>RAIL use cases involving a growing number of actors, namely, Travellers, Business Users, Travel Data Providers and Social Network platforms.

Travellers will benefit from the Business Analytics functionalities regarding the computation of KPIs of interest tied to transportation systems that users are currently using or planning to use. Analysing, for example, the status of train delays at a train station can help the traveller adjust her/his current or planned itinerary.

The Traveller can also take advantage of Business Analytics functionalities for visualising weather information and knowing future happenings located in the current or foreseen travel stops.

Business Users, such as a transport provider, will make use of KPI computation capabilities in order to adjust their business goals and needs.

Travel Data Providers will interact with the WP6 module to ensure that all other actors will obtain correct and updated travel data.

The Business Analytics platform will also retrieve social network messages and feedbacks from the users who are travelling. This information will be used in order to infer useful knowledge for improving the quality of services and, more in general, the travel experience.

### 2.4.3 Use cases

The Business Analytics module is the data analytics provider of the IT<sup>2</sup>RAIL system and contributes to its activities with the following capabilities. The actors described in the previous paragraphs play a central role in the implementation of the following use cases shown in **Error! Reference source not found.** (an extract from **Error! Reference source not found.**):

- **Analyse Travel Data:** the Business Analytics module offers capabilities to Analyse travel data provided by both other work packages (e.g. Travel Companion, Travel Shopping, Booking and Ticketing, Interoperability Framework) and external data providers. Information and data collected by all these data sources are used to compute indicators and KPIs needed to show a general overview of the current transport and travel situation.
- **Analyse Travel Events:** the Business Analytics module offers the abilities to examine events that might affect the travel experience of the IT<sup>2</sup>RAIL users. In this regard, the Business Analytics receives events computed and generated by the IT<sup>2</sup>RAIL Trip Tracking and correlates them along with other information supplied by external and internal providers, such as Transport service operators and IT<sup>2</sup>RAIL work packages through the IF.
- **Analyse Social Data:** messages exchanged by social network users are important to people that use the IT<sup>2</sup>RAIL Business Analytics. On the basis of this information, business users can understand the quality of services experienced by travellers and address improvements on services offered by transport operators. Furthermore travellers can provide their feedbacks to the Business Analytics platform by means of the Travel Companion mobile app. The latter asks travellers to answer several questions included in Travel Questionnaires. Then, on the basis of this information, feedbacks and scores provided by travellers are turned into KPIs.

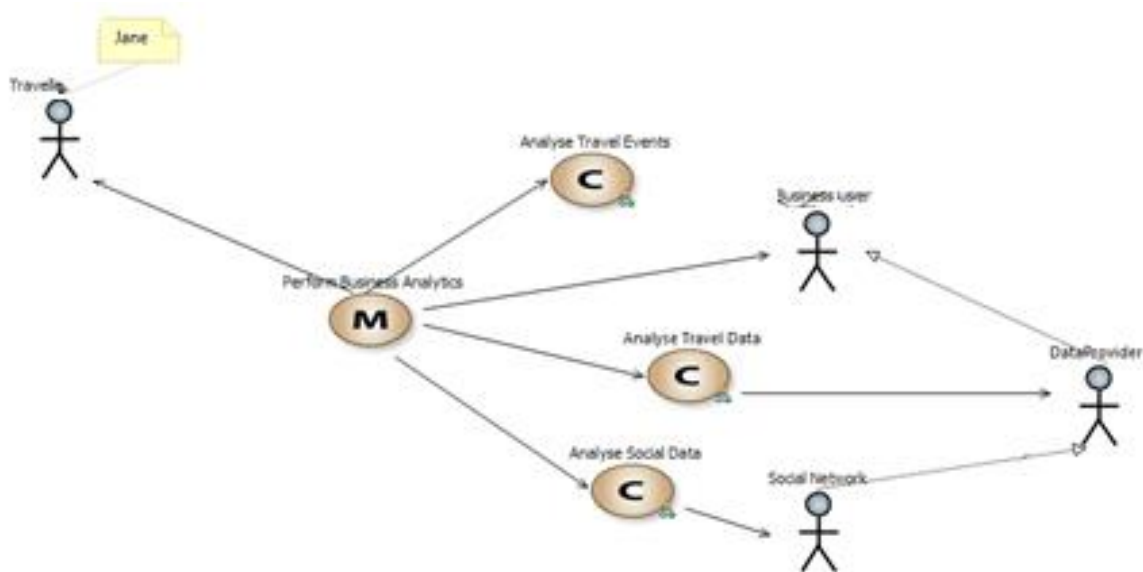


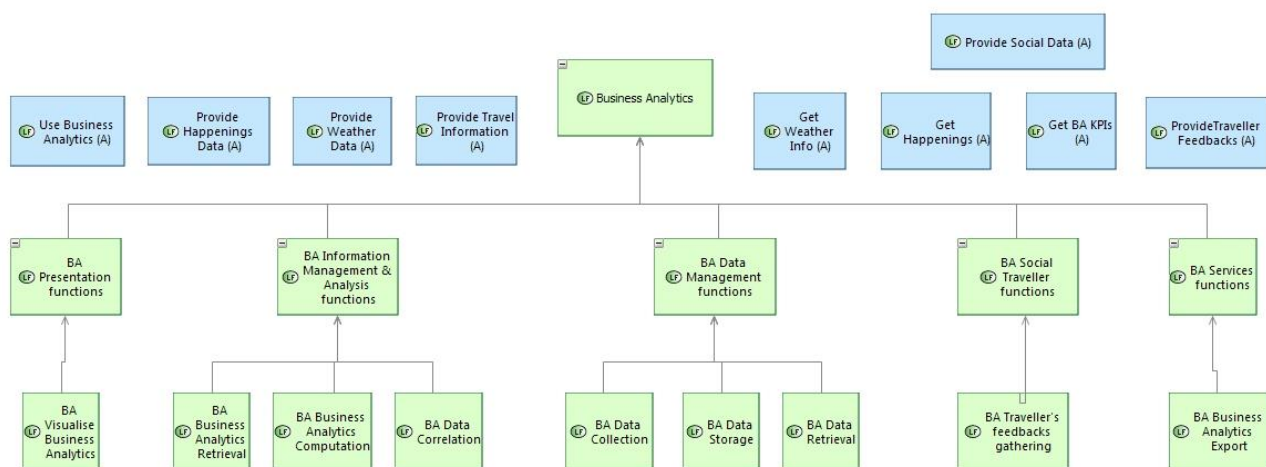
Figure 2: Business Analytics use cases

## 3. FUNCTIONAL ASPECTS

### 3.1 FUNCTIONS

The IT<sup>2</sup>RAIL Business Analytics is in charge of providing analytics and insights to both IT<sup>2</sup>RAIL users and other software applications by means of the following logical functions.

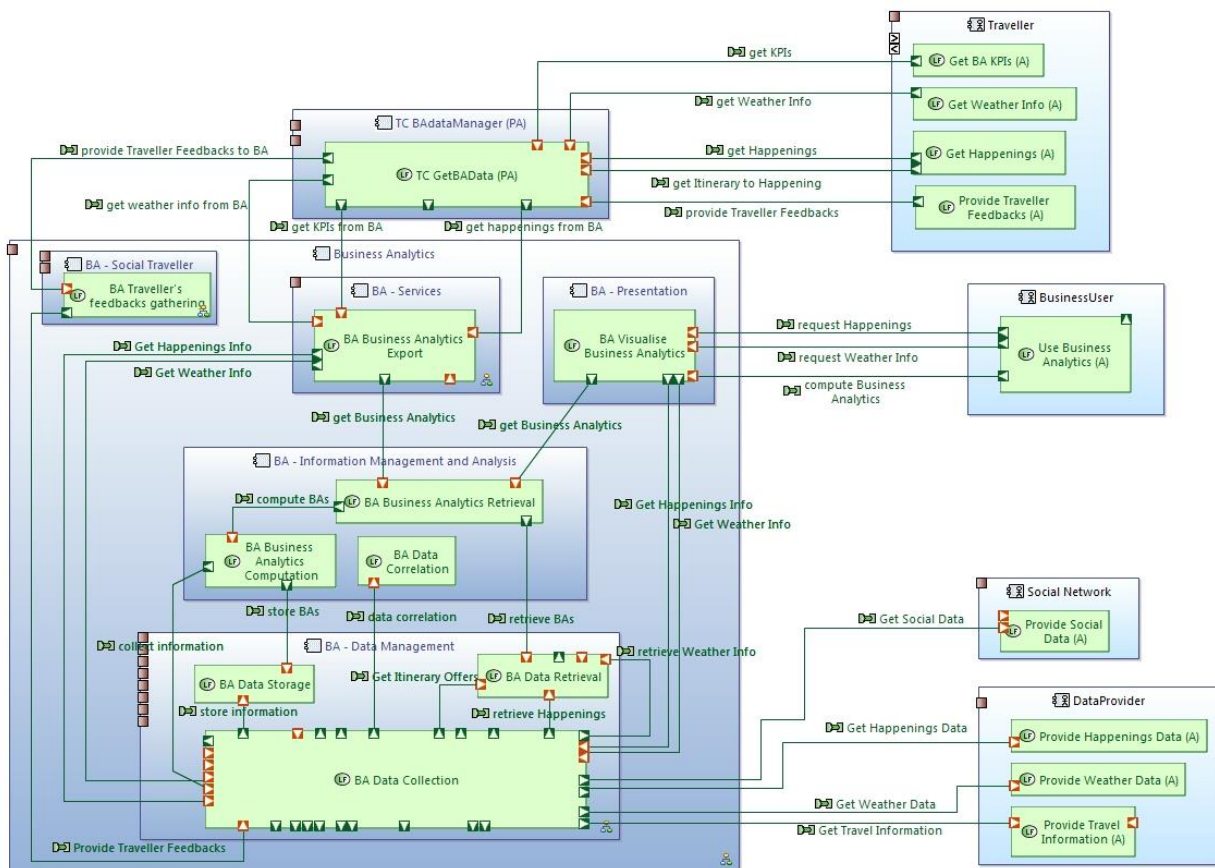
**Figure 3: Business Analytics functions breakdown** corresponding to *Model reference: “[LFD] Business Analytics functions breakdown” diagram, SVN version 794* shows the logical breakdown of the IT<sup>2</sup>RAIL Business Analytics.



**Figure 3: Business Analytics functions breakdown**



*Error! Reference source not found.: Business Analytics logical architecture and functions' allocation* corresponding to *Model reference: "[LAB] BA - Logical Architecture Blank" diagram, SVN version 794* shows instead the allocation of functions to main components of Business Analytics and to the actors interacting with them.



**Figure 4: Business Analytics logical architecture and functions' allocation**

Inspecting the *Error! Reference source not found.* diagram, it is easy to see that all functions can be grouped in five macro functions describing the functionalities offered by the IT<sup>2</sup>RAIL Business Analytics.

- **BA Presentation functions:** this group of logical functions is responsible for displaying indicators computed by Business Analytics platform to the IT<sup>2</sup>RAIL users.
  - **BA Visualise Business Analytics:** Information may be shown in different ways (charts, tables, dashboards) and with a particular granularity (daily, weekly, monthly), also based on the roles of the users themselves. This Presentation function provides results into two different modes:

- The *Transport Intelligence* delivers to transport operators indicators derived from both IT<sup>2</sup>RAIL internal (e.g.: transportation, travel events) and external data (e.g.: usage, customer experience and satisfaction).
  - The *Travel Intelligence* delivers to passengers indicators on travels (e.g. average duration, number of travel legs, travel green footprints) and social information related to specific journeys.
- **BA Information Management and Analysis:** this group of logical functions is in charge of the calculation of the Business Analytics based on the data collected by the BA Data Management logical functions. Basic indicators as well as aggregated ones may be included in the IT<sup>2</sup>RAIL analytics classes.
    - **BA Business Analytics Retrieval:** this logical function is in charge of retrieving the computed KPIs which are stored in the repositories.
    - **BA Business Analytics computation:** this logical function is in charge of computing the various indicators on the basis of information collected from several data sources. As already indicated, such data could be either “raw” data or pre-processed data.
    - **BA Data Correlation:** this logical function is in charge of correlating the raw data in order to calculate aggregated information that is used to compute specific KPIs.
  - **BA Data Management functions:** this group of logical functions is responsible for data gathering and conversion into Business Analytics platform internal format. A set of connectors will be defined in order to integrate and retrieve information from both internal (IT<sup>2</sup>RAIL modules) and external (e.g. Internet, social network platforms) data sources.
    - **BA Data Collection:** this logical function manages data collection. This function is provided by using communication solutions (e.g. web services) among the IT<sup>2</sup>RAIL platform components. For instance, when a Business Analytics calculation is needed, an invocation is made in order to retrieve data related to a specific time interval. This logical function allows to gather information (e.g. weather data, timetables, events, happenings, social data) that are required to compute analytics. Furthermore access to external information will be made by means of web service invocations, file transfer (e.g. CSV, JSON), querying to further repositories and third party APIs. Incoming semantic data may require additional processing with WP1 support.
    - **BA Data Storage:** this logical function aims at storing huge and variable (i.e. structured and unstructured) amount of data in specific databases. This storage is organised in repositories that retain different kinds of information. Profiled and authorised users will gain access to data according to their roles.
      - *Analytics Repository:* it stores indicators computed after an invocation to the Business Analytics module for an analytics calculation request.

- *Data Repository*: it stores the data needed for analytics calculation. These data are not expected to be accessed from other IT<sup>2</sup>RAIL modules, but may be used for historical purposes and statistical operations. Stored data could be arranged in:
  - *Travel Data*: data regarding travels (e.g. timetables, delays, prices) and passengers (e.g. travellers data, bought tickets).
  - *Social Data*: data regarding feedbacks from the users on social networks or via proper travel questionnaires.
  - *Other Data*: any other kind of data useful for Business Analytics calculation (e.g. weather, events, happenings)
- **BA Data Retrieval**: this logical function deals with the retrieval of information stored in the repositories and needed for the computation of the KPIs, indicators and indexes.
- **BA Social Traveller functions**: this group of logical functions is responsible of analysing travellers' feedbacks provided by means of questionnaires, specific blogs or websites related to the travellers' experience in order to detect particular situations related to travel and transport domains that IT<sup>2</sup>RAIL users are experiencing.
  - **BA Traveller's feedbacks gathering**: this logical function is in charge of collecting traveller's feedbacks:
    - directly, through questionnaires, to be filled in by the users and regarding their opinions on the multi-modal travel managed by one or more operators
    - indirectly, through social networks information analysis.
- **BA Services functions**: this group of logical functions deals with services exposed to external and internal software modules that offer several functions for benefiting from the IT<sup>2</sup>RAIL Business Analytics capabilities.
  - **BA Business Analytics export**: this logical function exports KPIs and indicators to the IT<sup>2</sup>RAIL modules by means of services exposed through the Interoperability Framework support.

### 3.2 FUNCTIONS OF INVOLVED ACTORS

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The actors involved in the Business Analytics capabilities are:

- Traveller
- Business user
- Data Provider
- Social Network
- Transport Service Operator.

Figure 3: Business Analytics functions breakdown



also shows the logical functions (the blue ones) linked to the actors involved in the three WP6 capabilities (Analyse Travel Data, Analyse Travel Events, Analyse Social Data), while **Error! Reference source not found.** depicts the functions used from each actor.

The following list contains a short description of the actors' functions:

- **Get Happenings Data:** this logical function belongs to the Traveller actor and gets useful information concerning “happenings” (sport and cultural, events, performances, exhibitions, etc) taking place in a specific city and time window.
- **Get Weather Info:** this logical function belongs to the Traveller actor and gets weather information (both current and forecast) for a specific city in a specific time window.
- **Provide Traveller Feedbacks:** this logical function belongs to the Traveller actor and sends answers of Travel Questionnaires by means of the Travel Companion mobile app.
- **Use Business Analytics:** this logical function belongs to the Business User and includes all activities related to the need of computing some indicators by means of the Business Analytics platform without using the Travel Companion mobile app.
- **Get BA KPIs:** this logical function includes all activities carried out when a Traveller wants to compute some business analytics by exploiting the capabilities offered by the Travel Companion mobile app.
- **Provide Travel Information:** this logical function belongs to the Data Provider actor and provides useful information concerning travel and transport domains to the Business Analytics platform.
- **Provide Happenings Data:** this logical function belongs to the Data Provider actor and provides useful information to the Business Analytics platform, concerning “happenings” (sport and cultural, events, performances, exhibitions, etc) taking place in a specific time window and cities.
- **Provide Weather Data:** this logical function belongs to the Data Provider actor and provides weather information (both current and forecast) to the Business Analytics platform related to a specific time window and cities.
- **Provide Social Data:** this logical function belongs to the Social Network actor that provides contents such as messages by means of its own services to the Business Analytics module.

## 4. DESIGN DECISIONS AND CONSTRAINTS

This chapter describes the main decisions related to the design of the Business Analytics component of the IT<sup>2</sup>RAIL Project.

As mentioned in Section 2.3 the Business Analytics platform is supposed to be able to communicate with many different actors by using heterogeneous device types (PC, smartphone, tablet, etc.).

All this implies that the Business Analytics platform has to be designed by following a data-driven and interoperability approach; moreover the platform has to be able to collect information from open data sources, legacy systems and so on. Following these needs and requirements, a distributed service-oriented architecture is the most natural choice to meet these objectives.

There are two distinct approaches to Web Services:

- the first one, based on SOAP (Simple Object Access Protocol) offers the following advantages:
  - independence from programming languages, platforms, and transport protocols;
  - good performances in distributed environments;
  - standardisation, even with regard to authentication and addressing;
  - error handling is built-in.
- the other one, based on the REST principles, offers the following advantages:
  - easier to implement and maintain;
  - optimised for the HTTP protocol;
  - direct point-to-point communication.

Depending on the specific needs of each module of the Business Analytics component, one or the other approach will be used during the development and deployment.

## 5. CAPABILITIES: SEQUENCE DIAGRAMS

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This chapter contains UML sequence diagrams for each capability in which the Business Analytics module is involved. Following the design methodology used in IT<sup>2</sup>RAIL, the next step after the description of the capabilities is to define the functional scenarios at system level and then at logical level.

The following paragraphs describe the functional scenarios (UML sequence diagrams) at logical level of the three WP6 capabilities:

- Analyse Travel Data;
- Analyse Travel Events;
- Analyse Social Data.

For each of these capabilities there are two functional scenarios related to:

- Usage of the IT<sup>2</sup>RAIL Business Analytics by a Business User: these sequence diagrams describe the interactions of the IT<sup>2</sup>RAIL Business Users (such as an employee who works for a transport operator) by means of the Presentation logical functions of the Business Analytics.
- Usage of the IT<sup>2</sup>RAIL Business Analytics by a Traveller: these sequence diagrams describe the interactions of travellers with the Business Analytics through the Travel Companion mobile app.

### 5.1 FUNCTIONAL SCENARIOS FOR “ANALYSE TRAVEL DATA” CAPABILITY

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This scenario describes the actions carried out by either a Traveller or a Business User of the IT<sup>2</sup>RAIL Platform when he/she wants to compute some indicators and KPIs by exploiting travel and transport data collected by both IT<sup>2</sup>RAIL work packages and external data sources.

The other work packages involved in this scenario are:

- **WP1 – Interoperability Framework:** the Business Analytics retrieves Master data (related to the transport domain) and services descriptors in order to invoke the other Work Packages to collect transport and travel data.
- **WP3 – Booking and Ticketing:** the Business Analytics gathers information regarding travel data of products bought by the IT<sup>2</sup>RAIL users.
- **WP5 – Travel Companion:** the IT<sup>2</sup>RAIL mobile app shows the computed KPIs and indicators by using the services exposed by the IT<sup>2</sup>RAIL Business Analytics.

Other external data sources are related to the information provided by a Data Provider which supplies travel and transport information to the IT<sup>2</sup>RAIL Business Analytics.

### 5.1.1 Analyse Travel Data – BA Module

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Travel Data – BA Module”* corresponding to **Model reference: “[FS]L Analyse Travel Data - BA module” diagram, SVN version 794** describes the actions carried out by a Business User when he/she wants to compute Business Analytics on travel data.

In this case the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.

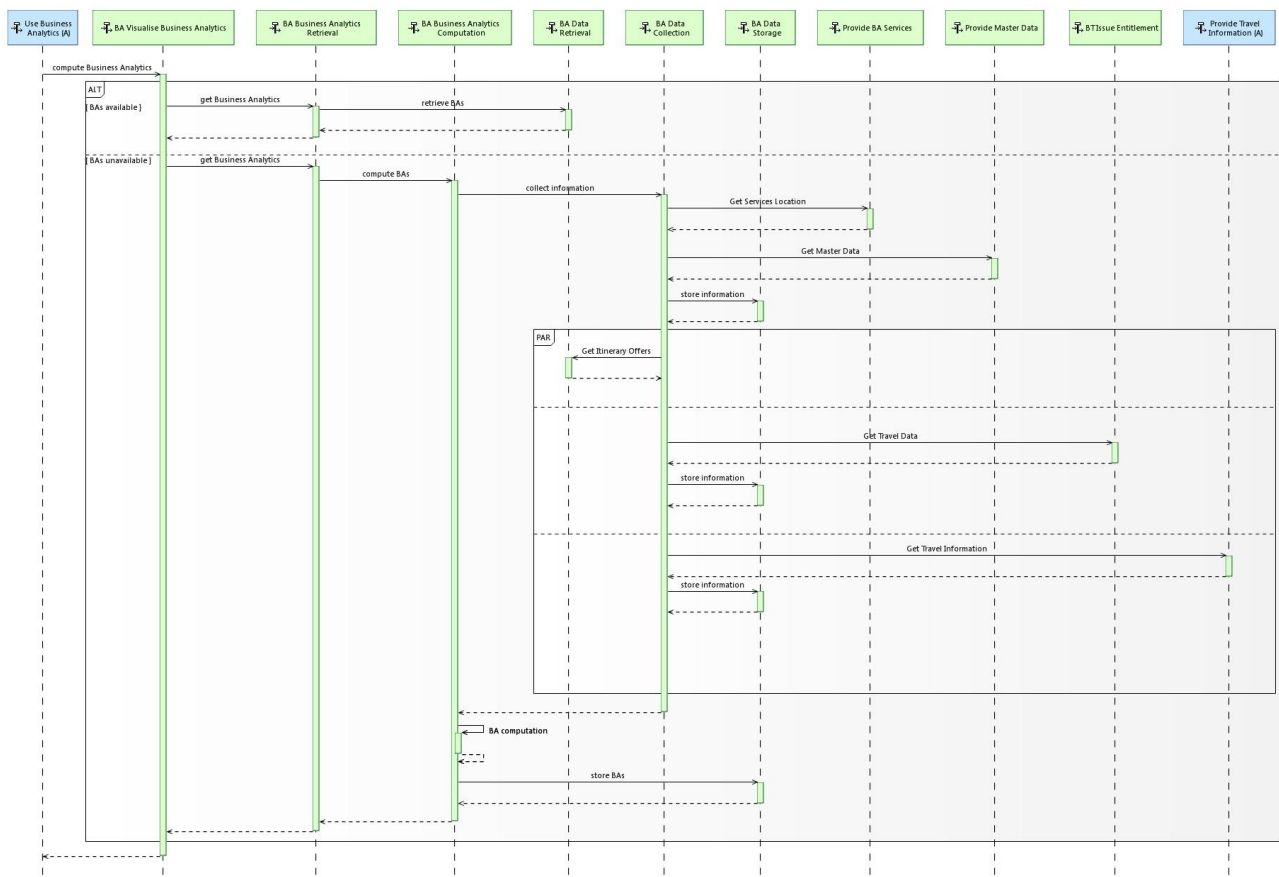


Figure 5: Functional scenario for “Analyse Travel Data – BA Module”

### 5.1.2 Analyse Travel Data – Mobile

The sequence diagram in **Figure 6: Functional scenario for “Analyse Travel Data – Mobile”: Functional scenario for “Analyse Travel Data – Mobile”** corresponding to **Model reference: “[FS]L Analyse Travel Data - Mobile” diagram, SVN version 794** depicts the actions carried out by a Traveller when he/she wants to compute Business Analytics on travel data.

In this case the actor uses the Travel Companion mobile app in order to retrieve the computed KPIs. For this reason the IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and the other IT<sup>2</sup>RAIL work packages.

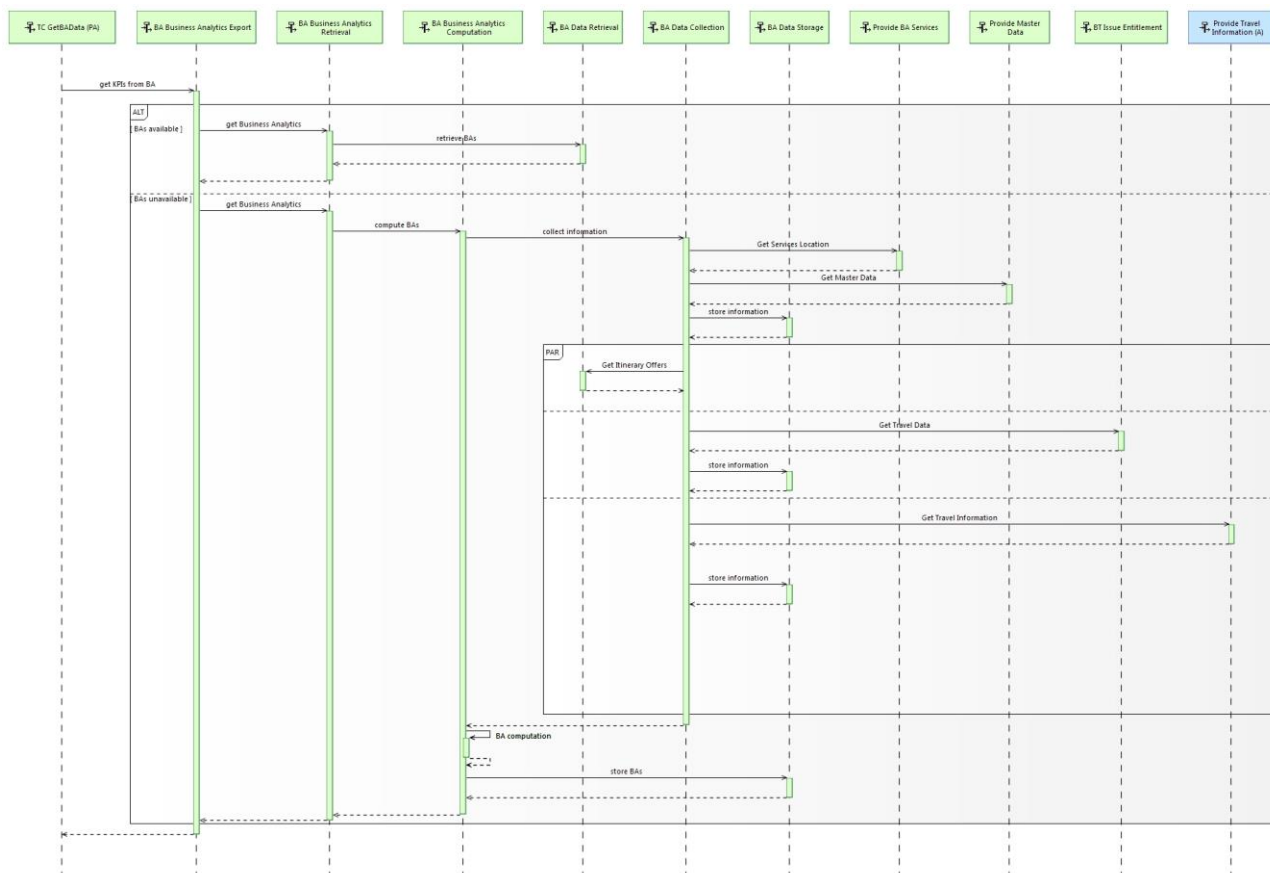


Figure 6: Functional scenario for “Analyse Travel Data – Mobile”

### 5.1.3 Analyse Travel Data - Happenings information – BA module

The sequence diagram in **Figure 7**: Functional scenario for “Analyse Travel Data - Happenings information – BA module”

: **Functional scenario for “Analyse Travel Data - Happenings information – BA module”** corresponding to **Model reference: “[FS]L Analyse Travel Data - Happening information – BA module” diagram, SVN version 794** describes the actions carried out by a Business User when he/she wants to know which happenings take place in a specific city and time window.

In this scenario, the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.

If the requested information is present in the repositories, the Business Analytics platform provides it to the Business User otherwise data are required to the Data Provider. Then Happenings are stored and sent to the Business User.

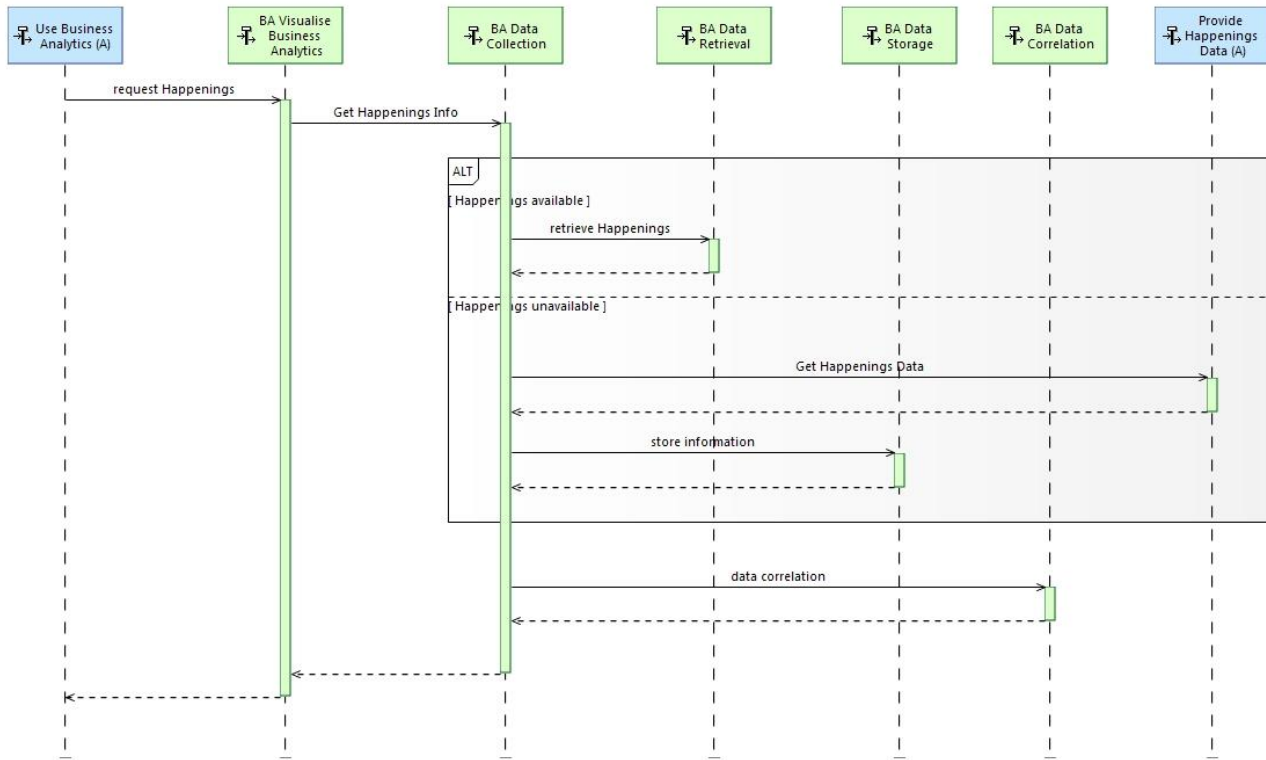


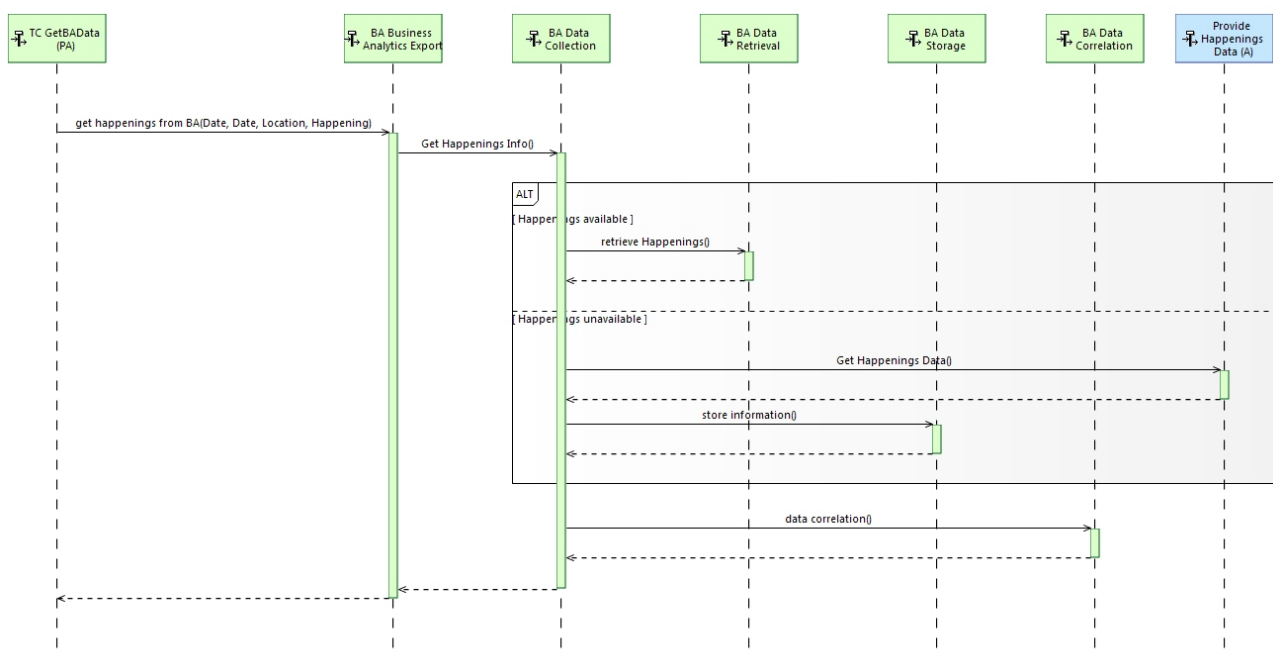
Figure 7: Functional scenario for “Analyse Travel Data - Happenings information – BA module”

### 5.1.4 Analyse Travel Data - Happenings information – Mobile

The sequence diagram in **Figure 8: Functional scenario for “Analyse Travel Data – Happenings Information – Mobile”** corresponding to **Model reference: “[FS]L Analyse Travel Data - Happening information - Mobile” diagram, SVN version 794** depicts the actions carried out by a Traveller when he/she wants to know which happenings take place in a specific city and time window.

In this scenario, the actor uses the Travel Companion mobile app in order to retrieve the requested information. For this reason the IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and the other IT<sup>2</sup>RAIL work packages.

If the requested information is present in the repositories, the Business Analytics platform provides it to the Traveller otherwise data are required to the Data Provider. Then happenings are stored and sent to the Traveller.



**Figure 8: Functional scenario for “Analyse Travel Data - Happenings information – Mobile”**

### 5.1.5 Analyse Travel Data - Weather information – BA module

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Travel Data - Weather information – BA module”* corresponding to *Model reference: “[FS]L Analyse Travel Data - Weather information - BA module” diagram, SVN version 794* describes the actions carried out by a Business User when he/she wants to know weather information (both current and forecast) for a specific city and time window.

In this scenario, the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.

If the requested information is present in the repositories, the Business Analytics platform provides it to the Business User otherwise data are required to the Data Provider. Then weather information is stored and sent to the Business User.

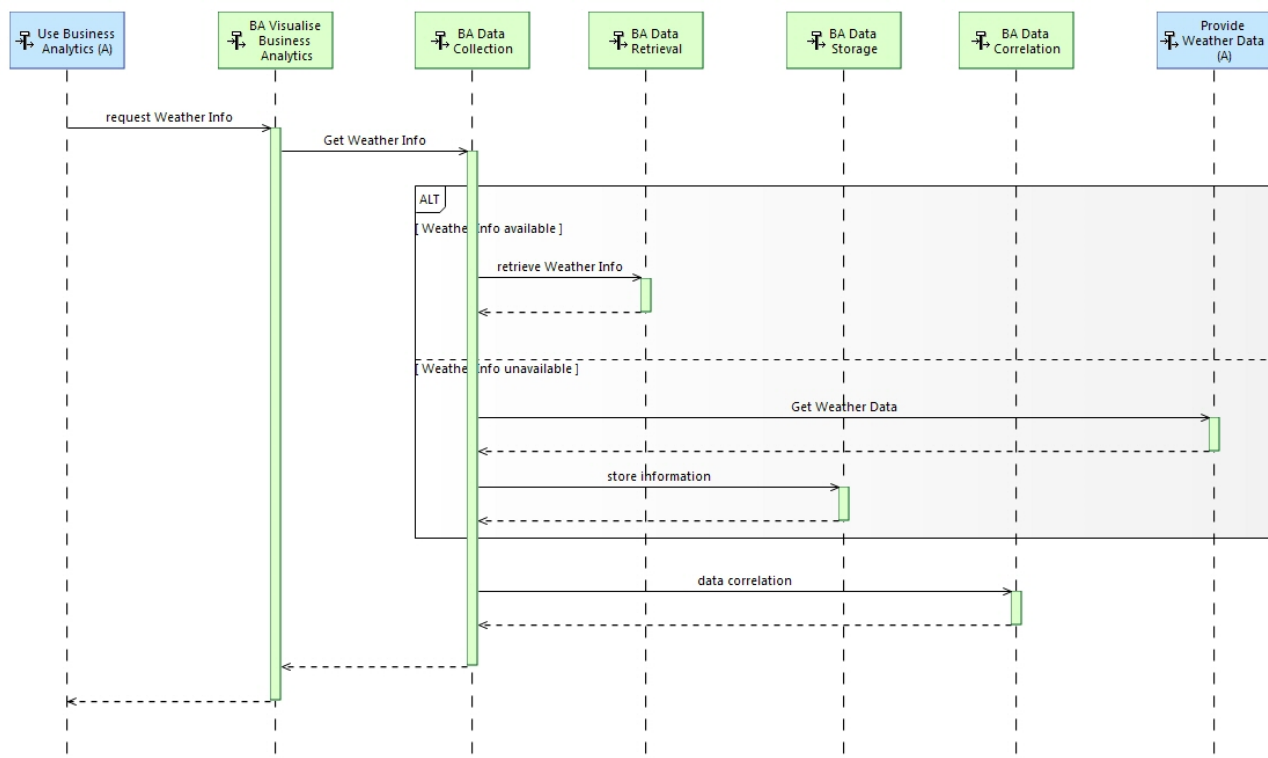


Figure 9: Functional scenario for “Analyse Travel Data - Weather information – BA module”

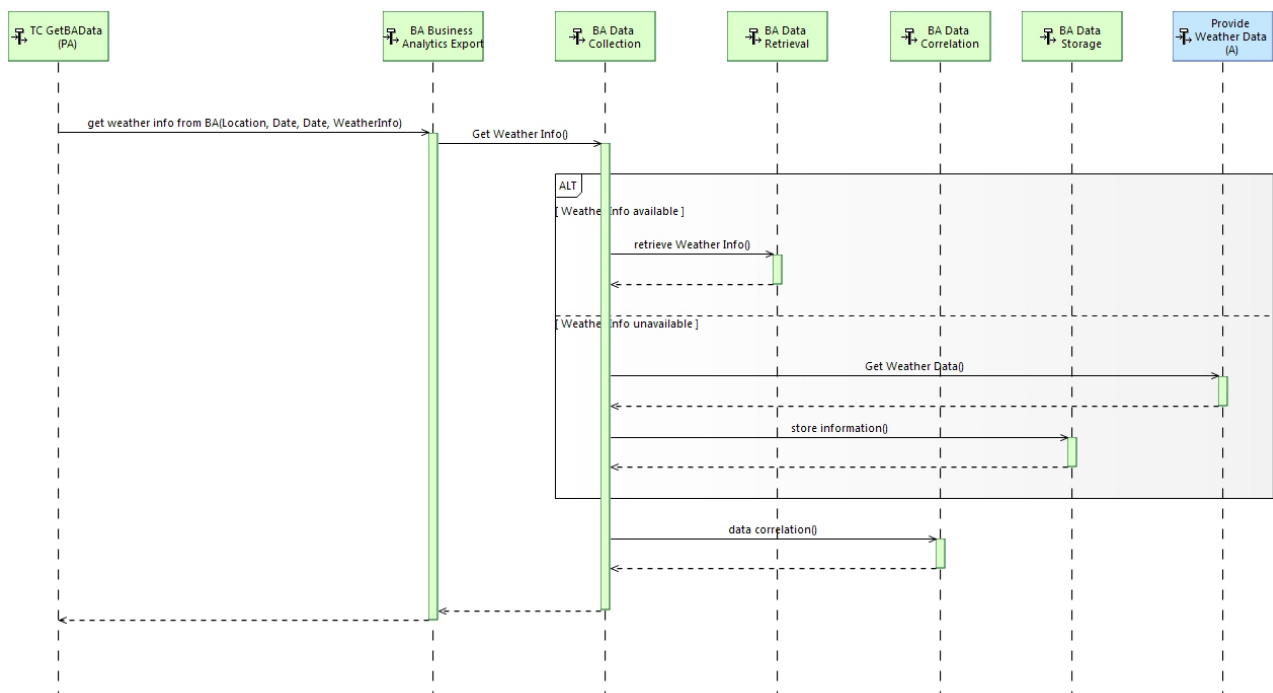


### 5.1.6 Analyse Travel Data - Weather information – Mobile

The sequence diagram in **Figure 10: Functional scenario for “Analyse Travel Data - Weather information – Mobile”** corresponding to **Model reference: “[FS]L Analyse Travel Data - Weather information - Mobile” diagram, SVN version 794** depicts the actions carried out by a Traveller when he/she wants to know weather information (both current and forecast) for a specific city and time window.

In this scenario, the actor uses the Travel Companion mobile app in order to retrieve the requested information. For this reason the IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and the other IT<sup>2</sup>RAIL work packages.

If the requested information is present in the repositories, the Business Analytics platform provides it to the Traveller otherwise data are required to the Data Provider. Then weather information is stored and sent to the Traveller.



**Figure 10: Functional scenario for “Analyse Travel Data - Weather information – Mobile”**

## 5.2 FUNCTIONAL SCENARIOS FOR “ANALYSE TRAVEL EVENTS” CAPABILITY

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This scenario describes the actions carried out by either a Traveller or a Business User of the IT<sup>2</sup>RAIL Platform when he/she wants to compute some indicators and KPIs on travel events that are occurring. Information collected by other work packages and external data sources is then correlated with the one provided by the IT<sup>2</sup>RAIL Trip Tracking (events provider).

The other work packages involved in this scenario are:

- **WP1 – Interoperability Framework:** the Business Analytics retrieves Master data related to the transport domain and services descriptors in order to invoke the other Work Packages to collect transport and travel data.
- **WP2 – Travel Shopping:** the Business Analytics retrieves itinerary offers sent to the Traveller. This process is described in the WP2 functional scenarios. This information could be used in order to be correlated with the one collected by other data sources.
- **WP4 – Trip Tracking:** the Business Analytics gathers events managed and computed by Complex Event Processing engine as well as messages and alternatives sent to Traveller through the Travel Companion mobile app.
- **WP5 – Travel Companion:** the IT<sup>2</sup>RAIL mobile app shows the computed KPIs and indicators by using the services exposed by the IT<sup>2</sup>RAIL Business Analytics.

Other external data sources are related to information provided by a Data Provider who supplies Travel and Transport information to the IT<sup>2</sup>RAIL Business Analytics.

## 5.2.1 Analyse Travel Events – BA Module

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Travel Events – BA Module”* corresponding to *Model reference: “[FS]L Analyse Travel Events - BA module” diagram, SVN version 794* shows the actions carried out by a Business User when he/she wants to compute Business Analytics on travel events.

In this case the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.

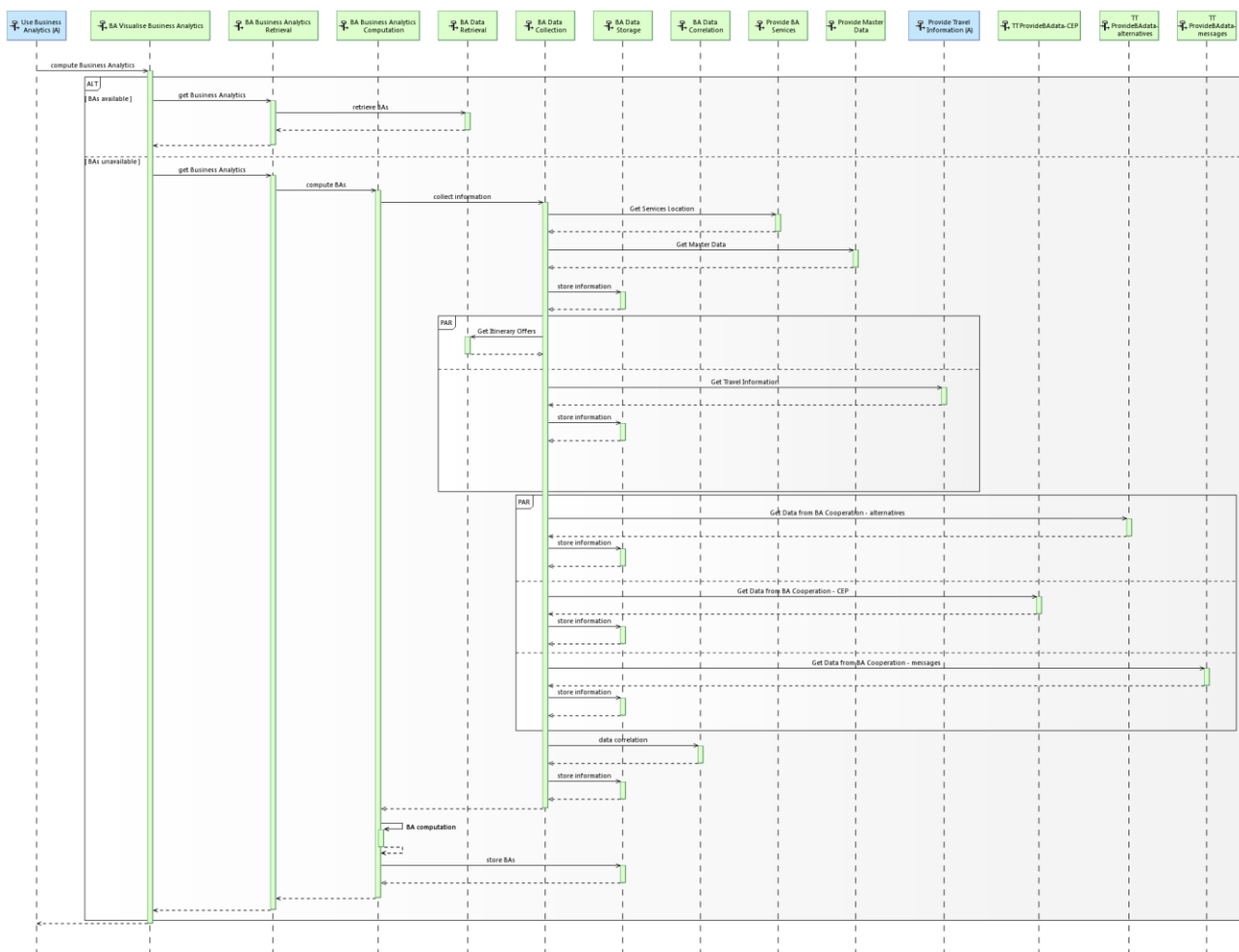


Figure 11: Functional scenario for “Analyse Travel Events – BA Module”

## 5.2.2 Analyse Travel Events – Mobile

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Travel Events – Mobile”* corresponding to **Model reference: “[FS]L Analyse Travel Events - Mobile” diagram, SVN version 794**) depicts the actions carried out by a Traveller when he/she wants to compute Business Analytics on travel events.

In this case the actor uses the Travel Companion mobile app in order to retrieve the computed KPIs, for this reason the IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and all IT<sup>2</sup>RAIL platform modules.

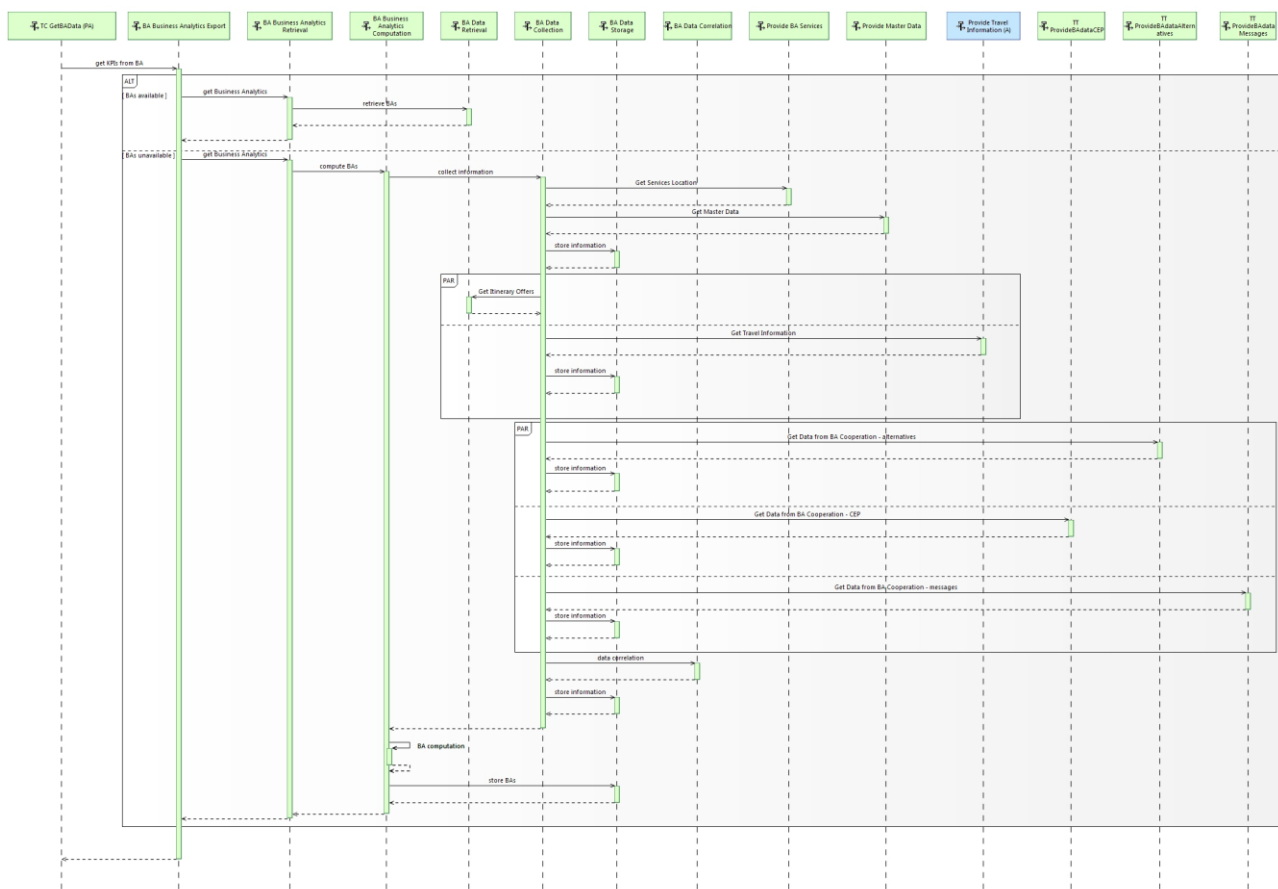


Figure 12: Functional scenario for “Analyse Travel Events – Mobile”

### 5.3 FUNCTIONAL SCENARIOS FOR “ANALYSE SOCIAL DATA” CAPABILITY

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This scenario describes the actions carried out by either a Traveller or a Business User of the IT<sup>2</sup>RAIL Platform when he/she wants to compute some indicators and KPIs on data collected by social network platforms or by means travel questionnaires. Travellers use social network platforms to share their feelings regarding news on facts that are occurring around the world. This kind of information may be used in order to detect particular situations related to travel and transport domains that social network users are experiencing. Messages sent to social network platforms will be crawled in order to perform some analysis by highlighting important details regarding the travel experience of the IT<sup>2</sup>RAIL users. At the same time, travel questionnaires filled in by travellers provide information which will be used by the Business Analytics platform in order to compute KPIs. These indicators are meaningful as help improve the quality of services that user experience on board of means of transportation.

#### 5.3.1 Analyse Social Data – Social Networks – BA Module

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Social Data – Social Networks – BA module”* corresponding to *Model reference: “[FS]L Analyse Social Networks - BA module” diagram, SVN version 794* represents the actions carried out by a Business User when he/she wants to compute Business Analytics on the basis of messages crawled from social networks.

In this case the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.

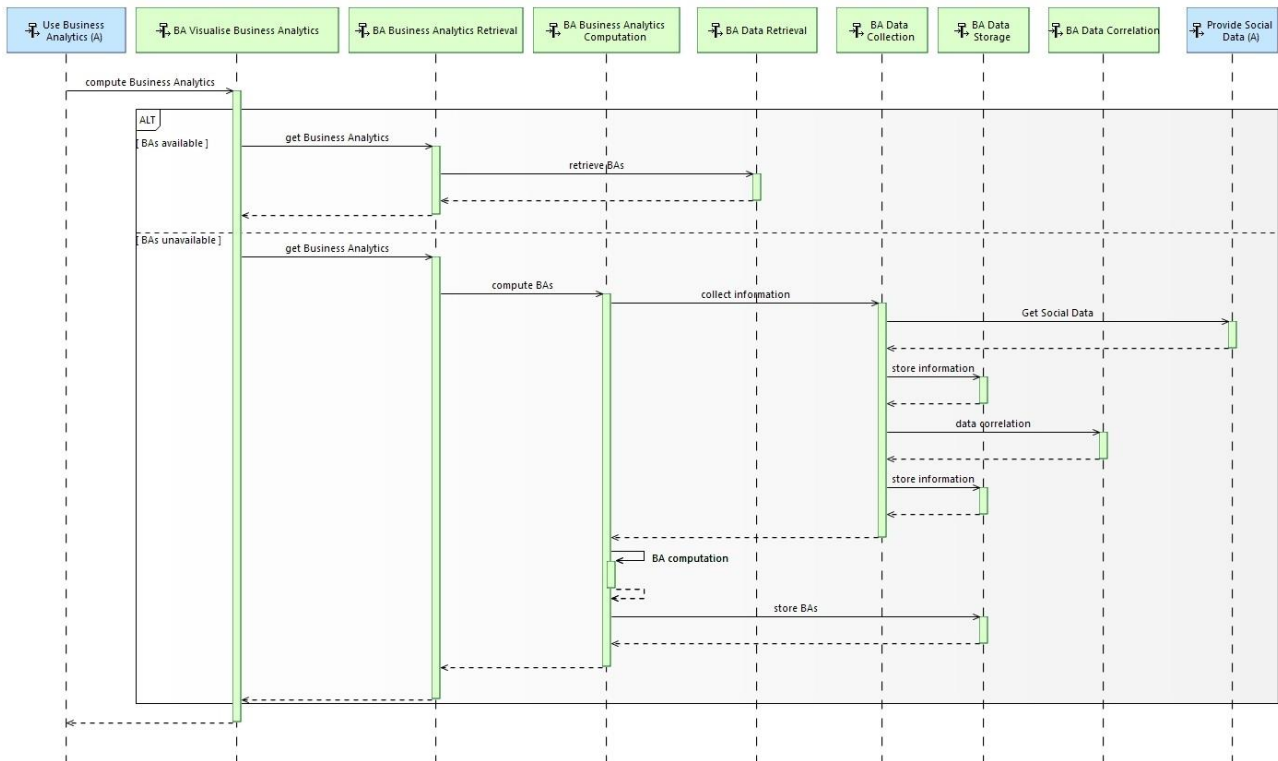


Figure 13: Functional scenario for “Analyse Social Data – Social Networks – BA module”

### 5.3.2 Analyse Social Data – Social Networks – Mobile

The sequence diagram in Error! Reference source not found.: **Functional scenario for “Analyse Social Data – Social Networks – Mobile”** corresponding to **Model reference: “[FS]L Analyse Social Networks - Mobile”** diagram, **SVN version 794** shows the actions carried out by a Traveller when he/she wants to compute Business Analytics on the basis of messages crawled from social networks.

In this case the actor uses the Travel Companion mobile app in order to retrieve the computed KPIs, for this reason, the IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and all IT<sup>2</sup>RAIL platform modules.

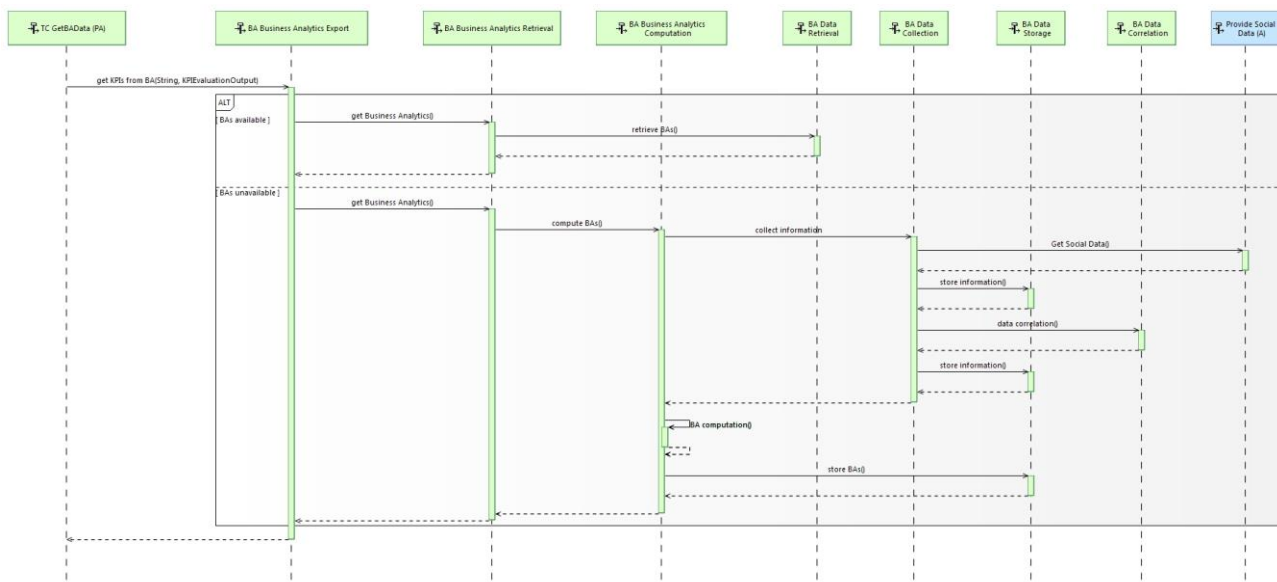


Figure 14: Functional scenario for “Analyse Social Data – Social Networks – Mobile”

### 5.3.3 Analyse Social Data – Get Traveller Questionnaire

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Social Data – Get Traveller Questionnaire”* corresponding to *Model reference: “[FS]L Analyse Social Data - Get Traveller Questionnaire” diagram, SVN version 794* represents the actions carried out by Business Analytics to receive and store Traveller Questionnaires sent by Travel Companion mobile app.

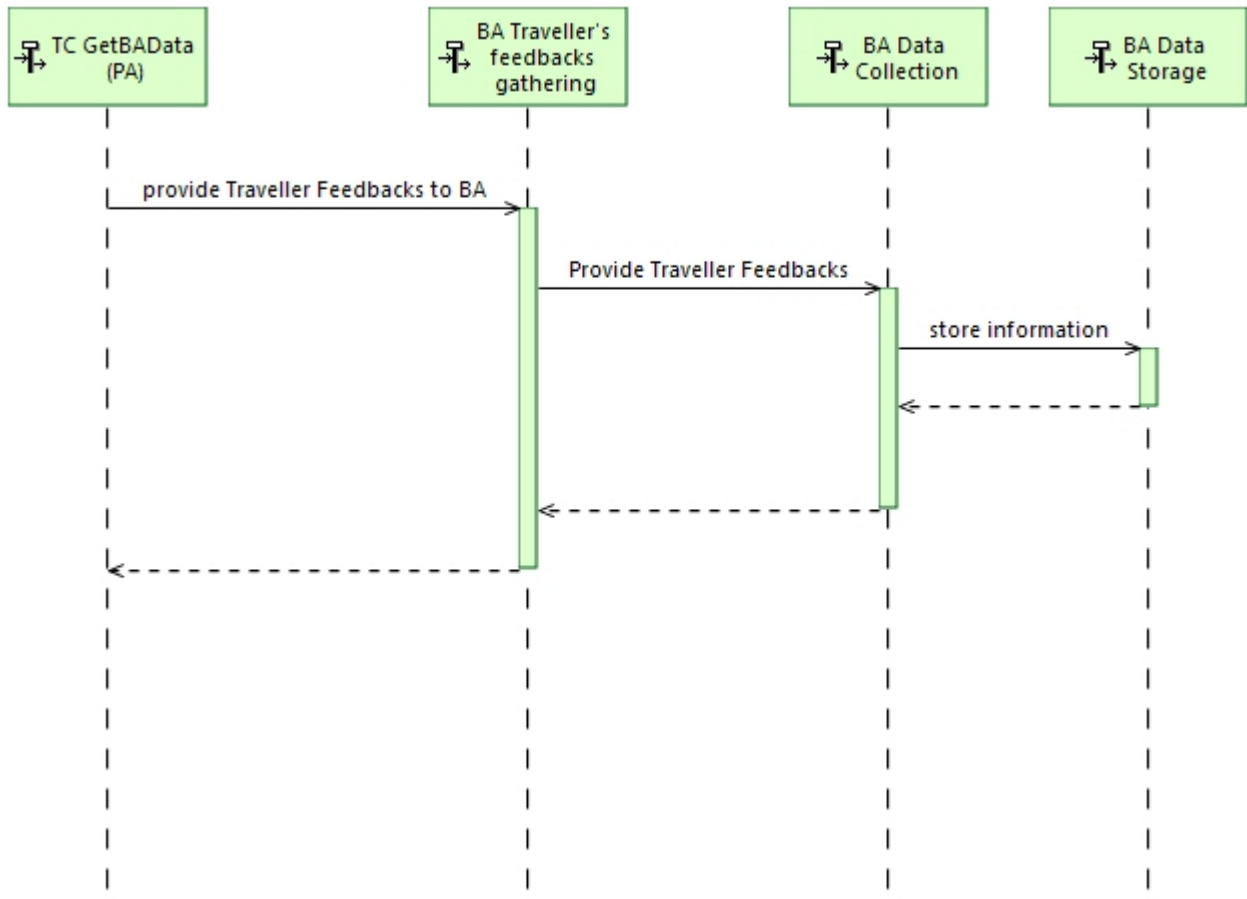


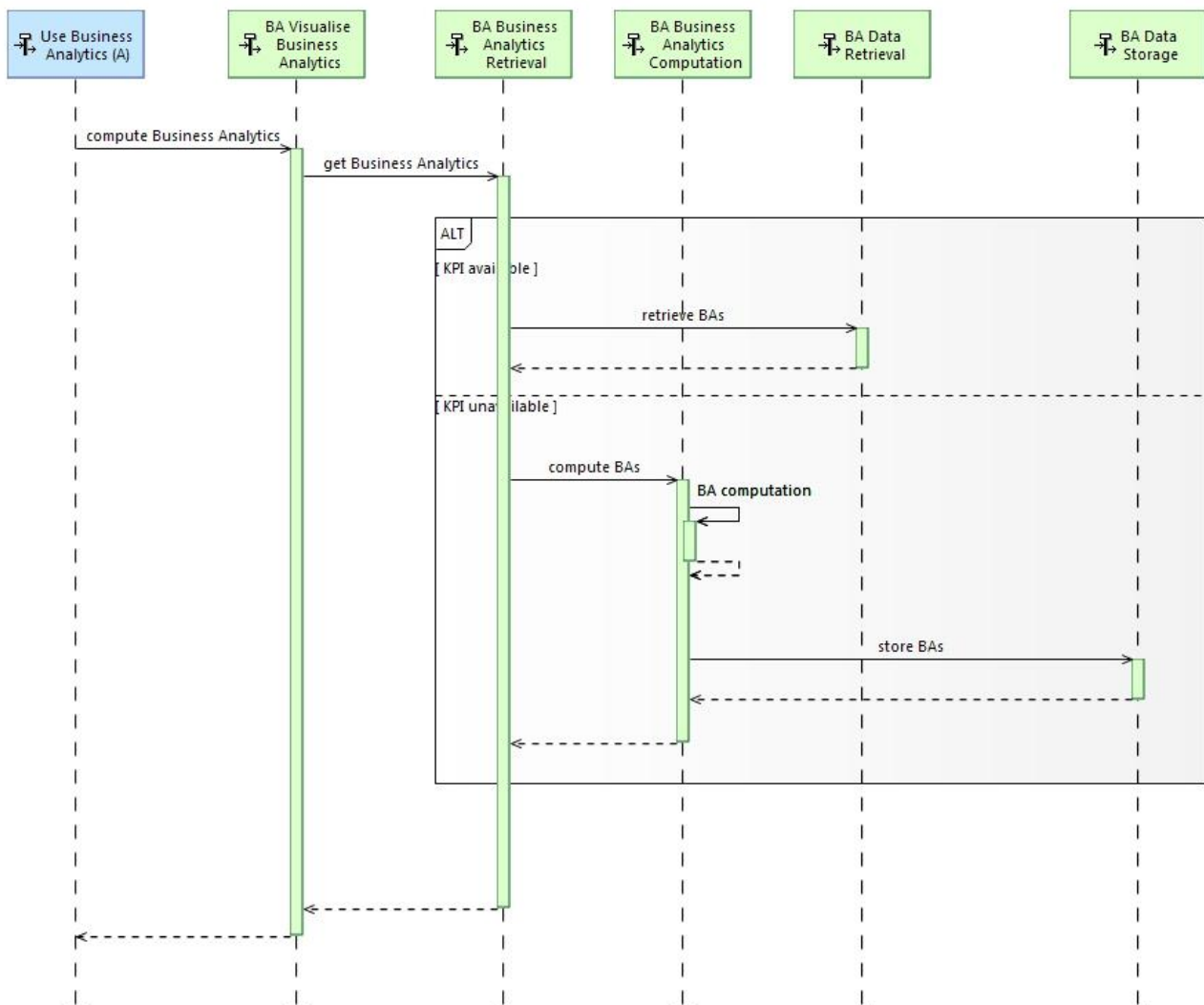
Figure 15: Functional scenario for “Analyse Social Data – Get Traveller Questionnaire”



### 5.3.4 Analyse Social Data – Traveller Feedbacks – BA Module

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Social Data – Traveller Feedbacks – BA module”* corresponding to *Model reference: “[FS]L Analyse Social Data - Traveller Feedbacks - BA module” diagram, SVN version 794* represents the actions carried out by a Business User when he/she wants to compute Business Analytics on the basis of answers of Traveller Questionnaire sent by travellers.

In this case the actor directly uses the Presentation functions on the web portal provided by the IT<sup>2</sup>RAIL Business Analytics.



**Figure 16: Functional scenario for “Analyse Social Data – Traveller Feedbacks – BA module”**

### 5.3.5 Analyse Social Data – Traveller Feedbacks – Mobile

The sequence diagram in *Error! Reference source not found.: Functional scenario for “Analyse Social Data – Traveller Feedbacks – Mobile”* corresponding to *Model reference: “[FS]L Analyse Social Data - Traveller Feedbacks - Mobile” diagram, SVN version 794* shows the actions carried out by a Traveller when he/she wants to compute Business Analytics on the basis of answers provided by means of Traveller Questionnaires.

In this case the actor uses the Travel Companion mobile app in order to retrieve the computed KPIs. The IT<sup>2</sup>RAIL Business Analytics exposes its services by means of an interface defined towards the Travel Companion and all IT<sup>2</sup>RAIL platform modules.

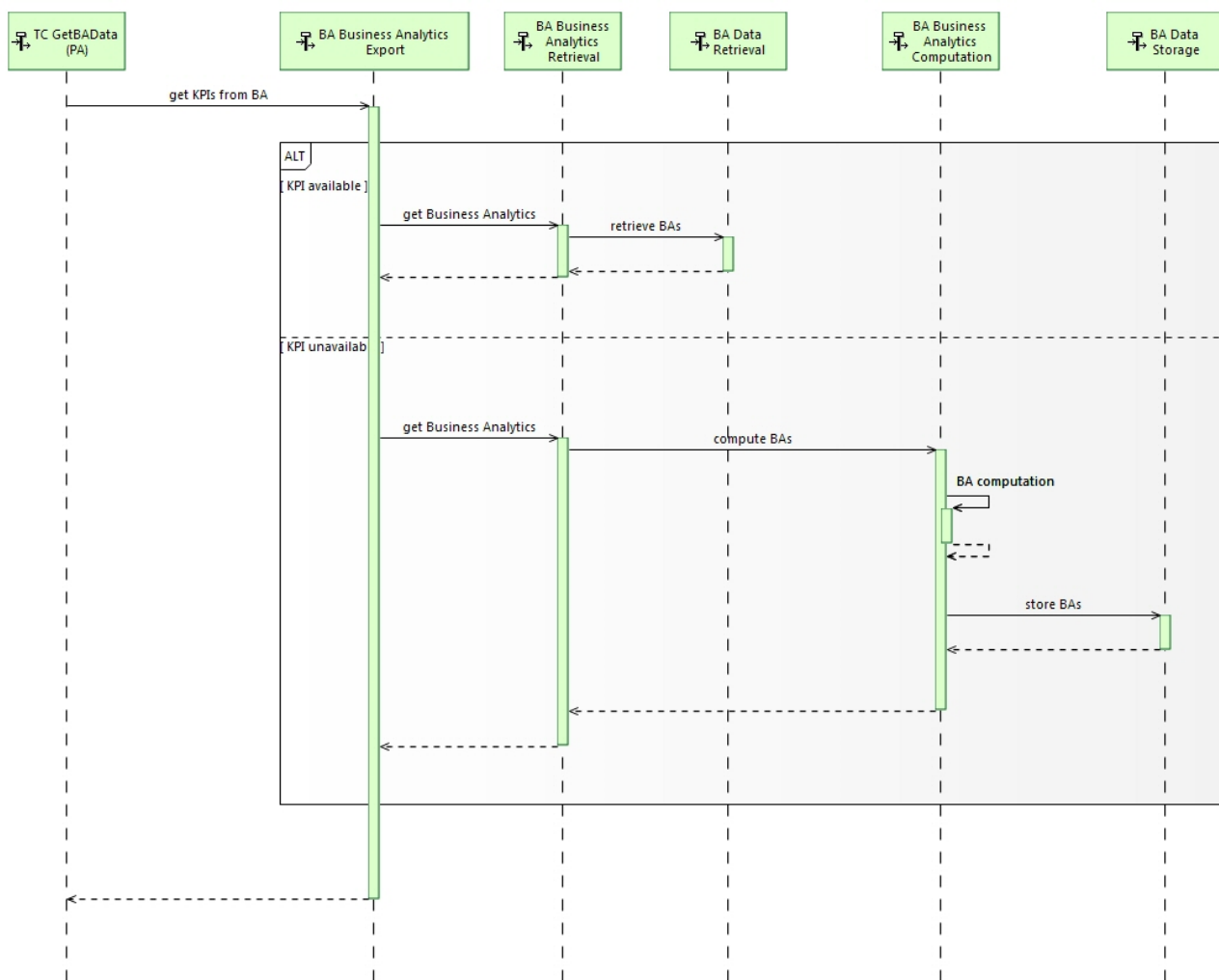


Figure 17: Functional scenario for “Analyse Social Data – Traveller Feedbacks – Mobile”

## 6.1 DATA MODEL

20/10/2017

**Line:** Represents the key element of the transportation network, e.g. a train line or a flight. It is characterised by departure and arrival stopping places, scheduled departure and arrival times, and a flag indicating whether this line is green.

**LineLink:** Connects a line with the links which it encompasses. It is characterised by the scheduled arrival and departure times, and by the number of the link within the line.

**Route:** Fragment of the line, delimited by two stops. It is associated with its line, and characterised by the numbers of the delimiting stops.

**Travel:** Travel of a line, executed in a specific date. It is associated with its line, and characterised by the actual departure and arrival times.

**TravelLink:** Connects a travel with the links which it encompasses. It is characterised by the actual arrival and departure times, and by the number of the link within the travel.

**Entitlement-WP6:** Entitlement for traveling. It is associated with a route and a travel. It might be associated with a shopping cart, if it was bought online, and with a customer, if the customer is a registered IT<sup>2</sup>RAIL user. It is characterised by purchase date and paid price.

**DisruptiveEvent:** Represents an event which has an impact on a travel. It is associated with the disrupted travel.

**EntitlementDisruption:** Connects the disruptive events with the entitlements they affected. It is characterised by the recovery time.

**CustomerSatisfactionSurveyTravel:** Represents a survey conducted to assess the satisfaction of a user about a specific travel. It is associated with the surveyed travel, and characterised by the score provided by the user.

**CustomerSatisfactionSurveyLink:** Represents a survey conducted to assess the satisfaction of a user about a specific link. It is associated with the specific link, and characterised by the score provided by the user.

**TravelSentimentAnalysis:** Represents the sentiment analysis executed on the data derived from social networks regarding a specific travel. It is associated with the analysed travel and characterised by the number of positive and negative retrieved posts.

**ShoppingCart:** Represents a shopping cart for entitlement purchase. It is characterised by a status, i.e. “completed”, “abandoned” or “in use”.

**I2RCustomer:** Represents a customer registered within IT<sup>2</sup>RAIL.

**I2RService:** Represents an ancillary service provided by IT<sup>2</sup>RAIL.

**I2RServiceUsage:** Represents the usage of an IT<sup>2</sup>RAIL service by an IT<sup>2</sup>RAIL user, in a specific date.

## 6.2 COMPONENTS AND INTERFACES

As depicted in *Error! Reference source not found.: Main components and interfaces of the Business Analytics platform* corresponding to *Model reference: “[IDB] BA - Interfaces Diagram Blank” diagram, SVN version 794*, the Business Analytics platform is composed by five main parts, which correspond to the main functions described in Section 3.1:

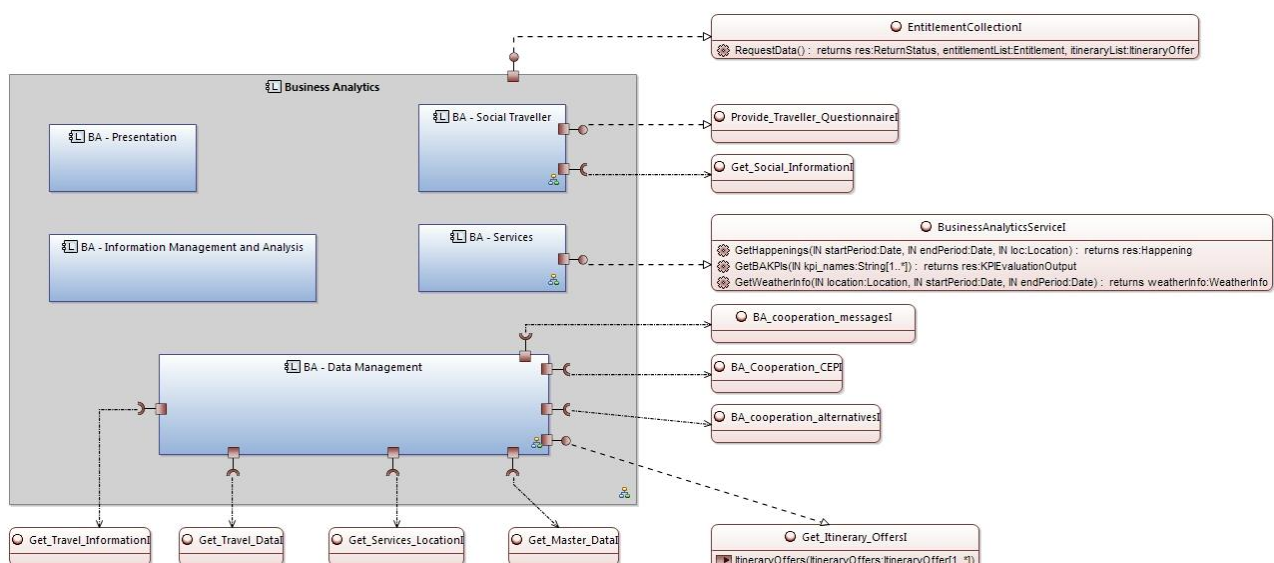
- BA Presentation;
- BA Information Management and Analysis;
- BA Data Management;
- BA Social Traveller;
- BA Services.

These components interact with each other by means of interfaces (some provided by the BA components, some provided by other IT<sup>2</sup>RAIL modules and used, or required, by BA components).

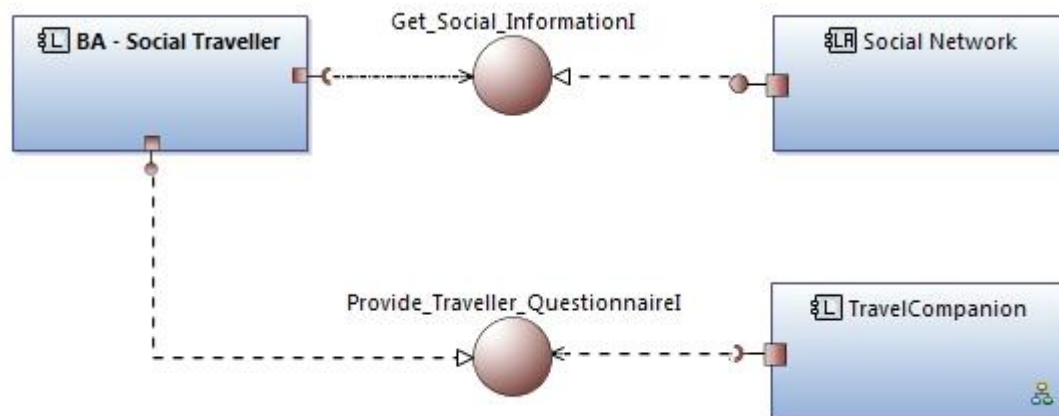
All these interfaces, depicted in *Error! Reference source not found.*, *Error! Reference source not found.* and *Error! Reference source not found.*, are described in the next paragraphs of this section.

These figures refer to the following Capella Model diagrams:

- *Error! Reference source not found.: External interfaces of the BA Social Traveller component* to “[CEI] BA - Social Traveller - Contextual Component External Interfaces” diagram, SVN version 794;
- *Error! Reference source not found.: External interfaces of the BA Services component* to “[CEI] BA - Services - Contextual Component External Interfaces” diagram, SVN version 794;
- *Error! Reference source not found.: External interfaces of the Data Management component* to “[CEI] BA - Data Management - Contextual Component External Interfaces” diagram, SVN version 794 .



**Figure 19: Main components and interfaces of the Business Analytics platform**



**Figure 20 External interfaces of the BA Social Traveller component**



**Figure 21 External interfaces of the BA Services component**

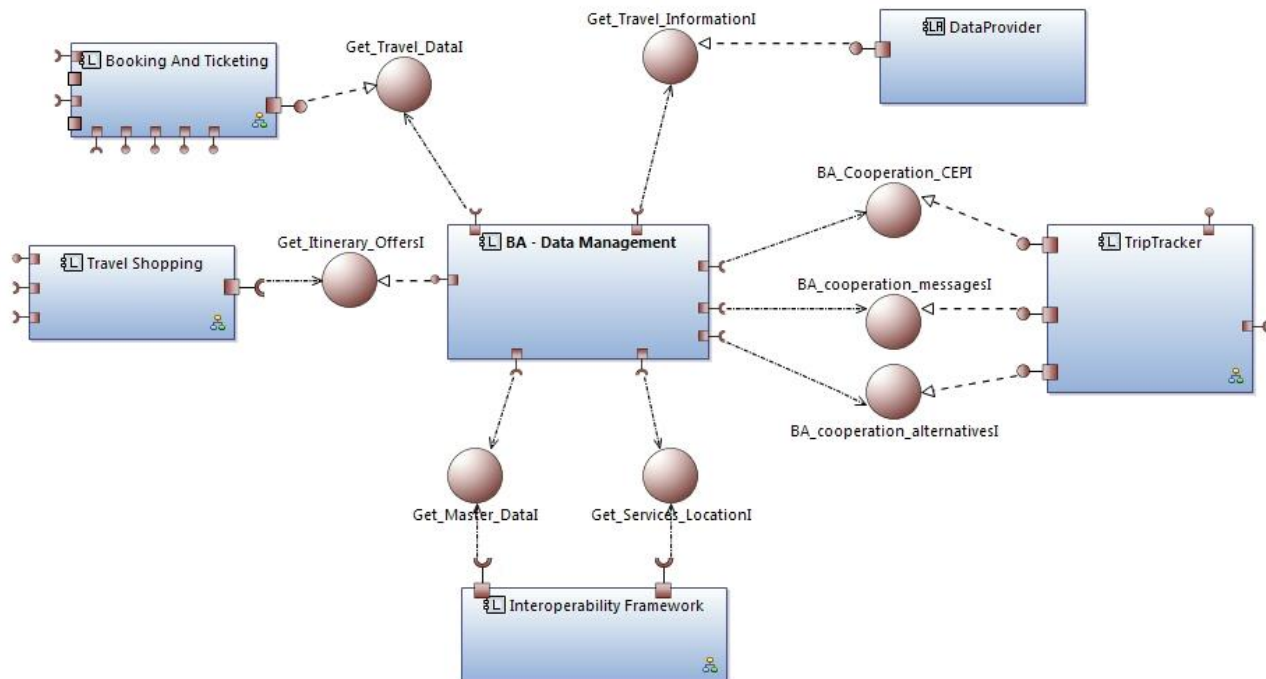


Figure 22 External interfaces of the Data Management component

## 6.2.1 Interfaces required by the Business Analytics

<b>Interface ID</b>	1		
<b>Interface Name</b>	Get_Master_Data1		
<b>Purpose of the interface</b>	This interface retrieves master data regarding transport operators from the Interoperability Framework.		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Interoperability Framework		
<b>Description</b>	This interface retrieves master data regarding transport operators from the Interoperability Framework.		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	The Business Analytics has collected master data for analytics purpose		
<b>Request/Input</b>	Start StopPlace global ID	M	Id of the first Stop Place of a MetaTravelExpertEpisode
	End StopPlace global ID	M	Id of the last Stop Place of a MetaTravelExpertEpisode
<b>Request/Output</b>	TravelExpert descriptor	M	Descriptor that supplies offer items on the metaroute
<b>Exceptions</b>	No exceptions		
<b>Notes and issues</b>	No specified		

**Table 1: Interface 1 - Get Master Data**



<b>Interface ID</b>	2		
<b>Interface Name</b>	Get_Services_LocationI		
<b>Purpose of the interface</b>	This interface retrieves information concerning the services location.		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Interoperability Framework		
<b>Description</b>	This interface retrieves information concerning the services location.		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	The Business Analytics can invoke the interfaces exposed by the other IT <sup>2</sup> RAIL work packages.		
<b>Request/Input</b>	serviceName	1	The service name to invoke
<b>Request/Output</b>	serviceLocation	1	Current service URI
<b>Exceptions</b>	No exceptions		
<b>Notes and issues</b>	No specified		

**Table 2: Interface 2 - Get Services Location**

<b>Interface ID</b>	3		
<b>Interface Name</b>	Get_Travel_Data1		
<b>Purpose of the interface</b>	This interface retrieves information for analysing travel data.		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Booking & Ticketing		
<b>Description</b>	This interface retrieves information for analysing travel data		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	The Business Analytics platform can correlate this information with other data related to the travel and transport domains. Finally a series of KPIs can be computed on the basis of user's requests.		
<b>Request/Input</b>	startPeriod endPeriod travelFilter	1 1 1	Initial date of the time window Final date of the time window Filter travels of interest (city, transport mode, etc.)
<b>Request/Output</b>	travelData	0..n	List of data concerning travels taking place during the input time window
<b>Exceptions</b>	No exceptions		
<b>Notes and issues</b>	No specified		

**Table 3: Interface 3 - Get Travel Data**

<b>Interface ID</b>	4		
<b>Interface Name</b>	BA_Cooperation_CEP		
<b>Purpose of the interface</b>	This interface provides information on events' evaluation from Complex Event Processing engine. One event may have different impacts to different customers. For each couple event-customer, three different impact levels and appropriate message types are expected to be distinguished in WP4.		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Trip Tracking		
<b>Description</b>	This interface provides information on events' evaluation from Complex Event Processing engine. One event may have different impacts to different customers. For each couple event-customer, three different impact levels and appropriate message types are expected to be distinguished in WP4.		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	Information on events is provided in an aggregated format and indicates the number of travellers affected by a specific event. The total number of events evaluated in the queried period shall be available.		
<b>Request/Input</b>	No input	-	-
<b>Request/Output</b>	Event ID	M	Unique event identifier inside IT <sup>2</sup> RAIL domain.
	Impact level	M	This parameter specifies the impact level linked to the event.
	Number of customers	M	Customers that have been affected by the event with the appropriate impact.
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 4: Interface 4 - BA Cooperation - CEP**

<b>Interface ID</b>	5		
<b>Interface Name</b>	BA_cooperation_messagesl		
<b>Purpose of the interface</b>	This interface provides information on all messages that were sent to the Travel Companion to be displayed to a customer, with a set of related information, including a link to the causal event (where appropriate).		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Trip Tracking		
<b>Description</b>	This interface provides information on all messages that were sent to the Travel Companion to be displayed to a customer, with a set of related information, including a link to the causal event (where appropriate).		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	Information on events is provided in an aggregated format and indicate the number of travellers affected by a specific event. The total number of events evaluated in the queried period shall be available.		
<b>Request/Input</b>	No input	-	-
<b>Request/Output</b>	Message ID	M	Unique message identifier inside the Trip Tracker
	Event ID	M	Event, which was the cause of the message
	Travel ID	M	Traveller, who receives the message (unique identifier inside IT <sup>2</sup> RAIL domain)
	Message Type	M	This field in fact indicates the severity of an event impacting on traveller's journey.
	Processing Time	M	The interval between capturing the event and sending the message
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 5: Interface 5 - BA cooperation – messages**

<b>Interface ID</b>	6		
<b>Interface Name</b>	BA_cooperation_alternativesI		
<b>Purpose of the interface</b>	In order to compute statistics related to proposed travel plan reallocation for each customer and all required aggregations (by customer, by transport/service provider, by time, and so on), the IT <sup>2</sup> RAIL Business Analytics requires to get at least any indication, whether some alternatives were offered to the customer or not.		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Trip Tracking		
<b>Description</b>	In order to compute statistics related to proposed travel plan reallocation for each customer and all required aggregations (by customer, by transport/service provider, by time, and so on), the IT <sup>2</sup> RAIL Business Analytics requires to get at least any indication, whether some alternatives were offered to the customer or not		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	Business Analytics collects information on alternatives offered upon customer's request		
<b>Request/Input</b>	No input	-	-
<b>Request/Output</b>	Message ID	M	Message, which invoked the request for alternatives.
	Travel ID	M	Traveller requesting alternatives.
	Number of proposed alternatives:	M	This field specifies the amount of alternatives proposed to the traveller
	Processing Time	M	The interval between the request is received and alternatives are proposed to the traveller.
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 6: Interface 6 - BA cooperation – alternatives**

<b>Interface ID</b>	7		
<b>Interface Name</b>	Get_Travel_InformationI		
<b>Purpose of the interface</b>	This interface retrieves travel information from external data providers		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Data Provider		
<b>Description</b>	This interface retrieves travel information from external data providers		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	No preconditions		
<b>Postconditions</b>	The Business Analytics collects information on travel and transport domains from external data sources.		
<b>Request/Input</b>	startPeriod endPeriod travelFilter	1 1 1	Initial date of the time window Final date of the time window Filter travels of interest (city, transport mode, etc.)
<b>Request/Output</b>	travelInfo	0..n	List of information concerning travels taking place during the input time window
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 7: Interface 7 - Get Travel Information**

<b>Interface ID</b>	8		
<b>Interface Name</b>	Get_Social_InformationI		
<b>Purpose of the interface</b>	This interface retrieves messages from social network platforms		
<b>Requestor</b>	Business Analytics		
<b>Provider</b>	Social network		
<b>Description</b>	This interface retrieves messages from social network platforms. All crawled messages are related with some topics specified by experts.		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Complete		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	<p>Authorisation key and security key in order to access to third party APIs.</p> <p>Specify the related topics used to crawl data from the social network.</p>		
<b>Postconditions</b>	The Business Analytics collects messages from social network platforms.		
<b>Request/Input</b>	startPeriod endPeriod topic	1 1 0..1	Initial date of the time window Final date of the time window Filter messages of interest (i.e. keywords)
<b>Request/Output</b>	Res	0..n	List of messages sent during the input time window
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 8: Interface 8 - Get Social Information**

## 6.2.2 Interfaces exposed by the Business Analytics

<b>Interface ID</b>	9		
<b>Interface Name</b>	Provide_Traveller_QuestionnaireI		
<b>Purpose of the interface</b>	This interface collects answers of Traveller Questionnaires from the Travel Companion mobile app		
<b>Requestor</b>	Traveller		
<b>Provider</b>	Business Analytics		
<b>Description</b>	This interface collects answers of Traveller Questionnaires from the Travel Companion mobile app		
<b>Impact to CREL</b>	Partial		
<b>Impact to AREL</b>	Partial		
<b>Impact to FREL</b>	Complete		
<b>Preconditions</b>	-		
<b>Postconditions</b>	The Business Analytics collects answers of Traveller Questionnaire from Travel Companion mobile app		
<b>Request/Input</b>	travelDate travelLeg meanOfTransportation userID userCommnet travelQuestions <ul style="list-style-type: none"> <li>question</li> <li>rate</li> </ul>	1 1 1 1 0..1 1..n 1 1	Date and time of travel leg Travel leg Transport mean used Traveller's User Id Optional comment by the user Travel Questionnaire Question text Vote (1-5)
<b>Request/Output</b>	No Output	-	-
<b>Exceptions</b>	No exceptions.		
<b>Notes and issues</b>	No specified.		

**Table 9: Interface 9 - Provide Traveller Questionnaire**



Interface ID	10		
Interface Name	BusinessAnalyticsServiceI		
Purpose of the interface	This interface allows to provide information concerning specific KPIs, happenings and weather information, analysis of messages collected by social media.		
Requestor	Travel Companion		
Provider	Business Analytics		
Description	This interface allows to provide information concerning a specific KPI, happenings taking place in a specific city and weather information, summary information on messages collected by social media.		
Impact to CREL	Partial		
Impact to AREL	Complete		
Impact to FREL	Complete		
Preconditions	A Traveller wants to visualise some business analytics or even useful information related to travel data		
Postconditions	The IT²RAIL Business Analytics collects KPIs, happenings and weather data; then sends them to Travel Companion mobile app in order to show them to the IT²RAIL user.		
GetBAKPIs			
Request/Input	kpi_names	1..n	Names of required KPIs
Request/Output	Res	1..n	Values of required KPIs
GetHappenings			
Request/Input	startPeriod	1	Initial date of the time window
	endPeriod	1	Final date of the time window
	Location	1	Place of interest
	• hasName	1	City name
Request/Output	Res	0..n	List of happenings taking place in the required city during the input time window
GetWeatherInfo			
Request/Input	startPeriod	1	Initial date of the time window
	endPeriod	1	Final date of the time window
	Location	1	Place of interest
	• hasName	1	City name
Request/Output	weatherInfo	1..n	List of weather information for the required city during the input time window
Exceptions	No exceptions.		

Notes and issues	No specified.
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**Table 10: Interface 10 - Business Analytics Service**

[illegible]

Notes and issues	No specified.
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**Table 11: Interface 11 - Get Itinerary Offers for BA computations**

## 7. TECHNICAL ARCHITECTURE

The IT<sup>2</sup>RAIL Business Analytics consists of several components that implement the logical functions described in the previous paragraphs. The following sections describe each component of the Business Analytics architecture.

### 7.1 DATA MANAGEMENT

The Data Management component is in charge of defining a set of tools to collect and integrate data from internal, external and Internet data sources. Its main functionality is to provide the correct way for storing information. For this purpose it is necessary to analyse the incoming data (types and volumes) that the IT<sup>2</sup>RAIL Business Analytics will manage and the type of information required after its processing. WP6 exploits the original data and transform it into valid and added value information. All this process needs to be extendable in order to integrate new incoming data, new functional requirements or new integration requirements.

The Data Management component will be able to handle the following information:

- **IT<sup>2</sup>RAIL internal data:** operative data collected by other IT<sup>2</sup>RAIL work packages.
- **Traveller experience indicators:** information coming from social network platforms and the associations with passenger data.
- **Monitor the performance of the transport systems or any part of them:** information related to the trip data and environmental data.
- **Business statistics like trends, statistical deviations:** information computed on the basis of trip and environmental data.
- **Traveller's feedbacks on transport quality of service:** information regarding passengers' feedbacks on the services provided by transport operators.

### 7.2 BIG DATA STORAGE

The key reason behind the rise of big data is their use to provide actionable insights. A concise, contemporary definition of big data is "*high-volume, -velocity and -variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making*". Typically, organisations use analytics applications to extract information that would otherwise be invisible, or impossible to derive using existing methods. As explained in the previous paragraph, the data management component is in charge of defining the interfaces with the Big Data

Storage and the internal and external data resources in order to collect and integrate information into a repository that provides quality and timeliness to the business analytics process. This kind of repository has to be scalable, robust, and it has to comply with the required Service Level Agreements (SLA) posed by the analytical services. Big Data storage might comprise structured and unstructured data that exist in high volumes and undergo high transformation rates.

These repositories should allow minimum latency requirements so that the analytical services that use the Big Data Storage module may provide timely answers depending on the needs of each of the data consumers. Summarising, Big Data Storage will handle very large amounts of data, such as traveller experience indicators, performance of the transport systems and so forth, and keep scaling to keep up with growth. This storage will also be able to provide the input/output operations per second (IOPS) necessary to deliver data to analytics tools by satisfying the required service level agreements (SLA).

### **7.3 INFORMATION MANAGEMENT AND ANALYSIS**

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The Information Management and Analysis component is in charge of the computation of the Business Analytics based on the data collected and stored in the repositories. This component includes processes allowing to move data from multiple sources, reformat them, clean them and charge them in another database, data mart or data warehouse to analyse and support a business process.

Some of the features included in the Information Management and Analysis logical functions are:

- Extraction of useful business information from a large volume of data handled by heterogeneous source systems.
- Assurance of traceability of the information provided, maintaining consolidated detailed data.
- Availability of data aggregation procedures which favour a global view of the business processes involved in the implemented system.
- Best practices in the definition of the ETL Model and processes which guarantee flexibility in terms of growth (processing capacity) and evolution (new lines, new products).

### **7.4 PRESENTATION**

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The Presentation component represents the graphical interface that will be used by operators to visualise the analytics of the IT<sup>2</sup>RAIL Platform. This component offers the ability to visualise a unified representation of the information related to the indicators and KPIs. The Presentation component may be accessed through:

- a web-based interface that enables transport operators to access the Business Analytics with authentication functions provided by the Travel Companion module.

- mobile devices that allow travellers to connect to the Presentation component integrated into the IT<sup>2</sup>RAIL mobile application.

The IT<sup>2</sup>RAIL platform users will have to connect to the Presentation component of the Business Analytics module by using an authentication mechanism. Authentication will be provided by means of a system that will allow granting of access to functionalities of the component according to the user's role.

The Presentation component consists of two views:

- the *Transport Intelligence* that delivers to Transport operators dashboards on IT<sup>2</sup>RAIL internal (such as transportation KPIs, travel events, usage, customer experience and satisfaction indicators) and external information (based upon analytics on big data, such as social data) that may be based upon different segmentation criteria. Furthermore Transport operators may perform analysis on: Travel data and impacting events, Traveller's feedbacks on delivered transportation services, periodic performance indicators.
- the *Travel Intelligence* that delivers to Travellers statistics on travels (e.g. average duration, number of travel legs, travel green footprints, etc.) and social information (e.g. comments and opinions) associated to a travel to be planned. Basic collected information may include travel data, travel green footprint to be used to inform Traveller and to support his/her decision.

Information managed by the Business Analytics module may be shown depending on user's roles, on different channels (web, mobile) and by using different visualisation instruments (charts, tables, dashboards). An effective data visualisation is a crucial aspect for the decision making process and includes the analysis of huge amounts of data and the highlighting of trends and correlations. The graphical interface will be structured in several panels and components in order to allow users an easy usage and interaction.

Several tools will be available to the users in order to provide a visual representation of the information:

- dashboards are data visualisation tools able to show the current status of indexes, metrics and KPIs. Dashboards can be used in order to arrange and to combine graphs, charts, metrics, and numbers on a single screen or multiple panels. Data visualisation will be made available by means of a customisable interface that will allow to pull the information from the Analytics Repository.
- charts provide a graphical representation of the information. Graphs represent data by means of symbols and help better understand trends and correlations. Furthermore charts ease the understanding of huge amount of data by pointing out the relationships among them.
- reporting tools will deal with the process of organising data into summaries in order to monitor the processed information, starting from data coming from other IT<sup>2</sup>RAIL modules. Furthermore the reporting process will enable to create interactive and formatted reports that will update IT<sup>2</sup>RAIL users regarding information and events managed by IT<sup>2</sup>RAIL platform. Several types of layout will be available in order to show the information within the reports.

The Presentation component will also provide the outputs of the reporting process in several formats such as Excel, CSV, JSON, XML and PDF.

The employment of these tools will ease the identification of trends, patterns, correlations, outliers, anomalies related to business aspects.

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## 7.5 BUSINESS ANALYTICS SERVICES

The Business Analytics services component exports KPIs to other IT<sup>2</sup>RAIL modules that need to obtain information stored in the repositories related to the analytics. This component allows to publish all Business Analytics services in a standard way that can be consumed by other components by leveraging the facilities offered by the IT<sup>2</sup>RAIL Interoperability Framework.

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## 7.6 SOCIAL TRAVELLER

Social Traveller is a component of the IT<sup>2</sup>RAIL Business Analytics platform and is in charge of collecting travellers' feedbacks:

- directly, through travel questionnaires, which include a set of questions to gather feedbacks on multi-modal travel managed by one or more operators.
- indirectly, through social networks information analysis.

Travellers use social network platforms (e.g. Twitter, Facebook) to share their feeds regarding news on facts around the world. This kind of information may be used in order to detect particular situations related to travel and transport domains. Messages sent to social network platforms will be collected by this component since they may contain particular information regarding transport quality of service, such as delays or feedbacks. Moreover this component is able to receive feedbacks and scores provided by means of Travel Questionnaires available on the Travel Companion mobile application. Collected data will be converted into indicators (KPIs) in order to measure Traveller's satisfaction level. Several business analytics will be computed on the basis of messages gathered by this component. These indicators will measure what the travellers think regarding travels and transport (e.g. specific travel legs). Furthermore this component will be responsible for analysing specific blogs or websites related to the travellers' experience, comparing them with the contents within the official accounts of the transport operators. Information included in the messages will be analysed by exploiting systems able to extract meaningful values from messages' contents.

**End-of-document**