BONVOYAGE

From Bilbao to Oslo, intermodal mobility solutions, interfaces and applications for people and goods, supported by an innovative communication network

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Deliverable D2.2:

BONVOYAGE Architecture

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Editor:	Vincenzo Suraci [CRAT]
Author(s):	Vincenzo Suraci [CRAT], Silvia Canale [CRAT], Lorenzo Ricciardi Celsi [CRAT], Federico Lisi [CRAT], Valentina Bracaglia [CRAT], Tiziana D'Alfonso [CRAT], Francesco Delli Priscoli [CRAT], Pietrabissa Antonio [CRAT], Francesco

	Liberati [CRAT], Martina Panfili [CRAT], Vittorio Palmisano [CRAT], Saverio Mascolo [CRAT], Manlio Proia [CRAT], Francesco Sorvillo[TRIT], Andréa Vassilev [CEA], Christelle Godin [CEA], Etienne Labyt [CEA], Stephan Strodl [FLU], Anton Fitzhum[FLU], Daniel Skrach [FLU], Nicola Blefari Melazzi [CNIT], Maria Bianco [CNIT], Andrea Detti [CNIT], Giuseppe Tropea [CNIT], Nerea Rojas [MLC]
Internal Reviewer(s):	Andréa Vassilev [CEA], Etienne Labyt [CEA], Dag Kjenstad [SINTEF]
Abstract:	The deliverable presents the work done within Work Package 2, with regards to requirements, functionalities, use cases, functional modules, software components, interfaces and exchanged data. The BONVOYAGE final reference architecture is presented.
Keyword List:	Requirements, Functionalities, Use Case, Architecture, Interfaces, Data Objects.

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Abbreviations

ABBREVIATION	DEFINITION
APP	Application
CAI	Commonly Agreed Interface
DB	Database
DBMS	Database Management System
DDBMS	Distributed Database Management System
EU	European Union
FEV	Fully Electric Vehicles
GPS	Global Position System
GTFS	General Transit Feed Specification
ICN	Information Centric Networking
ICT	Information and Communication Technology
IP	Internet Protocol
IT	Information Technology
ITS	Intelligent Transportation System
MMD	Multi-modal Mobility Database
NAP	National Access Point
OGC	Open Geospatial Consortium
OSM	Open Street Map
PDA	Personal Digital Assistant
POI	Point of Interest
RDSS	Regional Data Service Server
RFID	Radio-Frequency IDentification

ABBREVIATION	DEFINITION
RTTI	RunTime Type Information
SOAP	Simple Object Access Protocol
SP	Service Provider
TIP	Transport Information Provider
TISP	Transport Information Service Providers
TO	Transport Operator
ToC	Table of Content
TSP	Telematic Service Providers
UC	Use Case
VDI	Versatile Digital Item

Table 1: Abbreviations

BONVOYAGE Glossary

Table 2 lists and describes the terms that have been considered relevant in this deliverable.

BONVOYAGE GLOSSARY TERM	DEFINITION
Collective transport	A system of vehicles such as buses and trains that operate at regular times on fixed routes and are used by the public.
Functionality	Represents a capability (or a set of capabilities) offered by the system toward external entities, or by a sub part of the system toward another sub part of the system.
Individual transport	Represents the identified domain in which the user is the driver and has the control of the vehicle (bike, car sharing, car-pooling…)
Interface	Link between the different components in the architecture and defined by means of the set of services that the component supports.
Intermodal	Refers to the use of different transport modes in a journey to reach a destination
Internames	Internames is an "Information-Centric" communication Network, which collects and distributes all data through their identifying names, instead of their location on a particular server or host. Further, Internames is an advanced ICN which is able to operate across heterogeneous network realms.
Interoperability	Ability of two or more ICT Services to exchange information and use the information that has been exchanged in order to deliver new services or extend existing ones.
Platform	A platform is a group of technologies that are used as a base upon which applications, processes or technologies are developed
Reference Functional Architecture	High-level and preliminary description of the system, expressed in terms of interacting functional modules, each being a set of (homogeneous) functionalities.
Requirement	A requirement is a condition or capability needed to solve a problem or achieve an objective
Scenario	Scenarios describe the stories and context behind why a specific user or user group will use a specific solution or product. They note the goals and questions to be achieved and sometimes define the possibilities of how the user(s) can achieve them on the product. Scenarios are critical both for designing the system, their interfaces and for usability testing. Scenarios are generally used by user research people to communicate with design teams.
Service Providers (SP)	Represent the stakeholders that create apps or services which use the BONVOYAGE platform

BONVOYAGE GLOSSARY	
TERM	**DEFINITION**
Short Story	A short story is a brief statement, described in a very easy to read way, containing BONVOYAGE features from an end-user perspective. The short story describes the type of user, what they want and why from BONVOYAGE. Short Stories provide a quick way to handle needs without a big and annotated document that is difficult to read.
Stakeholder	The term of stakeholder refers to an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project.
Technology Providers (TP)	Represent the stakeholders that create or are responsible of the maintenance of the BONVOYAGE platform
Transport Information Providers (TIP)	Represent the stakeholders that will offer related transport information to BONVOYAGE platform, like Freight Operators, Transport Operators, Travel Operators, Information Providers
Use Case	A Use Case describes the behaviour of a system in a certain situation. Thus, the Use Case describes: • The entities that participate in the Use Case (actors) • The constraints that govern the Use Case • The circumstances in which the Use Case occurs (pre-condition) • The circumstances in which the Use Case concludes (post-condition) • The objective of the Use Case • The sequence of the interaction between the user and the system
User	Represent the stakeholders that will consume the services provided by the apps based on the BONVOYAGE platform (or the BONVOYAGE application itself). Passengers: Citizens that will make use of the services provided by the project. Private Driver: Citizens, truck and bus drivers... which drive a vehicle Companies: e.g. Transport operators who wants to find available services to be delivered Other entities that require specific information from BONVOYAGE.
User need	A User need describes the expectation of the user to the system

Table 2: BONVOYAGE Glossary

1 Introduction

1.1 Deliverable Rationale

This deliverable summarises the work undertaken and the results obtained within the work package 2 (WP2), “System requirements and design”. This WP has the objective of collecting and analysing the system requirements and, on the basis of such analysis, designing the system architecture and the interfaces between the BONVOYAGE components. For this purpose, WP2 has been divided into three main tasks: Task 2.1 “Requirements and Use Cases”; Task 2.2 “System architecture” and Task 2.3 “Interfaces”.

1.2 Quality review

Version control, Review Team - responsible staff/ beneficiary/ quality check levels

VERSION CONTROL TABLE			
VERSION N.	**PURPOSE/CHANGES**	**AUTHOR**	**DATE**
0.1	Draft index of the document	Vincenzo Suraci	08/10/2015
0.2	ToC review	Vincenzo Suraci	08/11/2015
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0.4	New title & insertion of preliminary contributions from TRIT and CEA	Lorenzo Ricciardi Celsi	24/03/2016
0.5	Insertion of contribution on state of the art	Lorenzo RIcciardi Celsi	17/04/2016
0.6	Insertion of contribution on functionalities	Federico Lisi	18/04/2016
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0.9	Internal review	Etienne Labyt, Dag Kjenstad	27/04/2016
1.0	Final check. Authorized	Nicola Blefari Melazzi	29/04/2016

Table 3: Review Team

1.3 Executive summary

1.3.1 Deliverable description

The document is organized as follows:

- Section 1 (this Section) describes the deliverable, its structure, results and impact.
- Section 2 introduces the key design goals of the architecture. It shows the fundamental concepts and the context the BONVOYAGE platform will operate in.
- Section 3 presents a revised set of Use Cases, Requirements and Functionalities that have been introduced in the previous deliverable, "D2.1 - Use Cases and Reference Architecture".
- Section 4 presents the BONVOYAGE reference architecture, showing how it comes from a straightforward top-down design process that starts from the uses cases and ends up in a rational system architecture that borrows also from software architectures developed in other research projects.
- Section 5 focuses on the internal interfacing architecture. This is useful to understand how to develop an implementation of the reference architecture presented in the previous sections, for instance leveraging both existing commercial solutions and the outcome of research effort, and also how to implement third party services on top of the platform.
- Section 6 describes in detail the impact of data sources the BONVOYAGE platform will be fed with on the design of the architecture. It discusses the distributed nature of the platform and design choices based on typology (e.g. static/dynamic, real-time, sensor based, etc.) of external data.
- Section 7 focuses a selection of the presented use cases, grouping them in meaningful "reference" application scenarios that will ultimately challenge the BONVOYAGE project.

1.3.2 Summary of results

The following achievements and results are included in this deliverable:

- Reviewed list of BONVOYAGE use cases, requirements, functionalities, functional modules and their formal validation through a web based analysis tool;
- Finalization of the BONVOYAGE composable, functional reference architecture and comparison with relevant, state of the art architectures;
- Identification of the project's data sources and external interfaces;
- Identification of the functional modules internal interfaces and related data objects;
- Identification of the BONVOYAGE software components, that will be the starting point for the BONVOYAGE demonstrator implementation, as an instance of the BONVOYAGE reference architecture.
- Identification of the project scenarios and selection of the meaningful subset of use cases to be implemented and validated.

1.3.3 Impact on other Project activities

The reference architecture presented in this document impacts on all the other technical workpackages. Indeed, the BONVOYAGE architectural components, described in Section 4, have been associated to each technical workpackage (WP3 to WP6). Furthermore, the BONVOYAGE story, use cases and related scenarios, defined respectively in sections 1, 2 and 7, will influence the work to be done in WP7.

2 Key architecture design goals

The aim of BONVOYAGE is to tell users what is the **best way to go from a place to another**, door to door, by using any combination of any transport means.

To this end, the project is designing, developing and testing a platform **optimizing multimodal transport of passengers and goods**. The platform integrates travel information, planning and ticketing services, by automatically analysing non-real-time data from heterogeneous databases (on road, railway and urban transport systems); real-time data (traffic, weather forecasts, data from smartphone and wearable sensors); user profiles; user feedback. The platform is supported by an **innovative communication network** that collects and distributes all the data required to optimize a travel.

This deliverable focuses on the design of an architecture based on **three main system components**: i) **applications and services**, which must cope with multimodal, dynamic, distributed, multiparty, open scenarios; ii) a **travel optimizer tool** providing travel instructions, which are personalized for each user, adapted in real time to current transport conditions of a given context, and optimal for that user and that context; iii) a **communication network**, which provides large scale search and delivery of all relevant data, from schedules to sensor-generated and user generated real-time information.

In the following, we describe in more details each of these components, as a starting point for our top-down approach to the design of the architecture, trying to summarize their more innovative/appealing characteristics.

2.1 Description of main system components

2.1.1 Applications and services

Applications and services allow external heterogeneous actors to seamlessly interact with the BONVOYAGE platform. They provide functionalities to integrate and adopt services of transport operators into the platform and a mobile application to interact with end users. The mobile platform provides the user with route information and collects relevant user feedback using participatory sensing while traveling.

The mobile application enables users to find the best way to go from one place to another taking into account the users personal needs and preferences in terms of schedule, duration, costs, transport means, reliability, transport mode related to low user's stress level, etc. The application follows complementary interface and interaction design allowing users to intuitively request required information and receiving personalized multimodal travel routes. During the trip, the application guides the user with required information and reacts on dynamic, real-time conditions that interrupt and affect the ongoing trip. User feedbacks will be collected via unattended and attended feedback functionality taking into account new trends such as smart wearables. The user behaviour and feedback data are used to

derive data-driven user profiles that are used to customize services and travel solutions. The feasibility of the developed mobile platform will be tested and evaluated in realistic open scenarios.

In order to access and use external services and data the architecture provides integration and adaptation mechanisms to integrate technology dependent interfaces. An adaption framework for intelligent transport functionalities allows to easily integrate and personalize external transport operator services for BONVOYAGE users. This functionality ensures flexibility and expandability of the platform to integrate other transport services.

2.1.2 Travel optimizer

The travel optimizer is a core function of the BONVOYAGE platform. Our solution is a collaborative framework for distributed optimization services. This approach enables the necessary scalability to handle continent-wide travel networks combined with personalized travel preferences. At the same time, it also enables fast response to real-time events. Hence, the resulting solutions are truly intermodal, handling combinations of any private and public modality in the same journey. The existing, alternative technology heavily relies on extensive pre-processing which limits the possibility to exploit real-time information as well as personalized user profiles. The BONVOYAGE travel optimizer goes beyond these limitations thanks to its distributed architecture and its novel algorithms.

2.1.3 Telecommunications network

The highly heterogeneous, distributed and mobile nature of transport data, coming from data-centres, sensors, vehicles, goods and people on the move, calls for a new networking model.

The **current Internet model** is based on the Internet Protocol (IP) and provides users with communication channels between hosts (e.g. a client and a server) that are identified by an IP address. IP network nodes, or routers, forward data among users' hosts on the basis of their IP addresses, which statically determine where they are topologically located in the network. IP routers are blind as to what they are forwarding. Security is provided by securing the communication channels.

Our **alternative reference model** is called **Information Centric Networking** (ICN), a paradigm emerged to overcome some intrinsic limitations of the current Internet. In ICN, the network provides users with access to information by names, instead of providing communication channels between hosts. The idea is to provide "access to named data" as the fundamental network service. This means that all information (e.g. a document, a picture) is given a name that does not include references to its location; then, user's requests for a specific information are routed toward the "closest" copy of such information, which could be stored in a server, in a cache contained in a network node or even in another user's device; finally the content is delivered to the requesting user by the network. With ICN, the communication network becomes aware of the name of the information that it provides and the routing decisions are made on the basis of the information name. This enables nodes to

carry out advanced delivery services, like caching and multicasting, thus reducing the resources needed on servers, and improve responsiveness and reliability of applications. In addition, ICN secures the information package itself, instead of securing the communication channels, thus information can be trustily delivered also by untrusted servers or nodes and remain protected also when emerges from a communication channel (e.g. a picture is protected not only while it travels into the network but also after arriving at destination). As a result, ICN: i) improves network efficiency, thanks to in-network caching and information-based routing; ii) naturally supports mobility and multicast communications; iii) eases the operation of fragmented networks, or sets of devices disconnected from the rest of the network (e.g. sensors networks, vehicular networks, social gatherings, mobile networks on board trains, planes, or networks stricken by disaster; note also that ICN could be applied to the whole Internet but also to a subset of it, this is especially useful in our environment); iv) offers simpler application programming interfaces; v) provides an information-oriented security and access control model which is rapidly becoming essential, in a world where all traffic in being encrypted, wreaking havoc with established network mechanisms.

2.2 Innovative characteristics supported by the architecture

Innovative characteristics of our architecture with respect to current solutions include:

- optimization of a **multimodal** trip (e.g. resulting from a combination of bike+train+plane+bus+on foot)
- taking into account **dynamic, real time**, conditions (e.g., delay of trains, construction work on a road, bad weather, user's stress level…)
- taking into account **user preferences and profiles**, including dynamic information like preferred transport modes and user's stress level related to different transport modes as estimated from previous travels through data collected by wearable smart sensors and smartphone sensors
- facilitating the **large-scale search, sharing and delivery** of transport solutions and related data among transport providers, travel service operators, applications and users; this is one of the main problems nowadays: how to collect transport information not only from big airlines/train operators but also from all the millions, small scale, bus/local transport/private providers
- allowing transport providers to keep their **data and services in their premises, with their formats and interfaces**, rather than transfer them to a third, centralized party (e.g. Google) and/or to comply with specific format (e.g. GTFS)
- allowing travel operators or applications **to get data directly from the transport providers** rather than from a third party
- allowing any one to **easily publish transport solutions, including private citizens** (e.g. for car sharing purposes, hitching a lift)
- allowing any one to **set up access restriction and privacy policies on published data** and then verify the owner and the authenticity of published data
- allowing any one to **easily exploit all such information** (e.g. anyone can develop an application and become an online travel platform provider).

The following chapters detail the design process we have followed in order to come up with a functional architecture based on the above mentioned three basic building blocks and able to accommodate the key innovations listed above.

As anticipated, the design process started as top-down, but was complemented with bottom-up solutions for what concerns the design of the internal interfaces between the components of the architecture.

3 Revised Requirements, Functionalities, Use Cases

This chapter summarises the activities carried out to review, enhance and finalise BONVOYAGE requirements, functionalities and use-cases in order to obtain consolidated lists of BONVOYAGE requirements, functionalities and use-cases. These serve as basis for design, development and implementation Tasks envisaged under the project technical Work Packages (namely: WP4 Intelligent Transport Functionalities; WP5 Adaptation Functionality; WP6 Multimodal integrated interfaces and Apps; WP7 System Integration and Validation).

3.1 Requirements

BONVOYAGE requirements aim to illustrate what actions / functionalities BONVOYAGE platform should perform in a cross-border, multi-modal, door-to-door journey planning process, with reference to both **passenger and freight transport services**.

Concerning the methodological approach, requirements were defined based on:

- A benchmark analysis of widely used mobility/travel technology platforms and Apps, that mapped, analysed and compared existing functionalities offered by mobility/travel technology platforms and Apps currently available on the market;
- A careful investigation on enhanced and new functionalities to be included in BONVOYAGE in order to make BONVOYAGE a real innovative mobility platform and achieve a concrete progress in the field[1].

Requirements are distinguished in two main categories:

- **Functional requirements** that describe how the platform works in order to enable a specific functionality/operation.
- **Non-functional requirements** that describe how the platform shall provide a specific functionality/operation.
  Non-functional requirements focus on security features, expressed in terms of confidentiality, integrity and availability, as well as on Internames Communication System features.

Functional and non-functional requirements both relate to the following stakeholders categories[2]:

- Users, which include: passengers interested in using BONVOYAGE platform to plan and purchase a cross-border, multi-modal, door-to-door travel itinerary; citizens interested in

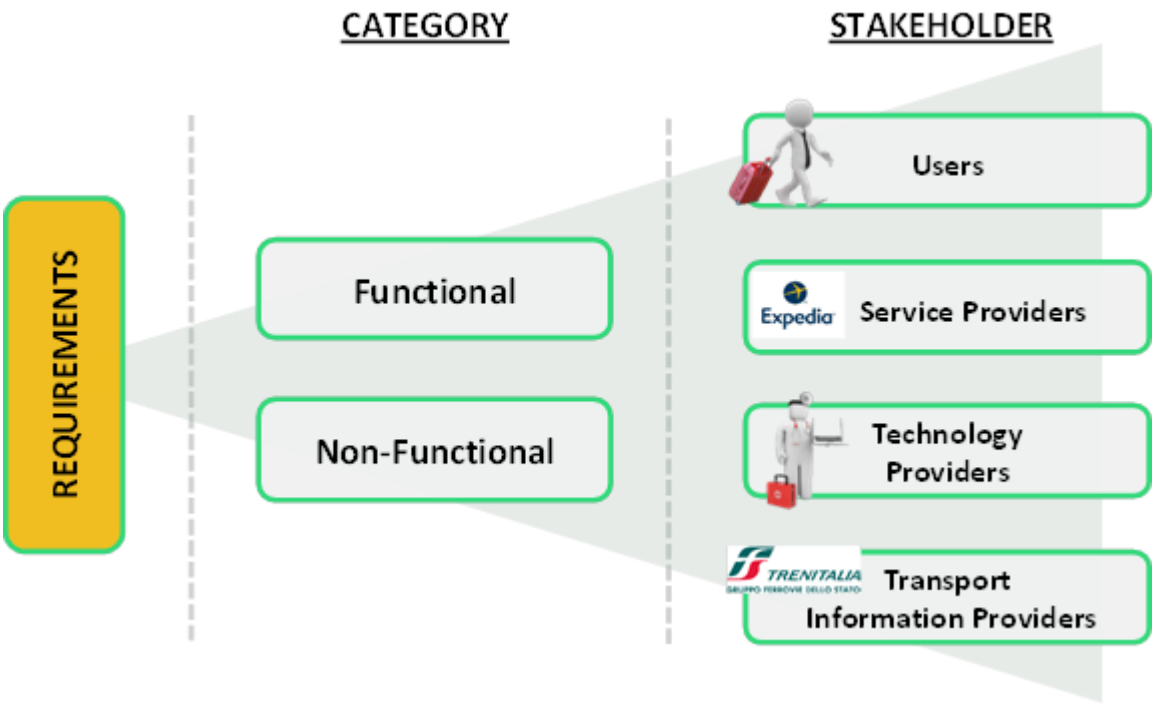
[1] A complete description of the methodology applied to define BONVOYAGE requirements can be found in Deliverable 2.1 – Chapter 4

[2] A detailed description of BONVOYAGE stakeholder categories can be found in Deliverable 2.1 – Chapter 4.

looking for and purchasing cross-border freight transport services; freight transport operators that want to use BONVOYAGE platform to identify new, cross-border and more efficient routes they could cover for freight delivery within Europe;

- Service providers: companies, passengers and freight transport operators that manage Apps or services which retrieve information on passengers and freight transport services "owned" by the BONVOYAGE platform in order to provide services to their own end-users;
- Technology providers: stakeholders that create or are responsible for the maintenance of the BONVOYAGE platform;
- Transport information providers, which include: passengers and freight transport operators as well as travel operators that provide information and data on their services to BONVOYAGE platform; other stakeholders that will provide context-related information to the platform in order to enrich its intelligent capabilities (e.g. weather, sensors and crowd-sourced data, parking facilities).

The picture below illustrates the link between BONVOYAGE requirements and stakeholders categories:



With respect to the initial list defined in Deliverable 2.1, BONVOYAGE requirements were fine-tuned, merged (when redundant) or integrated with new relevant requirements (e.g. BU491 "Users aggregation for car sharing services"; BU981 "Vertical Support and re-planning of the trip in case of high user stress level") in order to better highlight specific platform features (e.g. car sharing / car polling services; detection of user stress level through Internet

of Things sensors) as well as to make requirements more clear and understandable, thus easing the future development and implementation activities.

Importantly, a prioritization exercise was necessary to start identifying the most relevant requirements to be implemented in the BONVOYAGE prototype and validated during the project demonstration phase, with the aim to conciliate the wide and articulated range of requirements with the effort allocated to the project development and demonstration activities. For this purpose, requirements were prioritized based on the following criteria:

- BONVOYAGE specific innovative and distinctive features / functionalities that shall be demonstrated and validated by the end of the project (e.g. the Intelligent Transport Functionalities: User Profiler Tool, the Multi-Objective Optimisation Tool; the Tariff Scheme Design Tool);
- business and industrial interests, needs and innovation perspectives expressed by project partners;
- mobility platforms state of the art.

The outcome of the prioritization exercise was the classification of BONVOYAGE requirements in four different priority levels, based on their relevance for BONVOYAGE platform operation and innovation potential. Therefore, requirements were distinguished in:

- **mandatory**: essential requirements for BONVOYAGE operation but not representing innovative platform features;
- **priority 1**: highly relevant requirements that express BONVOYAGE platform innovative potential and underlay BONVOYAGE innovative and distinctive functionalities, with special reference to user profiling, multi-modal transports and real time data communication. These functionalities represent the “core” of BONVOYAGE added value as they: concretely enable customised and multi-modal travel solutions planning; follow the new path and changes brought by the digital transformation with respect to citizens needs and expectations and transport operators/services evolution. For instance, these functionalities provide citizens an improved customer experience with respect to digital mobility services, allowing them to plan a door-to-door travel, associate to it and purchase any event, additional service they are interested in; they also allow transport operators to keep pace with technology innovation trends in the mobility field, strengthening their digital services and satisfying new citizen’s needs;
- **priority 2**: relevant requirements for BONVOYAGE platform, related especially to “social” features (e.g. chat inbox, word of mouth) and travel solution modification;
- **priority 3**: requirements expressing additional features of BONVOYAGE platform.

The table below provides an overview of requirements defined for the different stakeholders categories as well as of the results of the prioritization exercise.

		Stakeholders categories			
Totals		**User**	**Service Providers**	**Technology Providers**	**Transport info. providers**
Requirements	***208***	***155***	***22***	***9***	***22***
Mandatory	52	36	4	1	11
Priority 1	66	52	3	5	6
Priority 2	51	41	8	1	1
Priority 3	39	26	7	2	4

Table 4: Functional Requirements by priorities and by stakeholders categories

The following sections illustrates the list of priority 1 requirements and provides a comprehensive overview of the ambitious novelties and the progress that BONVOYAGE intends to introduce in the mobility and travel sector.

Requirements are divided according to the relevant stakeholder category and are distinguished into functional and non-functional requirements.

The comprehensive list of all BONVOYAGE requirements is provided in the Annex A to this deliverable.

3.1.1 User requirements

This section illustrates priority 1 requirements related to BONVOYAGE platform end-users, which exploits passengers and freight transport services provided by the platform.

The following general aspects are worth mentioning for passenger and freight transport services:

- For passenger transports, BONVOYAGE requirements provide the possibility to include not only “collective transports” but also “individual transports” (e.g. passenger own car and car sharing services) when planning the multi-modal travel itinerary;
- For freight transports, BONVOYAGE requirements deal with aspects related to delivery of goods from the point of view of individual users, transport operators and transport services providers who have different needs when planning/organizing a delivery service.

User functional requirements show the most innovative functionalities enabled by BONVOYAGE platform. They mainly include:

- Innovative features / functionalities envisaged under BONVOYAGE proposal and related to the capability of the platform to return customised travel solutions to each single user:
  - **User profiling**: the capability of BONVOYAGE platform to create, store and continuously update a comprehensive user profile, that is composed of: all the information provided by the user and related to his/her personal data and travel preferences (e.g. preferred transport modes, preferred locations); information on user preferences deducted by the platform on the basis of users effective mobility choices and travel behaviours detected over time. The user profile will serve as basis for BONVOYAGE platform when planning a customised travel solution;
  - **Customised travel solution planning**: the capability of BONVOYAGE platform to plan and return a list of multi-modal travel solutions based on both the user profile and the specific search parameters set by the user on a case-by-case basis; For the freight perspective, capability of provide the most efficient route according to the transport operator needs and external constraints that affect in the route calculation.
  - **User feedback provisioning:** the possibility for the user to provide a feedback on: the travel solution returned by the BONVOYAGE platform (e.g. the travel solution returned by BONVOYAGE platform meets his/her preferences and expectations); how the travel is going on.

    Importantly, user feedback may be provided on purpose by the user (explicit feedback) or detected by BONVOYAGE platform based on the user stress level during the travel (implicit feedback). They will be registered by BONVOYAGE in order to update user profile and preferences to be taken into account for future travel solution planning;
  - **“Virtual assistance” for travel monitoring, disruption detection and automatic re-planning:** the capability of BONVOYAGE platform to enable a virtual assistance functionality with the aim to: track and monitor how the travel is proceeding; identify and alert the user in case of disruptions that may cause difficulties to the user to cover

the whole travel itinerary; to automatically re-plan and suggest to the user an alternative, customised, multi-modal travel solution; automatically re-plan and propose the user an alternative travel solution if the user stress level is high;

- Innovative features / functionalities of interest of most of transport operators as they allow to offer a comprehensive and enriched journey experience to their customers, thus representing an added value for both transport operators (specifically for their daily business and competitiveness improvement) as well as for citizens, that will enjoy more complete, easy-to-use and satisfying journey planning services:
  - **Events / Ancillary services purchase:** possibility for the user to purchase events tickets (e.g. museums, concerts) and / or other ancillary services when purchasing the travel solution;
  - **Travel objective setting:** possibility for the user to define a specific objective he wants to reach while travelling (e.g. CO2 savings) and to be rewarded for the achievement of the target objective.
  - **Loyalty programmes, score collections and awarding:** possibility for the user to subscribe to a loyalty programme that allows him to collect scores (based on pre-set rules[3] and upon travel solution purchase) and obtains customised awards;
  - **Promotions/discounts awarding:** possibility for the user to receive discounts and promotions by both transport operators that have joined BONVOYAGE platforms and their partners offering different services than transports.

The following tables show the entire list of user priority 1 functional and non-functional requirements.

The table that summarize all the user requirements is at the end of this document (please see ANNEX A).

[3] Scoring rules will be defined under the Work Package 4 Intelligent Transport Functionalities – Task 4.3 Tariff Scheme Design Tool. They will aim to foster the user to select the most socially desirable mobility solutions (e.g. those with the lowest environmental impact).

Functional requirements

ID	TITLE	DESCRIPTION
BU30	**Base account definition/setting**	In every moment after completion of the initial basic registration, capability of BONVOYAGE platform to allow the user to update his account with the following additional, optional information: - Name; - Mobile phone number; - Nickname, photo, icon identification; - insertion and save of addresses / favourite places; - list favourite events/favourite places; - fidelity programmes of BONVOYAGE transport operators and service providers (e.g. Star Alliance awards); - age range; - employment. Account update can be done whenever the user wants to. Each information shall be sided by a box explaining why that information is required and how BONVOYAGE will use that information to determine the most suitable solution for the user (e.g., personalised discounts/promotions). In his account page, the user will have the possibility to display fidelity points accumulated.
BU50	**Profile loyalty categorisation/setting**	Capability of BONVOYAGE platform to categorize the user in different fidelity profile groups based on scores collected.
BU80	**Define profiles for the definition of the travel solutions**	Capability of BONVOYAGE platform to manage search engine parameters in order to give preference to defined travel solutions according to a pre-defined user profile.
BU90	**Differentiate travel solutions for profiling**	Capability of BONVOYAGE platform to diversify travel solutions according to different user profiles.
BU140	**Push notification suggesting transport or events tickets purchase**	Capability of BONVOYAGE platform to send the user push notification containing suggestions and / or proposals to purchase transport services or additional services targeted to the user: - Local Public Transport (LPT) ticket (for destination city LPT); - taxi; - car sharing; - museum tickets.

ID	TITLE	DESCRIPTION
BU160	**You add me on travel**	Capability of BONVOYAGE platform to allow the user to: - share route information (e.g.: travel time, estimated time of arrival) and location with "your friends" on the App BONVOYAGE; - share address associated with contact phone / smart phone (which then becomes the starting address / travel destination); - share information on the place reserved on the means of transport with their friends; - share favourite places with other applications that require location information; - share user location with other Apps; - share his travel solution with other users in order to share group tickets. (every sharing request shall be implicitly/explicitly accepted, ignored or refused by the beneficiary)
BU170	**Information on the state of the circulation**	Capability of BONVOYAGE platform to allow the user to share : - real time information on road traffic status (public transportation, road status, road works, roadblocks, accidents, road closures, etc.) with other BONVOYAGE users, adding the information on BONVOYAGE platform. The information on road works can be shared by the user with local law enforcement agencies, as BONVOYAGE platform is connected with them. Possibility for the user to share these data with all the community, or with defined clusters of users or with identified users (own "friends"). Possibility for the user to share information with other BONVOYAGE users (travellers).
BU171	**Real time information on the status of the circulation detected by BONVOYAGE**	Capability of BONVOYAGE platform to detect real time information / input from sensors/devices according to their time and space validity.
BU180	**Public transports information**	Capability of BONVOYAGE platform to allow the user to share real time information on public transports traffic / status (e.g. delays, strikes, itinerary changes, etc.) with other BONVOYAGE users, adding the information on BONVOYAGE platform. Possibility for the user to visualise information shared by other BONVOYAGE users concerning: - Public transportation Status (e.g. train / bus not started yet, late / early, filling rate, cleanness); - Public transport lines (e.g.: delay, strike, problems of access); - Line of bus, metro on "where you are" (e.g.: delay, line out of service, accidents, change track, change path, driver assessment, the wrong path);

ID	TITLE	DESCRIPTION
		- Stops / stations of public transport nearby.
BU200	**Radar interception**	Capability of BONVOYAGE platform to allow the user to set a filter system (km , number of hours) to visualise information on: - transportation; - state of the traffic - accidents (e.g. .: 100 km from the place of departure). These are features for user on the go. The user is informed of his choice with a pre-set time in advance (time defined by the user) about accidents along the way. This information will be received by the user through a push notification.
BU241	**Events or denomination based search**	Capability of BONVOYAGE platform to allow the user to indicate an event or a denomination instead of the origin / destination address. BONVOYAGE provides a list of pre-defined categories for possible denominations (e.g. Museums, restaurants, others).
BU250	**Services/events localisation**	Capability of BONVOYAGE platform to calculate and give the user information on location and distance of: - Car services (gas stations, parking); - Transport (bus stations, train, airports, etc.); - Public services (schools, universities, hospitals, police, post offices); - Shopping and services (supermarkets, shops, pharmacies, travel agencies; - Food and drink, restaurants; - Cultures and entertainment (theatres, cinemas, museums); - Hotels; - Outdoors (beaches, golf courses); - Natural features (islands, lakes, forests). Possibility for the user to define the area of the location (e.g.: 5/15 minutes by walk / drive). Capability of BONVOYAGE platform to localize service / event on the map.

ID	TITLE	DESCRIPTION
BU251	**SOS Services request**	Capability of BONVOYAGE platform to allow the user to require and receive road side assistance (if necessity) through BONVOYAGE platform. The user can send a request for assistance simply pushing a bottom on his BONVOYAGE App.
BU270	**Information visualisation**	Capability of BONVOYAGE platform to allow the user to visualise other shared information on the map (e.g. incidents).
BU280	**Information visualisation selection**	Capability of BONVOYAGE platform to allow the user to select information that will be visualised in the map.
BU320	**Planning - Inter-modal travel solution Settings**	Capability of BONVOYAGE platform to allow the user to: - Select preference path (e.g.: shortest, faster, less foreign exchange); - Select favourite transportation (e.g.: bus, subway, train, tram, trucks / heavy vehicles); - Select of routes to be avoided (e.g. toll roads, highways); - Identify preference level of different public transport / private (score 1-5): taxi, tram, bus, walk, train, subway, car, bicycle. - Select vehicles owned (car, motorcycle, bicycle); - Select access to transportation: car-sharing, bike-sharing, cars, motorcycles, bicycles; - Select of P.O.I (points of interest) for freight transport operators, like ports, stations, inter-ports; - Insert geographical coordinates of the arrival/destination point as input for travel solution planning.
BU321	**Planning - Travel solution Returning**	Capability of BONVOYAGE platform to find and rank feasible solutions according to the following selection criteria: - The best k solution (with k fixed) are returned; - Identification of the preferred solution among the k returned.

ID	TITLE	DESCRIPTION
BU330	**Planning inter-modal travel solution through filter**	Capability of BONVOYAGE platform to allow the user to search for a travel solution using the following filters: - price (price ranges, e.g.: 0-100 €, 100-200€, etc.); - class category (first class, second class, etc.); - hour range for departure and return trip (e.g. only morning; only evening; from hour XX to hour XX); . total journey duration; - comfort; - environmental impact/foot print (e.g. CO2 grams); - total travel time; - in-vehicles time; - number of changes; - offers; - meals; - feedback score; - services (Wi-Fi, non-smoker, gym, animals allowed). - special needs (in this case the user shall specify if the special needs relate to: disabled people; user with a baby chair; bikes to carry during the trip; pets to carry during the trip; luxury (this can also be a preference, but in this case, is treated as a need e.g.: limo and luxury for the honeymoon).
BU340	**Travel itinerary search and planning (high priority search modality and information to be displayed)**	Capability of BONVOYAGE platform to allow the user to make a research for a travel itinerary as follows: - search vehicle available for the selected route (with notification of any changes) - search for "mes" in the destination list / stations - insert an event run by BONVOYAGE partners as origin / destination of a journey (e.g. .: show run by a museum) - insert as a destination the geolocation of another BONVOYAGE (user subject to their consent). Possibility for the user to include in the travel itinerary search the following information: - commercial operators/merchants name (e.g. .: shop, restaurant); - number of passengers; - passengers age-range; - disabilities. BONVOYAGE will calculate and return a number of different multi-modal travel journeys for the selected itinerary taking into account: the preferences of public or private transport expressed during the user registration; category of membership of the user; previous actual mobility behaviour in similar circumstances and behavioural profiling based on

ID	TITLE	DESCRIPTION
		user feedbacks (if provided). BONVOYAGE will calculate solutions for - home town-destination by car; - home town-resort destination by local travel / national / transnational public transports.
BU350	**Additional information about the trip**	During the request of the travel solution. capability of BONVOYAGE platform to allow the user to enter information on: - the travel scope (e.g.: work, pleasure); - number of people (e.g.: alone, with friends, in couple, with children older than 1 year/8 years, etc.); - day time (early in the morning, late night, etc.).
BU371	**Trip monitoring and control**	Capability of BONVOYAGE platform to allow the user to check that the actual trip is in line with the selected one while travelling. The status of the trip and involved resources (in terms of transport modality) are monitored according to possibly different policy (e.g., fixed time, on demand, etc.). If a considerable deviation from the planned trip is detected or some resources become available or no more available, then - a new set of feasible solution is recomputed - the best k solutions (with k fixed) are returned This will be possible through the intervention of a virtual assistance (as described in requirements BU 990).
BU390	**Route visualisation**	Capability of BONVOYAGE platform to allow the user to: - Visualise the itinerary; - Visualise the route (map) followed by transport (user already on board); - Visualise points of interest for car drivers: picnic areas, camping sites, landmarks, tunnels, accident-prone areas; -Visualise specific road information for particular user categories (e.g. for the heavy vehicles drivers): width, permitted axel load, height in tunnels, gradient of slope/curvature, snow flow standard; restoring areas, parking area where the truck drivers can relax or sleep; - Visualise points of interest for car drivers and heavy vehicles drivers (e.g. dedicated areas along the roads where change snow chains).
BU400	**Non-existent route**	Capability of BONVOYAGE platform to send notification of unavailable travel solutions for the route start-selected (the notification can be related also to a single phase of the travel).

ID	TITLE	DESCRIPTION
BU440	**Define searching engine for travel solutions**	Capability of BONVOYAGE platform to select travel solutions aligned to a specific user profile and to reject solutions that are not in line with this profile.
BU450	**Defining objectives to be achieved in a given time interval**	Capability of BONVOYAGE platform to allow the user to define a target: calories, emissions, money. Each target reached allows the accumulation score/points (e.g.: more heat = more points; less emissions = more points, more money saved = more points). (preferential requirement).
BU460	**Mission/Travel monitoring**	Capability of BONVOYAGE platform to allow the user to track and visualise information on: - progress towards achieving the objectives; - time remaining at the end of the time pre-set for the achievement of (mandatory requirement)
BU470	**Mission/Travel cancellation**	Capability of BONVOYAGE platform to allow the user to delete the objective (of the mission)
BU490	**Car-pooling / car sharing service choice and booking**	Capability of BONVOYAGE platform to: - allow the user to book a car sharing service (by re-sending to the site manager of car sharing service selected) in route planning; - allow the user to share the booked car sharing service with other BONVOYAGE users that are interested in the same service to cover the same itinerary (entirely or partially). Possibility for the user to use his own car and share it with other users (car-pooling) to cover a specific route, instead of booking a car sharing service.
BU491	**Users aggregation for car sharing services**	When a different users are interested in the same car sharing service to cover the same itinerary, capability of BONVOYAGE platform to match the users based on: - their profile; - the feedback on reliability they have previously received by other BONVOYAGE users. When BONVOYAGE matches the user, capability of BONVOYAGE platform to send each user a push notification that: - proposes other users with which it would be recommended to share the car sharing service; - shows other users profile and feedback.

ID	TITLE	DESCRIPTION
BU580	**Integrated ticketing**	Capability of BONVOYAGE platform to produce multimodal / multi-service integrated ticketing.
BU660	**Best price management**	Once the BONVOYAGE has returned all the available travel solutions for the itinerary selected by the user, capability of BONVOYAGE platform to allow the user to visualise and select the best price (with related services) of the week or of the month
BU670	**Class Choice**	Capability of BONVOYAGE platform to allow the user to choose the preferred class/tariff
BU690	**Discounts/Promotions**	Capability of BONVOYAGE platform to allow the user to visualise discounts/promotions available and to buy them. The list of possible promotions shall be ranked according to user profile defined as: - the commercial profile assigned at the registration moment; - the behavioural profile emerged by analysing data about the user and the feedbacks provided.
BU790	**Booking services partner from integrated operators in BONVOYAGE**	Capability of BONVOYAGE platform to allow the user to book services from partners of transport operators integrated into the BONVOYAGE platform.
BU860	**Travel solution purchased Reimbursement**	Capability of BONVOYAGE platform to allow the user to: - require the reimbursement of travel solution purchased; - require partial repayments of a LPT service not enjoyed through contacts BONVOYAGE (online, free BONVOYAGE phone number)
BU961	**User sending feedback on a received travel solution**	Capability of BONVOYAGE platform to allow the user to: -insert and share his feedback on the travel solution he obtained for a specific itinerary; -visualize feedback on a specific travel itinerary uploaded and shared by other users. Feedback can be provided by the user only if he has concretely experienced a travel solution. Feedback can be provided in two ways: - by the user in a proactive way (from the Feedback functionality Tab of BONVOYAGE platform); - upon request of BONVOYAGE system (BONVOYAGE sends the user - through email - a request to evaluate his travel experience).

ID	TITLE	DESCRIPTION
BU970	**Follow me**	Capability of BONVOYAGE platform to allow the user to: - Receive assistance during journey to deliver an opinion and satisfaction degree on development of the trip concerning the overall travel solution and/or each single uni-modal step (e.g. during the travel, when a change of vehicle happen; on-line support). - Receive assistance by activating the function of rescheduling with the possibility of providing a negative feedback if applicable. - Enable indoor and outdoor maps visualisation (based on requirement BU261).
BU980	**Vertical Support and re-planning of the trip in the event of unforeseen**	Capability of BONVOYAGE platform to allow the user to: -send requests for help to re-plan trip in case of unforeseen circumstances; -receive support to re-plan the travel itinerary (hint alternative route) through the intervention of a virtual assistance [very ambitious requirement]. Virtual assistance can be activated in any moment by the user, except when he acts in a proactive way (as described in requirement BU961). Virtual assistance is always active by default for the heavy vehicles category.
BU981	**Vertical Support and re-planning of the trip in case of high user stress level**	While the user is travelling, capability of BONVOYAGE platform to: - receive information on the user stress level detected and processed by wearable sensors and communicated to BONVOYAGE platform; - automatically re-plan and propose the user an alternative travel solution if the user stress level is high. Once the travel is over, capability of BONVOYAGE platform to: - register the user stress associated to the travel solution and related transport modes; - propose the user travel solutions that do not include transport modes that may cause him / her a high stress level (for future requested travel solutions).
BU990	**Collecting score**	Capability of BONVOYAGE platform to allow the user to gather points/scores based on: - Travel solutions purchased (e.g. based on low environmental impact of the purchased travel solution); - Quantity and type of information mobility shared with other users; - Achievement of objectives. Possibility to gather scores from external services providers having a partnership with at least one of the BONVOYAGE partner operators.

ID	TITLE	DESCRIPTION
BU1000	**Score visualisation**	Capability of BONVOYAGE platform to allow the user to check his score, with his list of purchases / points earned, and its position in the ranking. Possibility for the user to visualise the ranking of the other users (general rank and rank weekly) to determine the user "reliability".
BU1010	**Award**	Capability of BONVOYAGE platform to allow the user to obtain awards (e.g. transports or car sharing, bike sharing free tickets). Awards proposition to the user will be based on these preferences (where possible). Possibility for the user to receive an award as BONVOYAGE scores from external services providers having a partnership with at least one of the BONVOYAGE partner operators.
BU1020	**Receiving and obtaining promotions/discounts**	Capability of BONVOYAGE platform to allow the user to: - receive promotions from the partners of BONVOYAGE, associated with specific classes of users (ex .: over 60); - receive offers from the partners of BONVOYAGE, for sites designated as favourites. - obtain reductions for TLP (e.g. .: older passengers (over 60) discount). - receive promotions/discounts according to the profile (commercial and/or behavioural) associated to the user; - disable the promotion receptions (through a specific settings functionality); - receive promotions / discounts or buy (at full price) tickets for events (e.g. museums, tourist tours).
BU1260	**Setting an alert on info-mobility update**	Capability of BONVOYAGE platform to allow the user to set and receive (when the BONVOYAGE App is on) an alert with new info-mobility about freight services, instantly or from time to time (e.g.: every day in the morning), when data is available from transport/traffic information providers sources.
BU1300	**Route optimization for freight**	Capability of BONVOYAGE to calculate the most efficient route based on one hand on the delivery profile and transport operator preferences and needs and in the other one in external constraints and restriction such us traffic and delivery regulation, driving conditions, weather, traffic status, real time incidents, including multimodal alternatives
BU1330	**Route optimization for freight delivery in case of unforeseen event**	In case of an unforeseen event (e.g. traffic), capability of BONVOYAGE platform to notify the user (freight transport operator) about the incident and allow the user to re-calculate an alternative route.

ID	TITLE	DESCRIPTION
BU1340	**Stopping point in route optimization for freight**	Capability of the BONVOYAGE platform to allow the user (transport operator) to include fixed stop points for consolidation of goods, delivery of goods as well as request the calculation of stop points on trip for driver rest, swapping. This requirement also include to allow the user visualise location (and availability) of on road parking facilities and loading/unloading areas.
BU1360	**Notifications to the clients**	When the a driver is on trip following a delivery route in the navigator, capability of the BONVOYAGE platform to allow the user (transport operator) to send a notification to the client when the driver is in his/her distribution area by SMS, e-mail, BONVOYAGE app...
BU1370	**User sending feedback on the quality of the services**	Once the freight service has been provided, capability of the BONVOYAGE platform to ask the user for assessing the service scoring aspects related to the quality, reliability, usability, user experience as well as providing free text for additional comments
BU1440	**Delivery note Traceability**	Capability of BONVOYAGE platform to allow the user to include and edit electronic delivery notes created by the transport operator. If the transport operator can't create electronic delivery notes, the possibility to send all required information so the BONVOYAGE platform can generate an electronic delivery note with a sign field.
BU1470	**Edit and save electronic sign**	Capability of the BONVOYAGE platform to display attached delivery notes and to edit the signature field on the screen of the smartphone to allow electronic signature (e.g. username and password) of the client. The signature could be saved.
BU1480	**Sending delivery notes**	Capability of BONVOYAGE platform to allow the user to send signed electronic delivery notes or attach a photo of the physical delivery notes (for stamps)

Non-functional requirements

ID	TITLE	DESCRIPTION
BU1240	**Data and communication security and integrity**	Capability of BONVOYAGE platform to ensure the user that all data and all communication among users are protected by international security standards so that users have the possibility to verify that information they receive has not been tampered with.

3.1.2 Service provider requirements

This section outlines priority 1 requirements defined for service providers that run Apps or services which exploit information on passengers and freight transport services stored in the BONVOYAGE platform in order to provide services to their own end-users.

In this regards, the innovative aspect concerns the feasibility of fast transactions between BONVOYAGE platform and systems of different external service providers. The table that summarize all the service provider requirements is at the end of this document (please see ANNEX B).

Functional requirements

ID	TITLE	DESCRIPTION
BSP190	**Questioning on available transport service providers**	Capability of the BONVOYAGE platform to provide information on available transport service providers for delivery of goods.
BSP200	**Questioning on available freight services to be delivered**	Capability of the BONVOYAGE platform to provide information on available freight services (e.g. origin, destination, date departure, date arrival, goods specifications) to be delivered.

Table 5: BONVOYAGE Service provider functional requirements

Non-functional requirements

ID	TITLE	DESCRIPTION
BSP160	**Speed data transaction**	Minimum speed data transaction between the service provider system and the BONVOYAGE platform should be 2 seconds without considering network reaction time on the calculation algorithm.

Table 6: BONVOYAGE Service provider non-functional requirements

3.1.3 Technology providers requirements

This section presents priority 1 requirements relating to stakeholders that develop and maintain the BONVOYAGE platform. Requirements mainly concern the following essential capabilities of the platform:

- Creation and update a user profile;

- Carrying out the multi-modal ticketing purchase.

The table that summarize all the technology providers requirements is at the end of this document (please see ANNEX C).

Functional requirements

ID	TITLE	DESCRIPTION
BT20	**Upload travel profile**	Capability of BONVOYAGE platform to include a new user travel profile to be used for travel solution research and travel document purchase.
BT30	**Define bonus identification/obligation**	Capability of BONVOYAGE platform to define rules to grant bonus through the combination of a pre-defined set of parameters/rules.
BT60	**Provide financial reporting for the profiling clients**	Capability of BONVOYAGE platform to retrieve periodic reports of purchases made by a profiled customer. Retrieved information relates to both invoiced and not-invoiced costs.
BT70	**Purchase of a multi-modal travel solution**	In case of multimodal ticket purchase, capability of BONVOYAGE platform to lead the user through the purchase process step-by-step, allowing him to buy separately tickets for transport mode operated by different transport operators. When the user purchases the single ticket, BONVOYAGE immediately transfers the amount to the concerned transport operator, relating to the payment solution used.

Table 7: BONVOYAGE Technology providers functional requirements

Non-functional requirements

ID	TITLE	DESCRIPTION
BT71	**Purchase of a multi-modal travel solution in a pre-set amount of time**	In case of multimodal ticket purchase, capability of BONVOYAGE platform to allow the user to complete the purchase transaction within a pre-set amount of time.

Table 8: BONVOYAGE Technology providers non-functional requirements

3.1.4 Transport information provider requirements

This section lists functional requirements for to passengers and freight transport operators as well as to travel service providers that supply information and data related to their services to the BONVOYAGE platform.

This section lists priority 1 functional requirements for to passengers and freight transport operators as well as to travel service providers that supply information and data related to their services to the BONVOYAGE platform. They relate to:

- the capability of BONVOYAGE platform to get, store and update the information on transport /travel services;
- conditions to be fulfilled for data exchange (e.g. communications security and speed).

The table that summarize all the transport information provider requirements is at the end of this document (please see ANNEX D).

Functional requirements

ID	TITLE	DESCRIPTION
BTIP30	**Inventory Modification**	Capability of BONVOYAGE platform to receive and manage a modified list of services offered by transport operators (e.g. number of seats, type of seats, seats reserved for categories, ancillary/related services, commercial properties; extra luggage; luggage deposit; insurance; lounge access). Modifications to the list of services are made by transport operators.
BTIP150	**TIP sending notifications**	Capability of the BONVOYAGE platform to let the Transport Information Provider to send notifications to the users (e.g., sales, last-minute changes…)
BTIP200	**Provide information related to freight services**	Capability of BONVOYAGE platform to receive, upload and manage information about freight services (offered or demanded) Thus, if the information is deleted from the source, it automatically will be deleted from BONVOYAGE.
BTIP210	**Provide information related to transport service providers**	Capability of the BONVOYAGE platform to receive, upload and manage information about transport service providers for freight delivery (company, routes, timetable, special characteristics such us cold chain, contact details…)

Table 9: BONVOYAGE Transport information provider functional requirements

Non-functional requirements

ID	TITLE	DESCRIPTION
BTIP130	**Speed data transaction**	Minimum speed data transaction between the transport information provider system and the BONVOYAGE platform should be 2 seconds without considering network reaction time on the calculation algorithm.
BTIP170	**Information Confidentiality**	The information provider shall have the possibility to restrict the audience of data it publishes to certain categories of users only
BTIP180	**Information Mobility**	Capability of BONVOYAGE platform to allow the information provider to publish information coming from data sources that are mobile and temporarily connect and disconnect from the network

Table 10: BONVOYAGE Transport information provider non-functional requirements

3.2 Functionalities

This Section provides an explanation on the work performed on functionalities in the period November 2015 – April 2016.

All of the following functionalities have been overhauled, modified, added or deleted with respect to the functionalities already described in D2.1.
In particular, the main changes have been made on the columns "ADDRESSED REQUIREMENTS" and "MODULE":

- ADDRESSED REQUIREMENT: We have added some requirements that satisfied each functionality.
- MODULE: We have modified the membership of several functionalities to the modules.

Furthermore, we have added two functionalities (i.e., SWITCH_LANGUAGES and DISCOVER_INFORMATION) and deleted six functionalities (i.e., CONTRACTOR_FEEDBACK, DRIVER_FEEDBACK, GET_DRIVER, REMOVE_BID, TRANSPORT_PROVIDER_FEEDBACK, UPDATE_BID, DATA_RELEASE, MONITOR_DELIVERY_PARCEL, ASK_TRAVEL_SOLUTION_USER_FEEDBACK, GET_FREIGHT_SERVICES), since they are not useful or have been incorporated in other functionalities.

The functionalities are described taking into account the following characteristics:

- **Id**: functionality identifier, it has been obtained reducing the name of each functionality;
- **Name**: for each functionality has been assigned a unique name;
- **Description**: it represents a long enough description of the main activities executed by each functionality;
- **Address Requirements**: it represent the requirements list satisfied by each functionality;
- **Module**: it describes the functional module in which each functionality is included;

The two new functionalities are presented below, for the complete list of functionalities, please see Annex E.

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
DIS_INF	DISCOVER_INFORMATION	This function is used to discover what kind of data sources (for instance published schedules or real-time feeds) are available in a certain region or matching a set of search criteria	BU20, BU100	Communication service
SWI_LAN	SWITCH_LANGUAGE	This functionality allows the user to access a language converter proposing the local (geo-referred) language as first option whenever he uses the BONVOYAGE platform.	BU1030	Mobility information management

3.3 Use Cases

Use cases aim to illustrates actions and functionalities that the BONVOYAGE platform is able to perform with respect to passenger and freight cross-border, multi-modal, door-to-door transport services.

Particularly, use cases highlight the BONVOYAGE platform innovative functionalities (e.g. user profiling, disruption detection and automatic re-routing) and describe how BONVOYAGE operates to satisfy journey planning requests from the different stakeholder categories.

BONVOYAGE use Cases have been clustered into the five macro-scenarios listed below[4]:

- UC_00 - General Use Cases;
- UC_01 - Travel solutions for drivers including multi-modality;
- UC_02 - Intermodal travel solutions for public transport;
- UC_03 - Special groups travelling in public transport;
- UC_04 - Freight transportation.

With respect to the initial list of use cases included in Deliverable 2.1, the integrations performed concern:

- the integration of *Use Case UC_02_03: Passenger needing to re-plan his journey path due to unforeseen events,* in order to provide a more detailed and comprehensive description of two essential capabilities of BONVOYAGE platform: the capability to detect the user stress level caused by a travel solution (through sensors) and automatically plan and propose an

[4] Complete information on use cases methodology and template used is available in Deliverable 2.1 – Section 5.

alternative travel solution to the user; the capability to save information of user stress level related to a specific transport mode and retrieve it to plan suitable customised travel solutions in the future (e.g. excluding transport modes that cause the use a high stress level);

- the update of use case *UC_02_42 Passenger planning a trip by car sharing,* in order to better explain: how car sharing and car-pooling options can be included in a multi-modal travel solution planned by BONVOYAGE platform; which functionalities BONVOYAGE platform provides with respect to these services; which actions a passenger can perform to enjoy these services.
- the updated of use case *UC_04_08 Setting an alert to be notified with new information* to better define type of information for setting an alert;
- new use case *UC_04_11B Multimodal route optimization for freight* as a variety of use case *UC_04_11 route optimization for freight* arisen due to the extension of the concept and scope of the revised requirements.

The use cases new version is presented below, the complete lists that summarizes the use cases are at the end of this document (please see Annex F).

Use Case UC_02_03: Passenger needing to re-plan his journey path due to unforeseen events

USE CASE ID	UC_02_03
Title	Passenger needing to re-plan his journey path due to unforeseen events.
Description / Goals	Overview: a user is going by train from point A to B. Due to extreme weather conditions, railway traffic is interrupted. The train stops in station X, which is halfway between points A and B. The user wants the BONVOYAGE platform to find an alternative travel solution to reach point B as soon as he can. Goal: this Use Case aims to show: • How a user can check updates on public transport circulation on BONVOYAGE platform; • How the user can "ask" the BONVOYAGE platform to re-plan his journey; • How the BONVOYAGE platform can detect the user stress level caused by a travel solution (through sensors) and automatically plan and propose an alternative travel solution; • How the user can display alternative travel solutions.

Constraints	Alternative public transport travel solution may cause the user an excessive delay in reaching his final destination.
Actors	Citizen (request the service) Transport operator (provide the service)
Pre-conditions	The user has registered to the BONVOYAGE platform. At the moment of travel ticket purchase, the user has subscribed to the info-mobility notification service and has required receiving notifications/alerts related to his journey. The user has saved his journey solution and itinerary on the BONVOYAGE platform (so the BONVOYAGE platform already knows the user final destination and his travel preferences). The user wears sensors able to detect and predict his stress level and to communicate it to his smart phone.
Main Flow / Activity step Description	1 While the user is travelling, BONVOYAGE platform monitors the trip and checks that the actual trip is in line with the selected one. To this aim, BONVOYAGE platform monitors the current status of the trip and involved resources (in terms of transport modality) according to possibly different policy (e.g., fixed time, on demand, etc.). 2 If a considerable deviation from the planned trip is detected, or some resources become available or no more available, or BONVOYAGE detects that the user is getting stressed by the travel itinerary, BONVOYAGE platform activates the Vertical Support option (this service automatically triggers when: the system realizes that the journey is not going according to the plans; there is a KO response to a feedback request; others travellers provide negative feedback for that route; it is possible to activate the mobile phone geo-localization). Then BONVOYAGE platform sends the user a notification with information on: • Public transportation status (e.g.: train / bus not started yet, late / early, deleted); • Public transport lines (e.g.: delay, strike, problems of access). 3 Through the notification, the BONVOYAGE platform advices the user that his train will not proceed the journey due to extreme

	weather conditions. 4 If a considerable deviation from the planned trip is detected, based on the itinerary information stored, the BONVOYAGE platform re-computes a new set of feasible solution and returns the best k solutions (with k fixed) are returned. 5 BONVOYAGE platform suggests the user 4 possible alternative journey options with related information: local public transport line; price; departure time; arrival time; duration; length of the journey; number of changes. 6 BONVOYAGE shows travel solutions prioritised according to user preferences. 7 The user displays the new preferred public transport travel solution (e.g. interurban bus) and related itinerary. 8 The user selects the new preferred public transport travel solution and related itinerary. 9 The BONVOYAGE platform asks the user if he wants to purchase the selected public transport travel solution. 10 The user activates the currency converter to know the travel solution exact price in local / geo-referred currency. 11 The user selects the payment functionality. 12 The user selects the preferred payment modality: credit card. 13 The user inserts his credit card data to purchase the ticket. 14 The BONVOYAGE platform processes the payment. 15 The user receives a notification about purchase finalisation. 16 The user saves the preferred travel solution/itinerary map to display it when he accesses BONVOYAGE platform or offline. 17 The user exits from the BONVOYAGE platform.

Post-conditions	The user can display the selected travel solution and the itinerary to be followed each time he accesses the BONVOYAGE platform or offline.
Alternative Flow 1	6a None of the suggested alternative travel solutions, based on public transport, allows the user to reach his final destination at a satisfactory time. 6a1 The user modifies its travel preferences and inserts only "private/individual" transport means (e.g. carpooling, car sharing). 6a2 BONVOYAGE platform shows the user a list of car sharing services available in station X. 6a3 The user selects the car sharing service he wants to use. 6a4 BONVOYAGE platform re-directs the user on the car sharing operator website so that the user can book a car. 6a2 The flow continues from step 7.
Alternative Flow 2	Following actions undertaken in Alternative Flow 1, the user is travelling through a car sharing service he has purchased. 2a During the trip, BONVOYAGE platform continuously measures and controls the user stress level, as an indicator of his level of satisfaction / appreciation of the suggested travel solution. Monitoring is performed through wearable sensors able to communicate analysis results to BONVOYAGE platform. 2b While the user is driving to his point of destination, wearable sensors detect that the user stress level is progressively increasing (e.g. because of traffic congestions that delay the trip) and communicate this information to the BONVOYAGE platform. 2c BONVOYAGE platform automatically plan an alternative travel solution, based on user profile and preferences. The new travel solution envisages a new itinerary to be covered by subway, so that the user will not have to drive nor it will be stuck because of the weather. 2d BONVOYAGE platform sends the user a push notification showing him the suggested alternative travel solution 1 with related information: local public transport line; price; departure time; arrival time; duration; length of the journey; number of changes. 2e The user displays the suggested travel solution and related itinerary. 2f The user selects the suggested travel solution and related itinerary. 2g BONVOYAGE platform asks the user if he wants to switch transport mode and purchase the selected alternative travel solution, showing the

	user: • YES button; • NO button. 2h The user selects the YES button. The flow continues from step 11. Once the user gets to his point of destination and the trip is over, BONVOYAGE platform registers the user stress level detected for each of the travel solutions. As a consequence, when the user asks BONVOYAGE platform a new travel solution, BONVOYAGE will not propose the user travel solutions that include transport modes that may stress the user (e.g. BONVOYAGE will exclude travel solutions based on car sharing services).
Alternative Flow 3	9a The user refuses to purchase the new travel solution. 9a1 The flow continues from step 17.
User requirements	• BU130 Info-mobility reception notification; • BU180 Public transports information; • BU240 User localisation; • BU290 Route maps; • BU371 Trip monitoring and control; • BU380 Travel solution visualisation; • BU390 Route visualisation; • BU510 Credit/debit card purchase; • BU550 Purchase notification; • BU980 Vertical Support and re-planning of the trip in the event of unforeseen; • BU1040 Currency switch

Table 11: Use Case UC_02_03: Passenger needing to re-plan his journey path due to unforeseen events

Use Case UC_02_42: Multi-Passenger Trip Planning by Car Sharing

USE CASE ID	**UC_02_42**
Title	Multi-Passenger Trip Planning by Car Sharing: Passenger planning a multi-modal trip, also including car sharing / car-pooling options, to be shared with other BONVOYAGE users.
Description / Goals	- Overview: a user wants to travel from point A to B, using both public transports and car sharing / car-pooling services.

	The user is also available to: • Share his car with other BONVOYAGE users, thus providing a car pooling service to users that follow the same itinerary; • Book a car sharing service to be shared with other BONVOYAGE users, that follow the same itinerary (entirely or partially). - Goal: this Use Case aims at showing how multiple passengers can access an available aggregated car sharing / car-pooling service for their travel among the solutions offered by the BONVOYAGE platform.
Constraints	-
Actors	Citizen (requesting the service) Transport operator (providing the service)
Pre-conditions	All users are registered to the BONVOYAGE platform and have inserted their travel preferences. BONVOYAGE must know the user's availability to use car sharing / car-pooling services.
Main Flow / Activity step Description	1. The user accesses the BONVOYAGE platform. 2. The user selects the "Search Travel solution" functionality. 3. The user inserts the following data: • Origin; • Date; • Arrival time. 4. To fill in the "Destination" field, the user selects the option "choose destination from…" 5. BONVOYAGE displays a list of options, including: • Favourite addresses; • Favourite places; • Favourite events. 6. The user selects the "Favourite events" option. 7. BONVOYAGE displays the list of favourite events. 8. The user selects the event. 9. BONVOYAGE automatically insert the event address in the "Destination" field. 10. The user clicks on the "Travel solution" button.

	11. BONVOYAGE display a list of travel routes to be travelled by car. 12. For each route, BONVOYAGE also displays available car sharing services. 13. The user selects the travel solution. 14. BONVOYAGE redirects the user on the car sharing service providers so that the user can book the service. 15. Once the user has completed the reservation, BONVOYAGE sends the user a notification saying that his reservation has been successfully completed. 16. The user exits from the BONVOYAGE platform.
Post-conditions	The user can display the selected travel solution in the History functionality within BONVOYAGE platform.
Alternative Flow 1	A group of three passengers (A, B, C), who already know each other, want to travel together, departing from the same point of origin and arriving to different points of destination. Therefore, they use the BONVOYAGE platform to plan a multi-modal and multi-destination travel solution. Passenger A shares his car with passengers B and C (car-pooling). 1. Passenger A inserts all the details and preferences related to the trip of the three passengers (e.g., origin, date, destination of A, destination of B, destination of C). 2. The Local Travel Solution Management module returns a set of feasible travel routes. The three passengers, based on their own preferences, will finally agree on one of the offered travel solutions. 3. The chosen solution foresees that passengers B and C be left at intermediate stops from where they will continue up to their destination by means of public transport (multi-modality). 4. The three passengers move along the selected path. 5. Once passenger A has reached his destination, he / she exits from the BONVOYAGE platform.
Alternative Flow 2	A group of three passengers (A, B, C), who do not know each other, want to travel from the same point of origin but arriving to different points of destination.

	1. Passengers A, B and C access the BONVOYAGE platform and insert all the details and preferences related to the trip of the three passengers (e.g., origin, date, destination of A, destination of B, destination of C). 2. The Travel Solution Management module returns a set of feasible travel routes. Each of the three passengers, based on their own preferences, independently selects, among all of the offered travel solutions, one involving the use of a car sharing service. 3. The Passenger Aggregator function automatically detects the presence of multiple users interested in same car sharing service. 4. Once these users have been identified, the BONVOYAGE platform suggests grouping such users into a single pool sharing the same car. 5. The three passengers accept to join the proposed carpool group and the BONVOYAGE platform orchestrates the selection of the driver, assigning this role to passenger A. 6. Given the carpool group and the preferences of the single passengers, the Local Travel Solution Management module computes the best ordered set of feasible travel solutions, foreseeing that passengers B and C be left at intermediate stops from where they will continue up to their destination by means of public transport (multi-modality). 7. The Local Travel Solution Management module iteratively proposes the feasible travel solutions to the three passengers until they agree on one of them. 8. Passengers B and C cancel their own previous car sharing reservations. 9. The three passengers move along the selected path. 10. The BONVOYAGE platform manages the payment among passengers. 11. Once passengers B and C have reached the established intermediate nodes, the driver exits from the BONVOYAGE platform.
Alternative Flow 3	A group of three passengers (A, B, C), who do not know each other, want to travel to the same point of destination, departing from different points of origin. Each passenger is available to share the car with other

	users. 1. Passengers A, B and C access the BONVOYAGE platform and insert all the details and preferences related to the trip of the three passengers (e.g., origin of A, origin of B, origin of C, date, destination). 2. The Travel Solution Management module returns a set of feasible travel routes. Each of the three passengers, based on their own preferences, independently selects one among all of the offered travel solutions. In particular, passenger A selects a travel solution characterized by the use of a shared car. 3. The Passenger Aggregator function automatically detects the presence of multiple users interested in travelling within the same area and available to join a carpool group. 4. Once these users have been identified, the BONVOYAGE platform suggests grouping such users into a single pool sharing the same car. 5. The users accept to join the proposed carpool group. 6. Given the carpool group and the preferences of the single passengers, the Local Travel Solution Management module computes the best ordered set of feasible travel solutions, foreseeing that passengers B and C have to be collected at intermediate stops in order to reach the same destination as passenger A. 7. The Local Travel Solution Management module iteratively proposes the feasible travel solutions to the three passengers until they agree on one of them. 8. Passenger A, according to the selected travel solution, collects passengers B and C at the established intermediate stops and then the three passengers move along the selected path. 9. Once the passengers have reached their common destination, the BONVOYAGE platform manages the payment among passengers, and eventually all the three passengers exit from the BONVOYAGE platform.
User requirements	• BU340 Intermodal trip planning and visualisation; • BU490 Car-pooling / car sharing service choice and booking; • BU491 Users aggregation for car sharing services;

	• BU980 Vertical Support and re-planning of the trip in the event of unforeseen.

Table 12: Use Case UC_02_42: Multi-Passenger Trip Planning by Car Sharing

USE CASE ID	UC_04_08
Title	Setting an alert to be notified with new information
Description / Goals	Overview: User (Transport Operator, transport provider, citizen) wants to fix an alert in the BONVOYAGE application in order to be notified when there is new available information (as soon as arrives or from time to time). Goal: this Use Case aims to show: • How a user can fix an alert in BONVOYAGE. • How that alert has useful information filtered by the user • How the user can set the frequency for receiving the alert • How the user can choose, besides receiving the alert on the phone, by email.
Constraints	
Actors	User (individuals or professionals): fix the alert
Pre-conditions	User must be registered
Main Flow / Activity step Description	1. User starts the BONVOYAGE application 2. User logs in BONVOYAGE 3. User creates a new alert 4. BONVOYAGE let the user select the type of the alert: a. Freight services for individuals b. Freight services (demanded or offered) for professionals c. Updates on external information related to a route (events, incidents, regulation…) 5. User selects the type of alert 6. User configure the alert based on the fields required when searching for the respective use cases (UC_04_01, UC_04_02, UC_04_03, UC_04_11, UC_04_11B)

	7. User selects the frequency to receiving the alerts: a. Push (as soon as new information arrives) b. From time to time: i. Frequency for receiving the alert: Every hour, Daily, Weekly, Monthly… ii. Time of the day for receiving the alerts 8. BONVOYAGE lets the user the possibility to send the alert by: a. BONVOYAGE application notification b. Email address (by default the user profile's email address will be shown) 9. User fixes the alert 10. User exits BONVOYAGE app
Post-conditions	Alert is saved BONVOYAGE will notify the user when new results are founded based on the criteria.
Alternative Flow	
User requirements	BU150 - Notification reception setting BU151 - Newsletter service BU1260 - Setting an alert BU1270 - Alerts to email

Table 13: Use Case UC_04_08: Setting an alert to be notified with new information

USE CASE ID	UC_04_11B
Title	Multimodal route optimization for freight
Description / Goals	Overview: This is a variation of UC_04_11 in which the transport operator wants to plan a long distance route for freight in the most efficient way based on freight characteristics, preferences and internal (delivery time) and external constraints (traffic regulation, events…). The transport operator wants also to get information on multimodal solutions as an alternative.

	Goal: this Use Case aims to show: • How the transport operator can get the most efficient route for the operation according to specific preferences and needs • How BONVOYAGE is able to show the efficiency of each route length based on associated quality parameters such as weight, vehicle type, fuel prize, price of services such as highways, ferry, parking, total costs…) • How BONVOYAGE is able to deal with multimodal solutions • How BONVOYAGE provides link for important information like booking of services, restrictions…
Constraints	Availability of information related to other transport modes for multimodal approach. Availability and standardization of external data sources for traffic, regulation according to BONVOYAGE architecture and Internames communication system.
Actors	Transport operator company, transport service providers, transport information providers
Pre-conditions	Online app or web-service Registration could be needed
Main Flow / Activity step Description	1 The transport operator (user) accesses the BONVOYAGE application 2 The user inputs relevant data: origin, destination, weight, special characteristics of the freight, time constraints. BONVOYAGE app displays a form to configure preferences or needs for consideration in the route calculation such us stop points (for consolidation of goods, driver rest, swap…) or include multimodal options and other parameters 3 BONVOYAGE calculates the route taking into account preferences and external constrains such as traffic regulation, events 4 BONVOYAGE shows information about the different routes sorted out by preference on time, distance, costs. 5 The User is able to consult the route details 6 BONVOYAGE application displays the map with the route and a complete description of the route: km, trip time, starting time, transport mode, stopping points and parking facilities, estimate

	costs, link for booking… by length. 7 Transport operator can: a. Modify some parameter to configure a new route b. Save the route 8 Transport operator exits the BONVOYAGE application
Post-conditions	BONVOYAGE application saves the route in the history in order to use it in the future. In case of traffic event, user will be notified and will be given the possibility of calculate an alternative route.
Alternative Flow	
User requirements	BU280 - Information visualisation selection BU290 - Route maps BU320 - Planning - Inter-modal travel solution Settings BU321 - Planning - Travel solution Returning BU330 - Planning inter-modal travel solution through filter BU370 - Travel time calculation (before and during the journey) BU380 - Travel solution information display BU390 - Route visualisation BU440 - Define searching engine for travel solutions BU480 - Travel solution choice BU660 - Best price management BU730 - Other transport services purchase BU740 - Highway, stop and parking subscription BU980 - Vertical Support and re-planning of the trip in the event of unforeseen BU1300 - Route optimization for freight BU1310 - Saving the optimized route BU1320 - Modifying the optimized route BU1330 - Route optimization for freight delivery in case of unforeseen event BU1340 - Stopping point in route optimization for freight BU1350 - Navigation from optimized route BU1420 - Navigation from received route BSP220 - Asking for an optimal route for freight

Table 14: Use Case UC_04_11B: Multimodal route optimization for freight

The following modifications has been made in relation to the requirements covered by the use cases:

- UC_04_01: Sending a parcel from A to arrive at B as quickly as possible:
  - The following requirement are not applicable to UC_04_01 due to are related to professional side, route optimization or requirements covered by specific defined use cases: BU1150; BU1220; BU1230; BU1260; BU 1270; BU1280; BU1290; BU1300; BU1310; BU1320; BU1330; BU1340; BU1350; BU1370
  - The following requirement are considered for this use case: BU660 (Best price management); BU1170 (List of couriers); BU1450 (Parcel monitoring) and BU1460 (Delivery notification)
- UC_04_02 and UC_04_03: Transport operator sending goods through an external transport provider
- Deleted: BU1190 (Favourite couriers, related to individuals) replaced by BU1150 (Favourite freights list)
- Added: BU1110 (Contact info of freight service's responsible); BU1240 (Data and communication security and integrity)
- UC_04_11 covers also the following requirements related to visualization of travel solutions, information, maps: BU280; BU290; BU321; BU330; BU440; BU480 and BU980

The requirements of service providers (BSP) and transport information providers (BTIP) related to transportation of goods have been revised and addressed by the following use cases:

ID	TITLE	USE CASES
BSP180	Setting alerts	UC_04_08, UC_04_09, UC_04_10
BSP190	Questioning on available transport service providers	UC_04_02
BSP200	Questioning on available goods to be delivered	UC_04_01, UC_04_03, UC_04_11
BSP210	Place a bid	UC_04_05
BSP220	Asking for an optimal route for freight	UC_04_01, UC_04_02, UC_04_11B
BTIP200	Provide information related to freight services	UC_04_03, UC_04_12, UC_04_13
BTIP220	Sending bids to the TIP	UC_04_02, UC_04_03, UC_04_12, UC_04_13
BTIP230	Parcel track	UC_04_02, UC_04_03, UC_04_12, UC_04_13

3.3.1 UC_00 General use cases

General use cases relate to user registration to the BONVOYAGE platform, account creation and profile update, as fundamental and preliminary steps to the usage of BONVOYAGE journey planning services.

They relate to both passengers and freight transport services.

Please find in Annex F the UC_00 table.

3.3.2 UC_01 Travel solutions for drivers including multi-modality

These use cases describe how passengers can request to the BONVOYAGE platform to include “individual transports” (e.g. user own car, bike) in the journey planning process, combining them with collective transport in the multi-modal travel solutions returned by the BONVOYAGE platform. They relate to both passengers and freight transport services.

Please find in Annex F the UC_01 table.

3.3.3 UC_02 Intermodal travel solutions for public transport

These use cases only relate to passenger transport services and illustrate how different stakeholder categories interact with the BONVOYAGE platform during or prior to the journey planning process:

- For users: use cases describe how a user can exploit BONVOYAGE platform to look for, select, book and purchase cross-border, multi-modal, door-to-door travel solutions, that are based on the best combination of individual and collective transport modes matching his / her specific profile and transport modes / travel preferences;
- For service providers: use cases outline how service providers can query the BONVOYAGE platform and get information / data on passengers and freight transport services that are stored in the BONVOYAGE platform;
- For technology providers: use cases describe how operators intervene to manage and maintain the BONVOYAGE platform, to ensure its operating capabilities with respect to users and service providers requests (e.g. definition of parameters for seat assignment; set-up of the multi-modal ticket purchase process);
- For transport information providers: use cases provide an overview of how passengers transport operators provide information and data on their services to the BONVOYAGE platform.

Please find in Annex F the UC_02 table.

3.3.4 UC_03 Special groups travelling in public transport

These use cases show how users with special needs or requirements (e.g. disabled people) can exploit BONVOYAGE platform to ask for and receive a customised travel solution.

Please find in Annex F the UC_03 table.

3.3.5 UC_04 Freight transportation

These use cases show how users can exploit functionalities offered by the BONVOYAGE platform in the domain of freight transport services. Please find in Annex F the UC_04 table.

4 Reference Architecture

4.1 Top-down design

The BONVOYAGE reference architecture is the result of a straightforward top-down design whose approach is depicted in Figure 1.

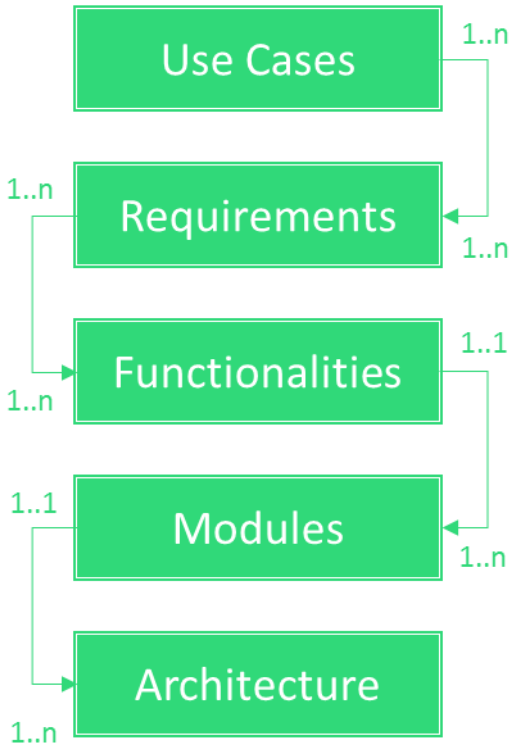


Figure 1: Top-Down architecture design process

First, a list of 95 use cases (see the previous section for more details) has been identified and subdivided into five groups: general use cases (Group UC_00), travel solutions for drivers including inter-modality (Group UC_01), intermodal travel solutions for public transport (Group UC_02), special groups travelling in public transport (Group UC_03) and freight transportation (Group UC_04).

Starting from the use cases, a list of 208 functional requirements (see the previous section for more details) has been identified. In particular, each functional requirement can serve one or more use cases, as well as each use case implies the satisfaction of one or more requirement (one-to-many relation). All the requirements associated to a specific use case, must be necessarily satisfied to validate that use case.

In order to satisfy each requirement, a set of 126 functionalities (see the previous section for more details) has been identified. Each functionality is needed to satisfy a functional requirement, as well as each functional requirement requires the implementation of one or more functionality (one-to-many relation). All the functionalities associated to a specific requirement must be necessarily implemented to satisfy that requirement.

The set of functionalities has been partitioned into a smaller set of 20 focused functional modules (one-to-one relation). Each functional module hosts one or more functionalities on the base of their similarity (one-to-many relation).

MODULE	FUNCTIONALITIES
Communication service	DIS_INF – DISCOVER INFORMATION DLV_INF - DELIVER_INFORMATION PUB_INF - PUBLISH_INFORMATION SUB_INF - SUBSCRIBE_INFORMATION SYN_INF - SYNC_INFORMATION
Public transport service	RMV_INF - REMOVE_INFORMATION UPD_INF - UPDATE_INFORMATION UPL_INF - UPLOAD_INFORMATION
Security management	VER_INF - VERIFY_INFORMATION
Membership management	BLD_TPR - BUILD_TARIFF_PROFILE GET_AWA - GET_GIFTS GET_MYS - VIEW_MY_SCORE GET_SCR - GET_SCORE GET_SRK - VIEW_SCORE_RANK GET_USC - GET_USER_SCORE PUT_SCR - PUT_SCORE RST_USC - RESET_USER_SCORE SET_SPL - SET_SCORE_POLICY SET_USC - SET_USER_SCORE UPD_USC - UPDATE_USER_SCORE
Planning and travel itinerary management	CAL_TRP - CALCULATE_TRIP_SOLUTION CNT_TRP - CONTROL_TRIP_SOLUTION
Travel objective and target management	ADD_OBJ - ADD_OBJECTIVE DEF_STP - DEFINE_STATIC_PARAMETERS DEL_OBJ - DELETE_OBJECTIVE SCORE - SCORE SHW_PRG - SHOW_PROGRESS SRC_ENG - SEARCH_ENGINE UPD_OPR - UPDATE_OPTIMIZED_ROUTE
Travel solution management	ADD_PSG - PASSENGER_ADD BLD_PRC - BUILD_PRICES CSH_BOK - CAR_SHARING_BOOK DEL_DSC - DELETE_DISCOUNTS EXS_REM - EXTRA_SERVICE_CANCELLATION MOD_DSC - MODIFY_DISCOUNTS MOD_SAP - MODIFY_SEATASSIGN_PARAMS

MODULE	FUNCTIONALITIES
	REM_PSG - PASSENGER_REMOVE SEL_TRS - SELECTED_TRAVEL_SOLUTION TRS_EXT - TRAVEL_SOLUTION_EXTENSION TRS_FIN - TRAVEL_SOLUTION_FINALIZATION TRS_MOD - TRAVEL_SOLUTION_MODIFICATION TRS_REM - TRAVEL_SOLUTION_CANCELLATION UPL_DSC - UPLOAD_DISCOUNTS VAL_PRC - VALIDATE_PRICES
User feedback and profile management	TCH_UFB - PUT_TRAVEL_CHUNK_USER_FEEDBACK UPL_TPR - UPLOAD_TRAVEL_PROFILE
Data interfacing service	ADD_PIN - ADD_PLATFORM_INFORMATION EXP_PIN - EXPOSE_PLATFORM_INFORMATION
Geolocation service	SRC_LOC - SEARCH_LOCATION
Maps management	MAP_LAY - MAP_LAYER
Partnership	PAR_OFF - PARTNERS_OFFERS
Passenger, freight and travel management	BIT_NOT - SET_BIDS_NOTIFICATION CRT_OPR - CREATE_OPTIMIZED_ROUTE CTR_CRE - COLLECTIVE_TRAVEL_CREATE CTR_UPD - COLLECTIVE_TRAVEL_UPDATE FAV_DRV - MARK_FAVOURITE_DRIVER FAV_FRG - MARK_FAVOURITE_FREIGHT GET_STA - GET_STATISTICS GTR_CRE - GOODS_TRAVEL_CREATE GTR_UPD - GOODS_TRAVEL_UPDATE ITR_CRE - INDIVIDUAL_TRAVEL_CREATE ITR_UPD - INDIVIDUAL_TRAVEL_UPDATE NVG_OPR - NAVIGATION_OPTIMIZED_ROUTE NVG_TZR - NAVIGATION_TRACEABILITY_TOOL PUT_BID - PUT_BID
Payment and reimbursement service	LPT_TIC - LPT_TICKET LPT_VAL - LPT_VALIDATION TIC_REI - TICKET_REIMBURSEMENT
Profile and account management	AUTHO - AUTHORIZATION CPR_SRC - CLIENT_PROFILE_SEARCHING DEF_BIO - DEFINE_BONUS_IDENTIFICATION/OBLIGATION PRF_CTE - PROFILE_CREATE PRF_DTE - PROFILE_DELETE PRF_UTE - PROFILE_UPDATE PSS_CTE - PASSENGER_CREATE PSS_UTE - PASSENGER_UPDATE SVE_DRV - SAVE_DRIVER SVE_FRG - SAVE_FREIGHT SVE_OPR - SAVE_OPTIMIZED_ROUTE SVE_SRC - SAVE_SEARCH
Ticket purchase service	PUR_TIC - PURCHASE_TICKET TIC_DET - TICKETS_DETAILS
Travel document management	PRO_USE_PUR - PROFILED_USER_PURCHASES SAL_TPP - SALES_2

MODULE	FUNCTIONALITIES
	SAL_USR - SALES _1 TAR_TRA - TARIFF_TRANSFER TIC_COD_CHA - TICKET_CODE_CHANGES TIC_CRE - TICKET_CREATION
Travel option purchase service	CUS_TIC_PUR - CUSTOMISED_TICKET_PURCHASE LEI_LOC_PUR - LEISURE_LOCAL_SERVICES_PURCHASE MOB_SER_PUR - MOBILITY_SERVICES_PURCHASE PAR_SER - PARTNERS_SERVICES TIC_MOD - TICKET_MODIFICATION
Mobility information management	ADD_INF - ADD_INFORMATION APP_UFB - PUT_APP_USER_FEEDBACK FGT_OPT - FREIGHT_OPERATOR FIL_INF - SET_FILTER_INFORMATION GET_CIS - GET_CIRCULATION_STATUS GET_FBF - GET_FEEDBACK_ON_FREIGHT GET_TSS - GET_TIMESCHEDULE_SERVICE GET_UFB - GET_TRAVEL_SOLUTION_USER_FEEDBACK INF_VIS - INFORMATION_VISUALIZATION MON_DVR - MONITOR_DELIVERY_ROUTE PAC_TRA - PARCEL_TRACKING PHT_DVN - PHOTO_DELIVERY_NOTE PRV_VAS - PROVIDE_VIRTUAL_ASSISTANCE PUT_UFB - PUT_TRAVEL_SOLUTION_USER_FEEDBACK SET_FBF - SET_FEEDBACK_ON_FREIGHT SGN_DVN - SIGN_DELIVERY_NOTE SHR_INF - SHARE_INFORMATION SND_DVN - SEND_DELIVERY_NOTE SRC_DRV - SEARCH_DRIVER SRC_FRG - SEARCH_FREIGHT SWI_CUR - SWITCH_CURRENCY SWI_LAN - SWITCH_LANGUAGE TRC_TOO - TRACEABILITY_SUPPORT_TOOL USE_SHR - USE_SHARED_INFORMATION
Travel solution information and visualization	DSP_DRV - DISPLAY_DRIVER_INFORMATION DSP_FRG - DISPLAY_FREIGHT_SERVICE DSP_FRR - DISPLAY_FREIGHT_RESPONSIBLE GET_OPR - GET_OPTIMIZED_ROUTE ONT_VIS - ONTRIP_VISUALIZATION ROU_VIS - ROUTE_INFO_VISUALIZATION STP_INF - PT_STOP_INFORMATION_VISUALIZATION STP_VIS - PT_STOPS_LOCATION_VISUALIZATION TRV_MEM - TRAVEL_SETTING_MEMORANDUM

Table 15: Functionalities provided by each functional module

To rationalize the implementation work, each functional module has been associated to a specific project's workpackage, so that all the related subsets of functionalities are in charge to that workpackage.

WORKPACKAGE	FUNCTIONAL MODULES
WP3 - Internames Communication Systems	Communication service
	Public transport service
	Security management
WP4 - Intelligent Transport Functionality	Membership management
	Planning and travel itinerary management
	Travel objective and target management
	Travel solution management
	User feedback and profile management
WP5 - Adaptation Functionality	Data interfacing service
	Geolocation service
	Maps management
	Partnership
	Passenger, freight and travel management
	Payment and reimbursement service
	Profile and account management
	Ticket purchase service
	Travel document management
	Travel option purchase service
WP6 - Multimodal Integrated Interfaces and Apps	Mobility information management
	Travel solution information and visualization

Table 16: Functional modules assigned to each workpackage

Each functional module exposes a set of interfaces needed to access their implemented functionalities. By means of those interfaces the functional modules can communicate internally, each other, and externally, with third parties and pre-existing modules. Furthermore, an additional set of interfaces based on the Internames paradigm provides to the BONVOYAGE modules a privileged way to easily discover and locate data and related information services. The set of functional modules and their interfaces constitutes the BONVOYAGE reference architecture.

4.2 BONVOYAGE Reference Architecture

The outcome of the work carried on within WP2 and described in the previous paragraph is the BONVOYAGE Reference architecture depicted in Figure 2.

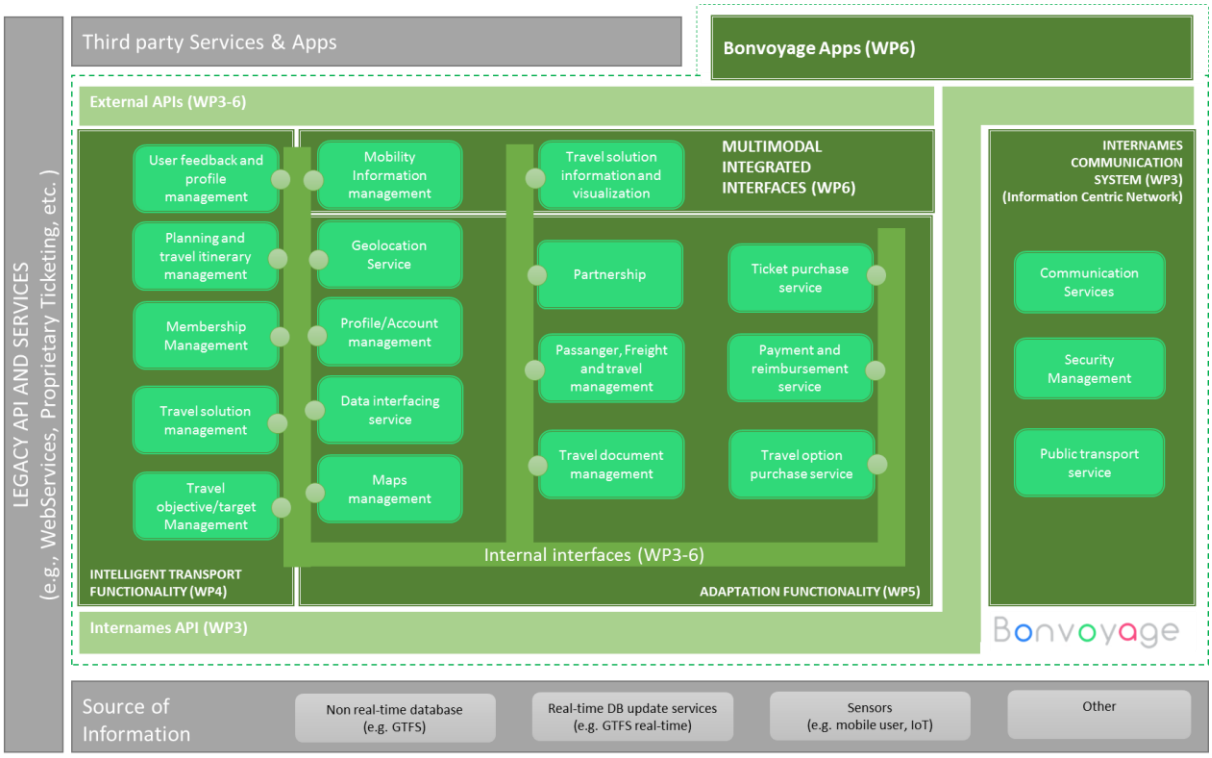


Figure 2**: **BONVOYAGE Reference Architecture

The reference architecture differs slightly from the one presented in D2.1: it represents an evolution since the functionalities associated to each module and their descriptions have been reviewed, and the Public transport service has been moved within the Internames communications system.

The overall BONVOYAGE functional architecture (edged by a green dotted line in Figure 2) get information from the underlying "Source of information" layer, and provides a set of functionalities to the "Third party Services and apps" layer. The BONVOYAGE set of functionalities is complementary or an alternative to the connecting "Legacy API and services" layer.

The BONVOYAGE functional architecture is organized in 4 functional blocks: (i) **Internames communication system**, (ii) **Intelligent transport functionality,** (iii) **Adaption functionality**, (iv) **Multimodal integrated interfaces**. All of them communicate each other and with the surrounding environment through dedicated interfaces (see Section 6 for more details).

Each functional block hosts some modules. The updated description of the twenty functional modules, divided by functional block, is reported below:

Internames communication system

- **Communication service** is in charge of the communication services, namely, it enables information publishing, subscription to a piece of information as well as information delivery to a specified recipient. It also enables information encryption and offers the opportunity to keep different pieces of information in sync. It is also used to discover what kind of data sources (for instance published schedules or real-time feeds) are available in a certain region or matching a set of search criteria.
- **Public transport service** allows Transport Operators to upload, update and remove information concerning routes, time schedules, lists of services, etc. to and from the BONVOYAGE Platform.
- **Security management** is in charge of checking that a piece of information has been published by the claimed publisher, that it has not been tampered with, and that it can be decrypted by the recipient based on the recipient's attributes.

Intelligent transport functionality

- **Membership management** is in charge of monitoring and recording the user's usage of the BONVOYAGE platform in order to collect and update user scores according to the current score assignment policy. It must also return the ranked list of the best rated scores as well as the list of Awards for a given user.
- **Planning and travel itinerary management** is in charge of computing optimal or near-optimal route alternatives from a given origin to one or more destinations by taking into account query parameters, user constraints and user commitments. It also monitors and detects the occurrence of dynamic events and chooses whether to calculate a new set of route alternatives, in case such dynamic events severely affect the previously calculated routes or even make them unfeasible (e.g., the previously calculated routes turn out to be not possible anymore, will be delayed, will have to be improved, etc.).
- **Travel objective and target management** allows the user to define an objective which will be properly taken into account by the "Planning and travel itinerary management" module. It also allows the user to monitor her/his progress towards the achievement of such objective as well as to accumulate points from achieved targets.
- **Travel solution management** is in charge of managing travel solution data. Such management is realized by associating passengers with the requested travel solutions, by "building" prices for all tariffs, offers, promotions and discounts and by allowing any transport operator to modify/update such tariffs, offers, promotions and discounts. As a result, this functional module is in charge of informing the BONVOYAGE platform about the travel solutions that have been chosen, on the basis of a given set of search parameters and of given user profiles.
- **User feedback and profile management** is in charge of collecting, storing and reacting to the user feedbacks and of managing their profile

Adaption functionality

- **Data interfacing service** connects the BONVOYAGE platform with an Information Provider, taking care of all the issues related to the heterogeneity of the connecting technologies. It exposes aggregated data coming from the BONVOYAGE platform to external applications or Service providers and allows external Service providers to fetch data from the BONVOYAGE platform.
- **Geolocation service** manages all requests aimed at finding an addresses or a POIs, thus enabling the search for routes, transport stops, etc. nearby.
- **Maps management** is in charge of allowing tile viewing on a smartphone or web app.
- **Partnership** offers the user the opportunity to avail him/herself of the promotions and discounts offered by the partners of the BONVOYAGE platform and it also sends the user the related notifications, targeted to the user's specific profile and preferences.
- **Passenger, freight and travel management** manages the creation and modification of travel requests, both individual and collective, as well as of goods travel requests.
- **Payment and reimbursement service** enables the creation and the validation of Local Public Transport travel documents and tickets. It also allows the user to receive reimbursement for a purchased travel solution.
- **Profile and account management** allows to create, delete and modify user profiles and account information. It also allows to create and update a passenger entity linked with a profile for each new user.
- **Ticket purchase service** enables the user to choose the payment modality when purchasing a ticket/travel solution. It also provides the user with all the information concerning commercial conditions (e.g., refund, compensation) as defined by the relevant transport operator, and is in charge of displaying all the details about the purchased tickets/travel solutions in a user-specific historical section.
- **Travel document management** is in charge of managing travel documents both from the technology provider's and from the user's perspectives. In particular, from the point of view of the technology provider, it allows to display the sales report containing information about the total amount sold, the cancelled refunded amount (if any), the number of passengers with respect to a specific aggregation cluster, the travel timeline, the transport means or service type, the channel/selling point, etc.
- **Travel option purchase service** allows the user to select a travel solution based on her/his travel preferences (e.g. passenger category, best tariff, class choice, seat choice…), to visualize discounts/promotions/alternative options available for that travel solution and to purchase a customized ticket (e.g. passenger category, best tariff, class choice, seat choice…). This functional module also offers the user the possibility to buy ancillary solutions, which can include both local (municipal services) and leisure (recreational services) services, as well as to purchase a set of additional mobility services, which can be furthermore associated with the pre-identified travel solution. It also allows the user to book some specific services and/or to modify/cancel a travel seat already booked or a service purchased and associated to a travel solution.

Multimodal integrated interfaces

- **Mobility information management** is in charge of allowing the user to add information and/or be informed about the transportation situation and the state of traffic as well as about weather, POIs and checkpoints. Such information is displayed in a device/technology neutral manner and can be shared with other users. Moreover, this functional module allows the freight transport information provider to provide the BONVOYAGE platform with information about the location of the parcel and lets the addressee user track and monitor the parcel path until delivery is finalized.
- **Travel solution information and visualization** is aimed at allowing the user to visualize the route followed by the means of transport (on-trip) and its current location. It is also aimed at displaying the information related to a travel solution (pre-trip), such as cost, codes of public transport, source-destination association, as well as the information of a specific public transport stop (scheduling, departing and arriving programmed, Interconnection with other modes of public transport…) and the arrival time. Moreover, it allows the user to set a memorandum of the travel in his/her own calendar and makes sure he/she receive useful notifications.

4.3 Reference Architecture modularity

It is worth to note that the description of use cases, requirements, functionalities, modules and interfaces reported in this deliverable is necessary to understand how the BONVOYAGE architecture works. But they also provide the developers the freedom to choose if and how implement them. The architecture reported in this document is just a reference architecture that can be deployed dynamically in a modular way, on the base of the needed use cases, requirements or functionalities required by a specific application scenario.

To better clarify the modularity concept that is behind the BONVOYAGE reference architecture, consider the scheme reported in Figure 3. When a third party application developer needs to figure out which is the best instance of the BONVOYAGE reference architecture able to support his application, he can select the subset of those use cases that are of interest for him (in Figure 3 the selected use cases are in green, while the discarded use cases are in light green). This subset of use cases, requires the satisfaction of a given subset of requirement that, in turn, implies the use of a subset of functionalities (in Figure 3 the selected requirements, functionalities and modules are in green, while the discarded ones are in light green). This logical flow leads to the identification of the minimal instance of the BONVOYAGE reference architecture that must be deployed to have the desired functionalities able to address the selected subset of use cases.

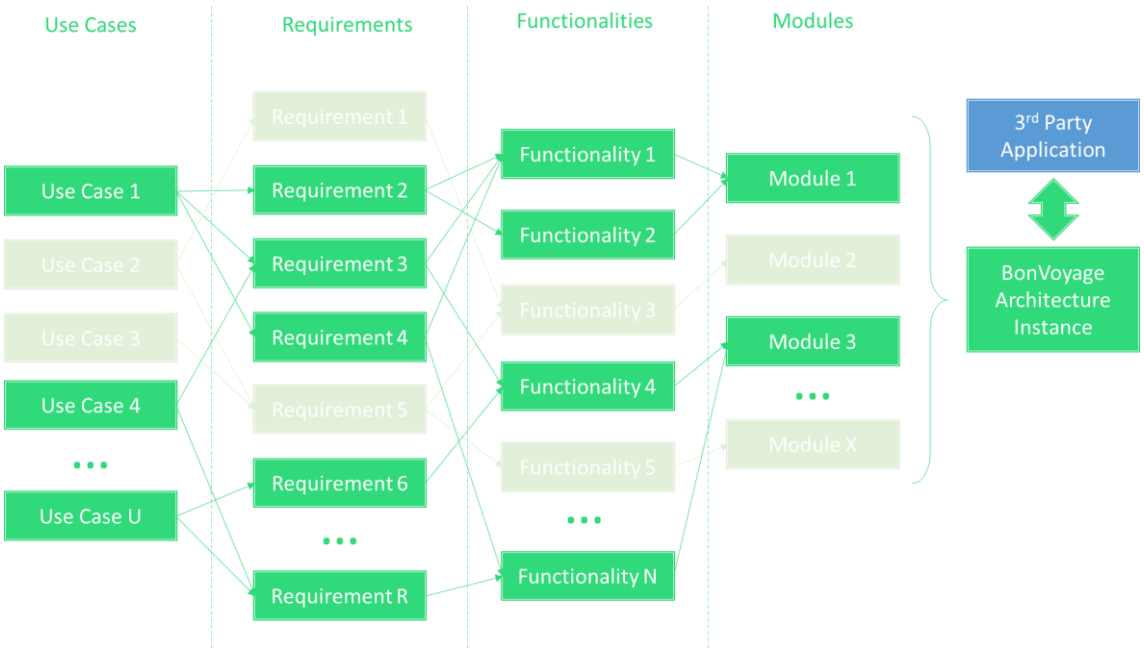


***Figure 3**: Modularity of BONVOYAGE reference architecture (the elements in light green are disabled, while the element in green are enabled)*

In order to identify the BONVOYAGE architecture instance that best matches with a 3rd parties application, it is not necessary to start from a selected subset of use cases. The application developer can also decide to select the BONVOYAGE architecture instance matching just a subset of requirements, or even directly picking up those functionalities that the he needs to implement his application.

The modularity of BONVOYAGE architecture provides a high degree of freedom to the developer when deciding to design and implement its application, but on the other hand the developer can need some decision support systems to make the best design choice.

For that reason the BONVOYAGE research team has developed an **architecture analysis tool**, that is described in the next sub-section.

4.4 Architecture analysis tool

In order to verify the consistence of the whole top-down design process, the BONVOYAGE research team has adopted a web based software tool[5] that provides the following features:

1. Manage (create, update, delete) the use case, requirement, functionality and module lists;

[5] The analysis tool is available at the following link: http://www.icaruservices.it/BONVOYAGE. Use the following credentials: username **guest** password **BONVOYAGE**.

2. Verify the relations between the use cases, requirements, functionalities and modules;
3. Basic decision support functionalities to select the best architecture instance (as subset of functionalities and modules) by means of a multi-objective approach.

This tool has been used to analyse the coherence of use cases, requirements, functionalities and modules. In particular, the following formal checks have been done:

- Each use case is associated to one or more functional requirement and viceversa, each functional requirement is associated to one or more use cases;
- Each requirement is associated to one or more functionality and viceversa, each functionality is associated to one or more requirements;
- Each functionality is associated to one module and viceversa, each module is associated to one or more functionality;

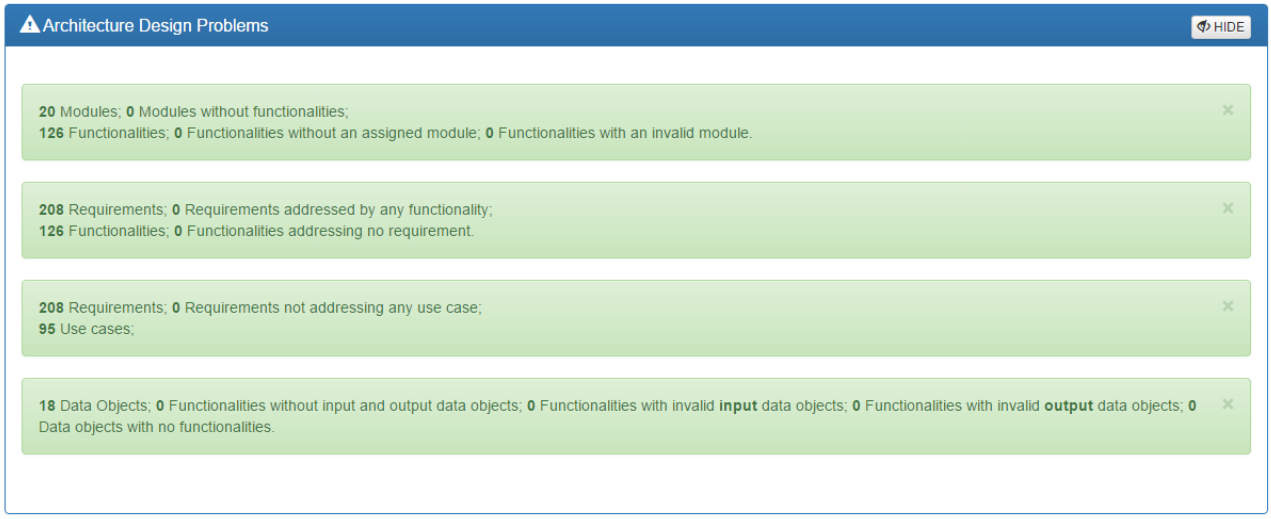


Figure 4**: **Results of the BONVOYAGE architecture design problem analysis

For the purpose of developing the most innovative functionalities and selecting the minimal BONVOYAGE architecture to be implemented in order to demonstrate the potential impact of the project findings, the architecture analysis tool allows to associate a weight to each requirement and functionality.

The architecture analysis tool allows to associate to each requirement the following scores: **Mandatory**, **Priority 1**, **Priority 2** and **Priority 3**. The meaning of those scores have been described in Section 3.1.

The architecture analysis tool allows to associate to each functionality the following scores:

1. **Priority 0**: if the functionality is poor in terms of innovation and expensive in terms of implementation;
2. **Priority 1**: if the functionality is poor in terms of innovation but easy to be implemented;
3. **Priority 2**: if the functionality is innovative but expensive in terms of implementation;
4. **Priority 3**: if the functionality is considered necessary for the success of the research project, regardless of the resources needed to implement it;

It is worth to note that the identification of the best instance of the reference architecture to be implemented is a difficult management decision process that must take into account the limited resources and the need of building a disruptive solution to demonstrate the project innovation. The requirements lead the innovation: their satisfaction is a measure of how the project can be helpful for the transportation stakeholders. On the other hand, the functionalities needed to satisfy the requirements can be very expensive to be implemented, in some cases, or already available on the market, in other cases. It is up to the project's architects providing wisely the weight for each requirement and each functionality: from their values it depends the overall decision. Indeed, the decision to develop a specific instance, other than another, of the reference architecture is a compromise that tries to optimize multiple criteria, while respecting the given resources' constraints.

For this purpose, the analysis tool provides the following functionalities that support the decision processes: (i) Optimization Problem, (ii) Use Cases Ranking, (iii) Use Cases Selection and (iv) Functionality Selection. These functionalities will be described in the next subparagraphs.

i) Optimization Problem

This functionality allows to solve a simple optimization problem formulated using the AMPL[6] scripting language as described below:

```
param U; # use cases
param R; # requirements
param M; # mandatory requirements
param N; # functionalities

param p {1..N};          # functionality weights
param F {1..R, 1..N};    # mapping requirements -> functionalities
param G {1..R, 1..U};    # mapping requirements -> use cases
param H {1..M};          # mandatory requirements

var x {i in 1..U} binary;
```

[6] For more detail on the AMPL scripting language, refer to the official web site http://ampl.com/

```
var y {j in 1..R} binary;
var z {k in 1..N} binary;

minimize f: sum {k in 1..N} (2-p[k])*z[k];

subject to req_fnc{j in 1..R, k in 1..N: F[j,k]=1}: y[j] - z[k] <= 0;
subject to req_usc{j in 1..R}: y[j] - sum {i in 1..U} G[j,i]*x[i] <= 0;
subject to req_mnd{j in 1..M}: y[H[j]] = 1;

end;
```

The script can be interpreted as the following: there are a number of **U** use cases, **R** requirements, **M** mandatory requirements and **N** functionalities. A vector **p** contains the functionality weights. The binary matrixes **F** and **G** map the relations, respectively, between the requirements and the functionalities and between the requirements and the use cases. A binary vector **H** reports the mandatory requirements. The decision variables are the binary vectors **x**, **y** and **z** that indicate which use cases, requirements and functionalities should be selected. The cost function is the sum of the selected functionalities weights. The cost function, changed in sign, must be minimized and is subject to three types of constraints:

1. if a requirement is selected, all the associated functionalities must be selected;
2. if a requirement is selected, at least one use case associated to it must be selected;
3. each mandatory requirements must be selected.

The outcome of the optimization problem is a selection of use cases, requirements and functionalities that maximize, under the aforementioned constraints, the global value of the functionalities to be implemented.

ii) Use Cases Ranking

The optimization problem functionality provides a first step selection of the best subset of use cases, requirements and functionalities to be implemented. But no ranking is provided. To rank the use cases or the functionalities a dedicated functionality is available, as shown in Figure 5.

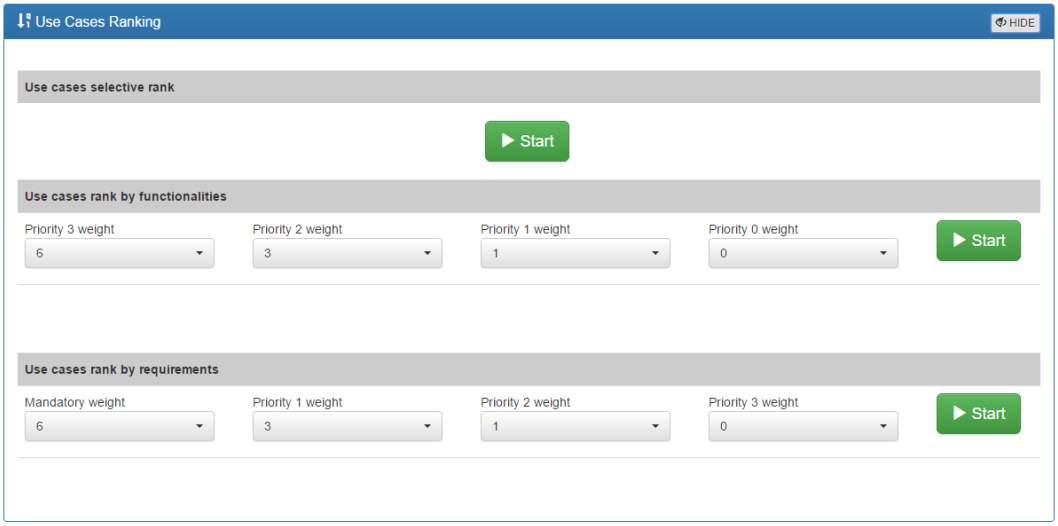


***Figure 5**: Use case ranking control panel*

The Use case selective rank can take as input the output of the Optimization problem, or the whole set of uses cases, and delivers an incremental ranked list of selected use case so as to maximize the functionalities coverage. It applies a greedy algorithm that takes into account, when selecting a new use case, of the overall value gain, measured taking into account the weight of each involved functionality. In Figure 6 the result of use case selective ranking is shown. Each row of the table represents one step of the greedy algorithm, the column Rank reports the overall rank score for the given set selected use cases reported in the third column of the table. For each set of use cases the related functionalities' coverage statistics are reported, showing the percentages and the number of functionalities to be implemented on the base of their priority (from priority 3, down to priority 0).

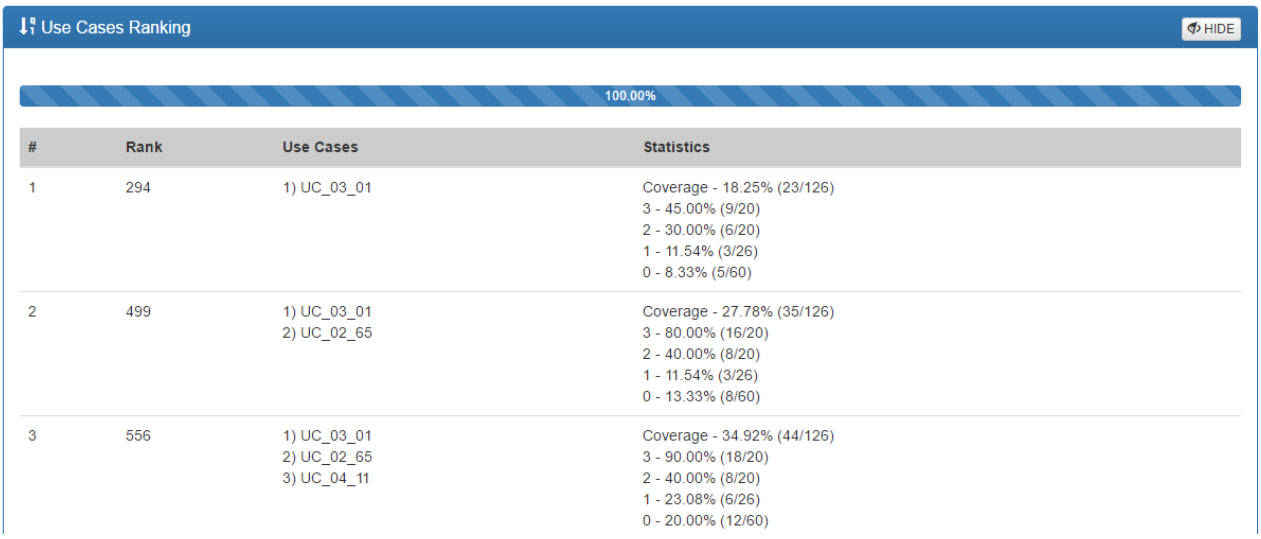


***Figure 6**: Use case selective rank result*

Furthermore, using the control panel shown in Figure 5, it is possible to associate a customizable weight (ranging from -10 to +10) to the different types of requirements' and functionalities' priorities.

As an example, if the weights for the functionalities' priorities is 6 for priority 3, 3 for priority 2, 1 for priority 1 and 0 for priority 0, the result of the use case raking is shown in Figure 7. For each use case, the total weight and, in parenthesis, the number of covered functionalities on the base of their by priority are reported.

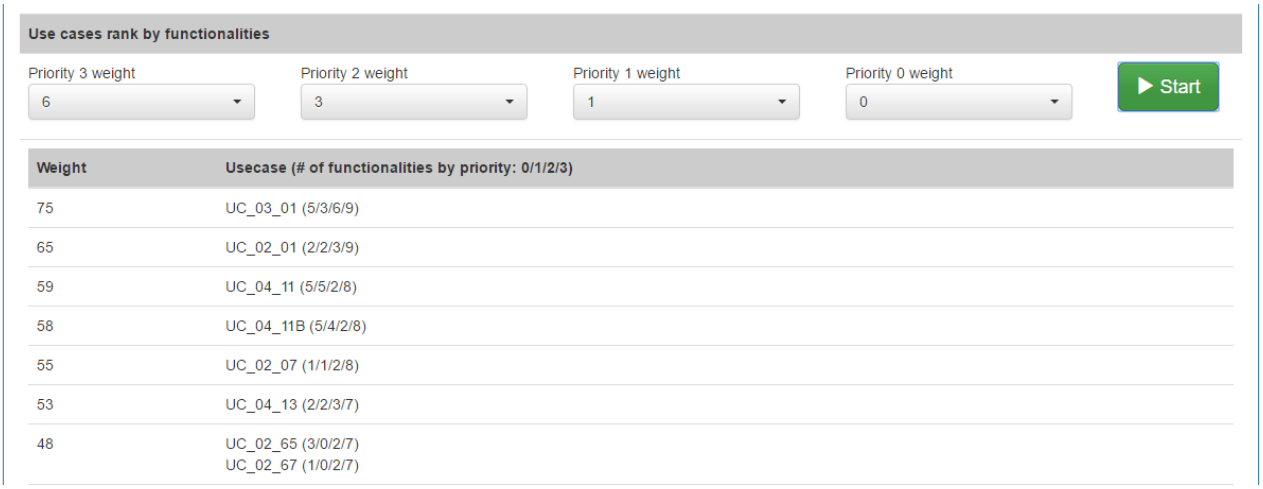


Figure 7: Use case ranking example

iii) Use Cases Selection

On the base of the use case ranking, it is possible to make a decision regarding the best use cases to select in order to map the most important requirements, but also to develop the most innovative functionalities. To figure out which is the impact of the use case selection on the reference architecture, a proper functionality is provided to manually select the Use Cases as shown in Figure 8.

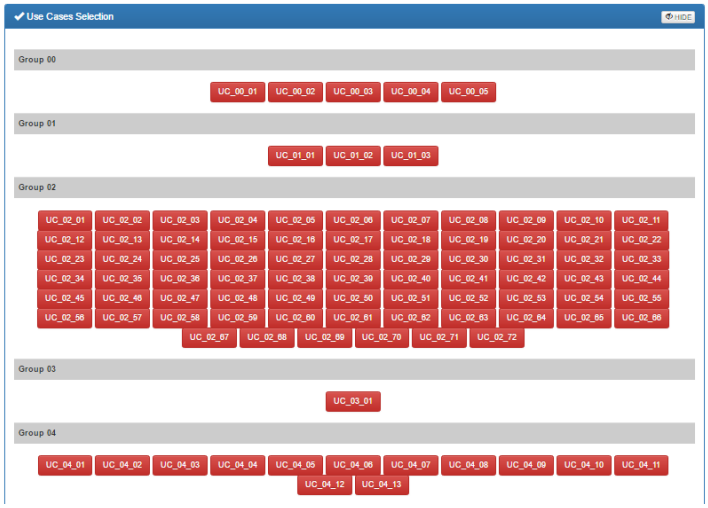


Figure 8: Use cases selection panel

When a use case is selected on the control panel, a set of statistics are reported regarding the coverage of satisfied requirements and functionalities to be implemented (sub-divided by workpackage) as shown in Figure 9 and in Figure 10.

Selected requirements statistics				
Coverage	**Mandatory**	**Priority 1**	**Priority 2**	**Priority 3**
17.6% (36/205)	26.0% (13/50)	23.4% (15/64)	5.8% (3/52)	12.8% (5/39)

Selected functionalities statistics					
Workpackage	**Coverage**	**3**	**2**	**1**	**0**
WP3	100.0% (8/8)	100.0% (7/7)	100.0% (1/1)		
WP4	18.9% (7/37)	42.9% (3/7)	0.0% (0/2)	33.3% (1/3)	12.0% (3/25)
WP5	31.3% (15/48)	100.0% (6/6)	20.0% (2/10)	50.0% (2/4)	17.9% (5/28)
WP6	22.2% (8/36)		25.0% (2/8)	28.6% (6/21)	0.0% (0/7)
Total	**29.5% (38/129)**	**80.0% (16/20)**	**23.8% (5/21)**	**32.1% (9/28)**	**13.3% (8/60)**

Figure 9: Use case selection report

Selected functionalities by workpackage		
Workpackage	**Module**	**Functionality**
WP3 100.0% (8/8)	Communication service (4/4)	DLV_INF - DELIVER_INFORMATION (Priority 3)
		PUB_INF - PUBLISH_INFORMATION (Priority 3)
		SUB_INF - SUBSCRIBE_INFORMATION (Priority 3)
		SYN_INF - SYNC_INFORMATION (Priority 3)
	Public transport service (3/3)	RMV_INF - REMOVE_INFORMATION (Priority 3)
		UPD_INF - UPDATE_INFORMATION (Priority 3)
		UPL_INF - UPLOAD_INFORMATION (Priority 3)
	Security management (1/1)	VER_INF - VERIFY_INFORMATION (Priority 2)

Figure 10: Use case selection report by workpackage

iv) Functionality Selection

This functionality allows to select a given functionality and discover which requirements it addresses and, in turn, which use cases it impacts on.

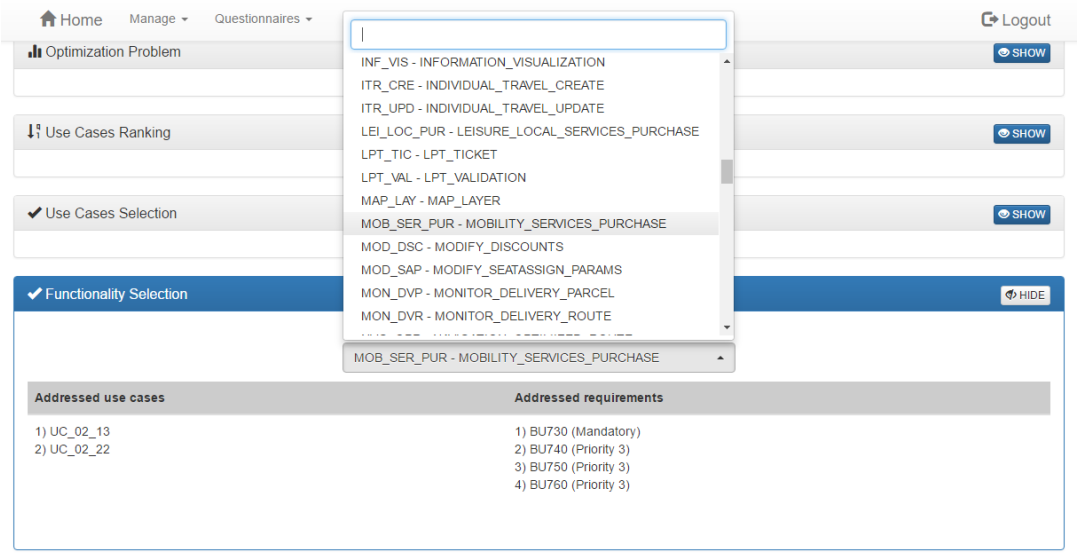


Figure 11**: **Functionality selection panel

4.5 Review of other projects' architectures

The BONVOYAGE platform relies on advanced methodologies, models and algorithms based on the previous experience of the partners in the Consortium and on the current State of the Art, both in the Transport and in the ICT areas. In this respect, the BONVOYAGE Consortium has carefully examined the architecture and outputs of the following projects and tools: FP7 PEACOX, FP7 OFELIA, MIT AutoEmotive, FP7 INTERSTRESS, FP7 CONVERGENCE, FP7 GREENICN, DYNAMO (a project within SINTEF's internal program), FP7 MOBINCITY, FP7 eCOMPASS, FP7 SMARTMUSEUM, FP7 FI-WARE, FP7 MOBINET, SMILE (a project funded by the Austrian Federal Government), FP7 Co-Cities, CIP Co-Gistics, NSF Named Data Networking (NDN), FP7 PURSUIT, NSF MobilityFirst, OpenTripPlanner (which is an open-source solution).

Out of these, taking into account the objectives of BONVOYAGE as well as the public availability of the related information, we have selected the most relevant subset of projects and tools whose architecture and functionality the Consortium believes to be particularly worth studying and analysing for the purpose of delivering truly innovative services as a result of the BONVOYAGE project itself.

Such projects and tools are hereby listed:

1. FP7 Co-Cities
2. FP7 CONVERGENCE

3. FP7 eCOMPASS
4. FP7 MOBINCITY
5. FP7 MOBiNET
6. FP7 PEACOX
7. FP7 SMARTMUSEUM
8. OpenTripPlanner (open-source).

A brief description of each of them is given below.

FP7 Co-Cities

In general, cooperative mobility solutions have been including dynamic navigation, intermodal routing and advice in real-time but do not deliver any information from the traveller to traffic management. This is why Co-Cities has been conceived as a pilot project aimed at introducing and validating cooperative mobility services in cities and urban areas, leading to the development of a dynamic feedback loop from mobile users and travellers to the cities' traffic management centres.

The objectives of Co-Cities are therefore the following.

- To extend the number of cities which install the In-Time Commonly Agreed Interface (CAI) and connect it to the traffic management centre for a regular feed of data and information. The CAI is the output of a previous European project (i.e., In-Time) and provides a common interface among city traffic management information and the Transport Information Service Providers (TISP).
- To develop a fast and reliable validation process for cooperative traffic information services by using a "reference platform."
- To make transport information services more attractive and appealing to users in urban areas.

Such objectives are achieved by means of the deployment of the following services.

- Interoperable and multimodal RTTI services to end users, offered by TISPs, using different hardware and software platforms such as personal navigation devices, smart phones and web services.
- Business-to-business services, enabling Europe-wide TISPs to cooperate with regional and urban authorities in fields such as strategy-based routing and adaptive mobility services.

The central part of the Co-Cities concept is an interoperable and multimodal Regional Data/Service Server (RDSS), which is a service-oriented middleware infrastructure providing

a number of data/services. These cover and enable the operation of end-user applications through TISPs.

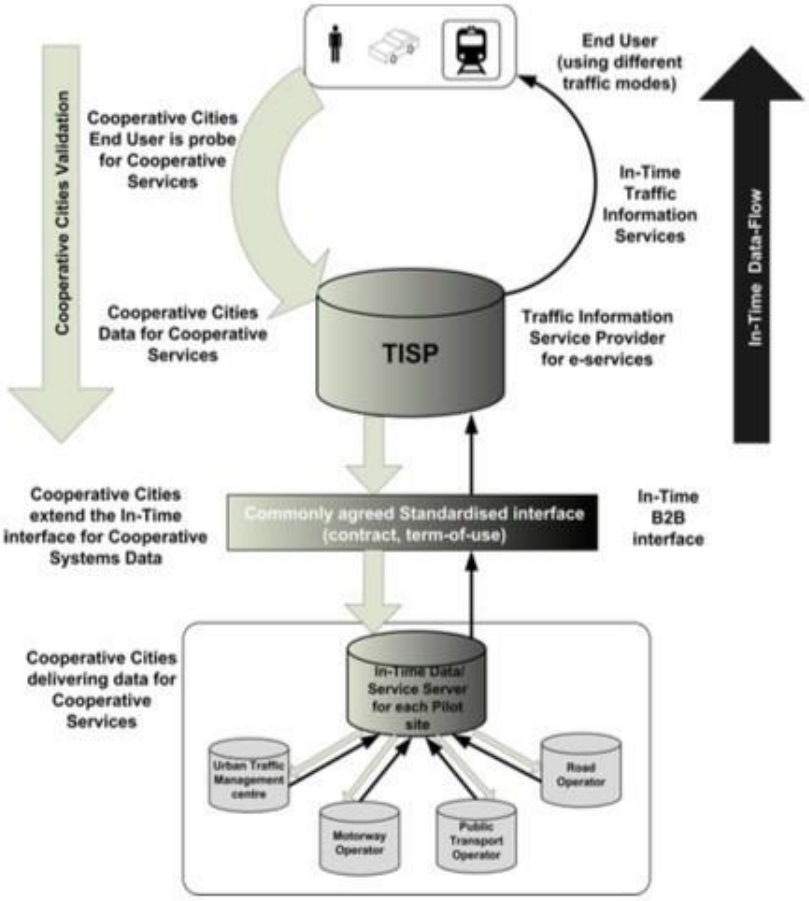


Figure 12: The Co-Cities architecture

Thanks to the architecture shown in the figure above, Co-Cities covers the full feedback loop from the end users to the TISPs as well as to regional and local authorities, including:

- User acceptance of the delivered and piloted services in the pilot cities of Co-Cities;
- Data services from the TISP to the traffic management centres of the cities involved but also to other transport modes and operators;

- Comparative assessment of the delivered data and information services against a "reference platform" in order to identify best practices and enable the exchange of experience among stakeholders[7].

In comparison with Co-Cities, BONVOYAGE too features a feedback loop delivering information from the traveller back to traffic management, but this is just one of the several innovative tools that the BONVOYAGE project is going to deploy.

FP7 CONVERGENCE

The goal of the CONVERGENCE project consists in enhancing the Internet with a content-centric, publish-subscribe service model, based on a common container for any kind of digital data. This container is called the Versatile Digital Item (VDI). VDIs are the basic unit of distribution and transaction in the CONVERGENCE network.

The introduction of the VDIs represents a shift from "host-centric" to "content-centric" networking, that is to a form of networking where the network layer provides users with content, instead of providing communication channels between hosts, and is aware of this content. The VDI container can be used to encapsulate any kind of digital information: not only classical media files, but also data about services, people and Real World Objects, such as items of merchandise identified with an RFID. VDIs bind meta-information (describing the content and structure of the item) and resources (other VDIs, audio, images, video, text, descriptors of RWOs, descriptors of people etc.). The meta-data describing the VDI includes structural information, cryptographic keys allowing robust authentication and protection of information included in the VDI, etc. VDIs are identified by a unique identifier, which is translated (or which is equal) to a network-level name used to route the VDI.

The second key feature of CONVERGENCE is represented by the support for a publish/subscribe service model: subscribers register their interest in an event, or a pattern of events, and are asynchronously notified of events generated by publishers. Publish/subscribe effectively decouples the application end-points in space, time and synchronization. This allows for greater scalability, a more dynamic network topology and a much enlarged and flexible typology of services.

The main players in the CONVERGENCE framework are depicted in the figures below: publishers advertise resources (data and service-access-points) on the CONVERGENCE system and subscribers express their interest in specific resources. The system notifies subscribers when the resources become available. Users can also search for resources and

[7] http://www.co-cities.eu/

obtain an immediate response. In this respect, search can be seen as a subcase of subscribing.

VDIs are used both to publish and to subscribe to content. Every resource that is stored or published in the CONVERGENCE system is associated with a VDI. Subscriptions express criteria that can be verified by inspecting VDI information.

The two figures below depicts the three conceptual levels of the CONVERGENCE system architecture. The second figure summarizes the scope of each level of the system architecture and the kinds of information exchanged at the interfaces between levels.

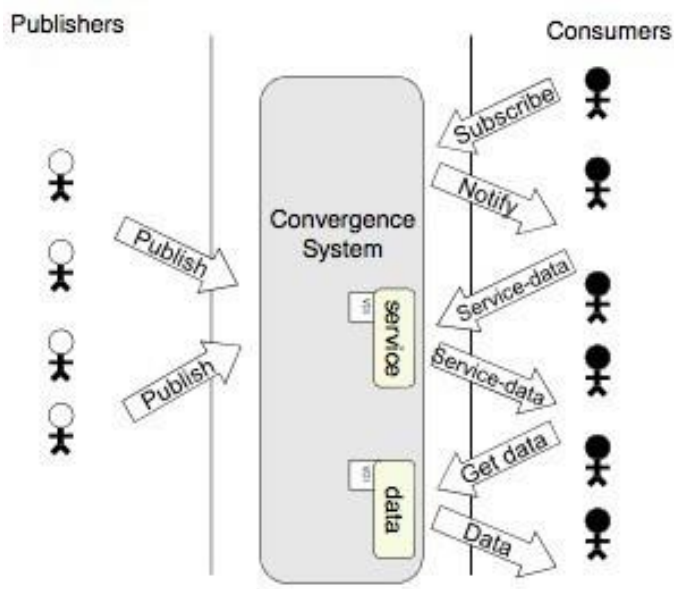


Figure 13: Publish/Subscribe service model in CONVERGENCE

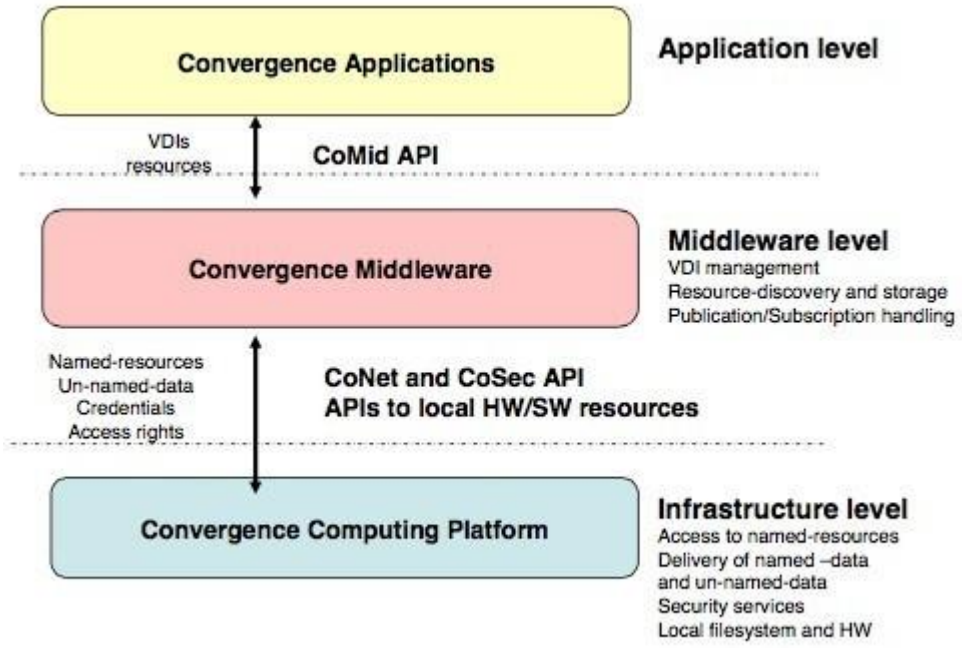


Figure 14: The CONVERGENCE system architecture

In particular, the Computing Platform level comprises key functional blocks providing novel content-centric networking (CoNet) and secure handling (CoSec) of resources within CONVERGENCE. The Computing Platform level also provides interfaces to access the local resources of the CONVERGENCE peers[8].

In comparison with CONVERGENCE, a pivotal feature in BONVOYAGE consists in resorting to an Information-Centric Network (ICN) with the aim of providing (i) seamless connectivity across different existing network realms (that may be administered by distinct transport operators or authorities); (ii) native support of mobility and security issues; (iii) travel-centric primitives for push/pull based services; (iv) high efficiency in communication and processing operations; (v) graceful deployability and interoperability with existing and upcoming networking systems (i.e., 5G and beyond). The highly heterogeneous, distributed and mobile nature of the data of interest, coming from data-centres, sensors, vehicles, goods and people on the move, calls for a network that is able to go beyond current paradigms. BONVOYAGE's innovative network, called Internames, allows name-to-name communication, without a static binding of end-points or users to their current location; in

[8] D3.2, System architecture, *FP7 CONVERGENCE*, 2011.

Internames names are used to identify all entities involved in communication: content, users, devices, logical points, and services. For instance, a sensor providing traffic information is identified by a name; a traveller is identified by a name; a database content is identified by a name; train, buses, cars, bicycles, planes, are identified by names; a transport service and an itinerary are identified by a name. All communications among such entities happen between names; it is the task of Internames to locate where such entities are located at a given time and to map name to location in a dynamic, context-dependent way, and to map a name not only to a current location but also to a protocol/service/communication type. Therefore, Internames will certainly benefit from what has been realized in the CONVERGENCE project and significantly improve such results in order to achieve the goals set by the innovative ITS foreseen by BONVOYAGE, according the above-mentioned criteria and features.

FP7 eCOMPASS

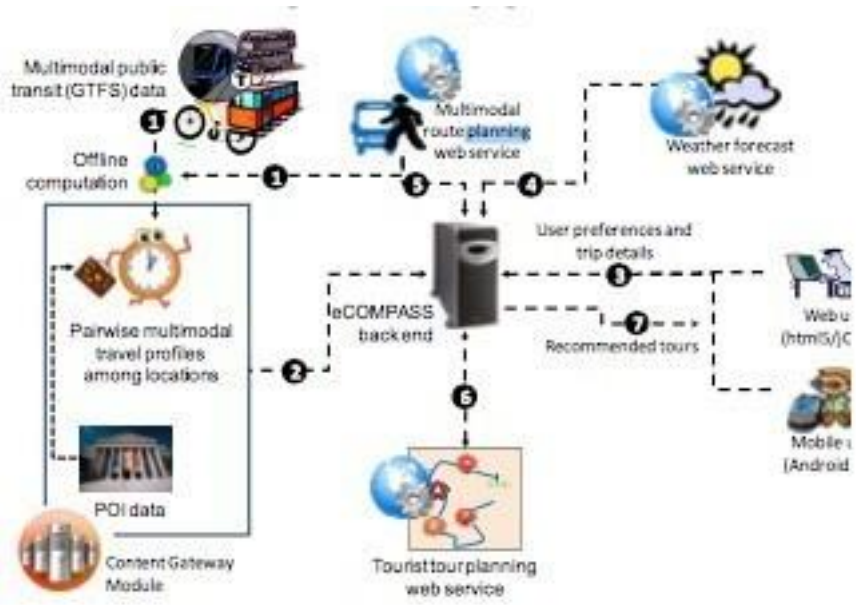


Figure 15: The eCOMPASS architecture

The eCOMPASS project has led to the development of several web services, combined in order to deliver personalized touristic route planning services via traditional web interfaces or mobile clients. In particular, upon receiving user queries, the application workflow of eCOMPASS is divided into two consecutive phases, the offline and the online one respectively.

The offline phase is aimed at (i) computing, based on multi-modal public transit (GTFS) data, the pairwise multi-modal travel time profiles among all locations and at (ii) grouping Points of Interest (POI) in disjoint clusters based on geographical criteria. All this information is stored in memory structures on the server side.

During the online phase, instead, user queries along with the user profile and trip details are sent, a weather web service is contacted in order to deliver a weather forecast for the trip dates, and then, based on the selected start/end tour locations, a multi-modal route planning service derives the personalized daily tourist tours, returning them in JSON format to the requesting client application and visualizing them on a map. In particular, the user specifies the start and end location of each itinerary, allowed to choose among available hotels (since most itineraries are expected to start and end at the user's accommodation), selected city landmarks (e.g., central squares), arbitrary locations (pointed on a map interface) and current location. The user also indicates his/her scheduled arrival date, the number of days to be spent at the destination and the preferred walking pace (to adjust the estimated walking travel times).

All in all, eCOMPASS behaves as a context-aware mobile application which derives personalized multimodal tours via selected urban attractions[9].

In comparison with eCOMPASS, BONVOYAGE plans to enhance the multi-modal route planning functions by solving the problem of optimizing long-distance (namely, on a Pan-European scale) door-to-door multi-modal and multi-passenger travel in an efficient way from the computational point of view. Moreover, BONVOYAGE too will rely on user profiling techniques, with the aim of providing the users with personalized optimal travel solutions.

FP7 MOBINCITY

Fully Electric Vehicles (FEV), for public and private transport, can contribute significantly to the lowering of the current pollution levels. However, FEV use is currently facing several weaknesses which are delaying its wider deployment, mainly due to the overall limited efficiency and limited driving range.

[9] D. Gavalas, M. Kenteris, C. Konstantopoulos, G. Pantziou, "A Web Application for Recommending Personalized Mobile Tourist Routes," *IET Sofware*, 6(4), pp. 313-322, 2012.

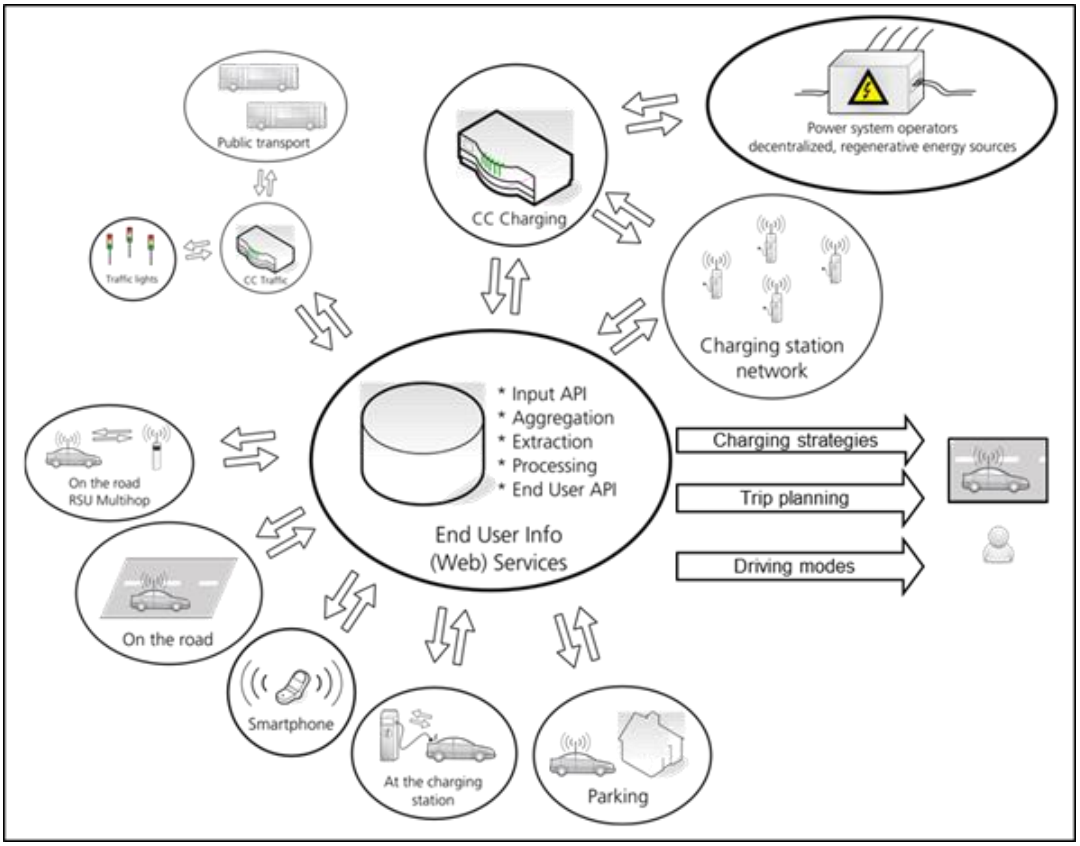


Figure 16: The MOBINCITY architecture

The MOBINCITY project has therefore been aimed at the optimization of FEV autonomy range and at the increase in energy efficiency thanks to the development of a complete ICT-based integrated system allowing interaction among driver, vehicle and transport and energy infrastructures, taking advantage of the information provided from these sources in order to optimise both energy charging and discharging processes (trip planning and routing). The main specific objectives of the project are the following.

- The development of a system to be installed within the vehicle for receiving information from the surrounding environment, which can have influence on the very vehicle performance (traffic information, weather and road conditions and energy grid).
- To optimise the trip planning and routing of FEV using information from these external sources including alternatives from other transport modes adapted to user's needs.
- To define efficient and optimum charging strategies (including routing) adapted to user and FEV needs and grid conditions.

- To implement additional energy saving methods (as driving modes and In-Car Energy Management Services) within the FEV interaction with the driver[10].

BONVOYAGE, among the different available transportation modalities, also considers FEV and thus has to solve a resource constrained shortest path problem for returning the desired optimal trip planning solutions to the requesting users. Therefore, the BONVOYAGE project plans to exploit and improve the outcome of the MOBINCITY project, especially as regards the development of dynamic optimal trip planning algorithms for FEV in urban scenarios using real-time information about traffic, weather and road conditions as well as about the energy grid.

FP7 MOBiNET

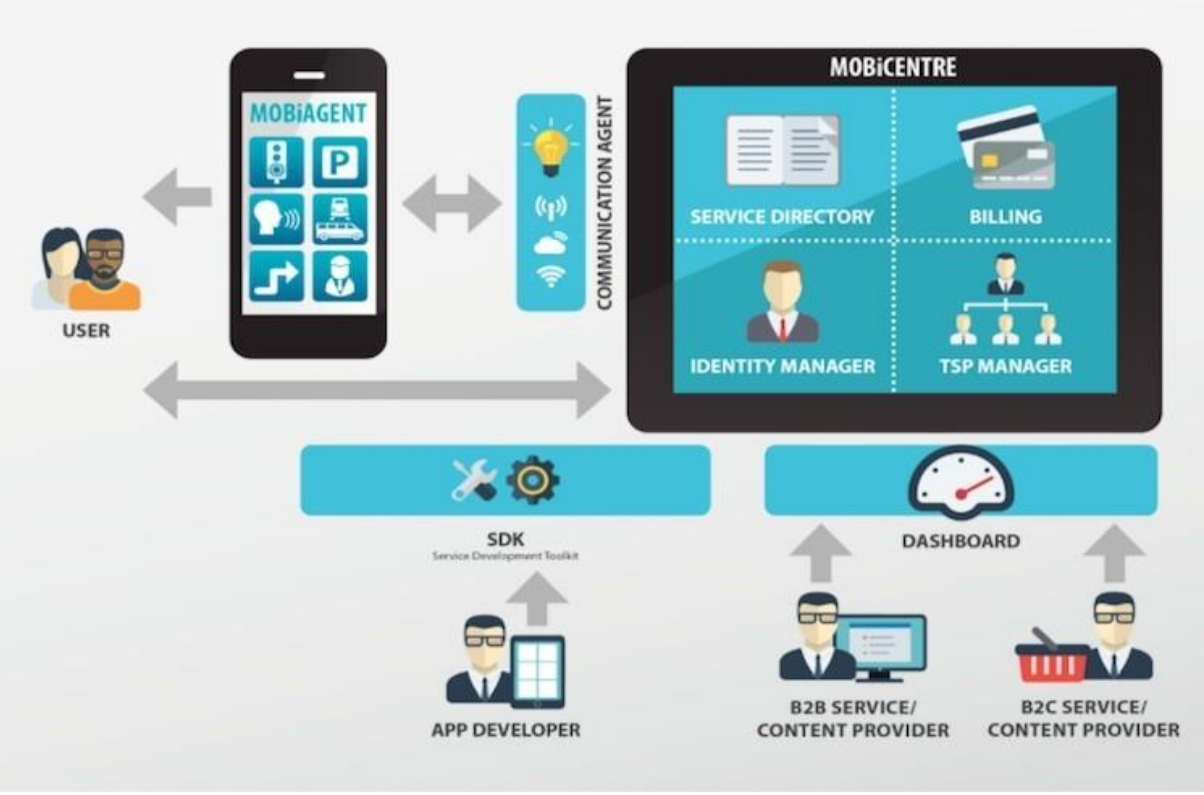


Figure 17: The MOBiNET architecture

MOBiNET has been designed as a Europe-wide e-marketplace of mobility services for

[10] http://www.mobincity.eu/

businesses and end users. The MOBiNET e-marketplace allows content and service providers to exchange transport and mobility services for new or third-party service development. In other words, MOBiNET works an Internet-based network linking travellers, transport users, transport system operators, service providers, content providers and transport infrastructures.

As shown in the figure above, the platform consists of two main components: the MOBiCENTRE, containing all central functionality to support service providers and other business stakeholders, and the MOBiAGENT, containing all the functionality made available on end user devices.

In particular, MOBiCENTRE is a cloud-based platform playing the role of the central facility, designed as a modular and scalable distributed system. It provides the commonly required infrastructure functionalities to support the whole service provider chain including service management, billing, communication, and identity management. It consists of the following components.

- The Dashboard behaves as the interface for data and service providers and therefore provides the basic portal framework in which other subsystems can plug in their user interfaces in order to form a corresponding MOBiNET market for service providers. In addition, it provides means for service monitoring and service composition.
- The Service Directory is a database of transport and mobility data and services. It provides basic capabilities to manage and search service descriptions including all relevant meta data, such as geographical location, as well as keywords/tags. In this sense, it works as the yellow pages of transport and mobility data and services. A data/content owner or service provider can access the Service Directory through the Dashboard. He can register his service by simply providing a description, which can be updated or deleted by the user anytime.
- The Billing component is capable of managing financial transactions for membership fees, business fees, service and app providers. The Billing component follows the whole transaction from the service provider request to the receipt emission for the user.
- The Identity Manager is the mechanism responsible for authentication and authorisation in MOBiNET. It provides capabilities to manage common identities and to handle all security and privacy related concerns. It handles all security and privacy related issues.
- The TSP (Telematic Service Providers) Manager collects telematics data from TSPs and distributes it to registered users like insurance providers or traffic advice

systems. It handles the communication between these parties and defines data formats to enable a consistent and common understanding of the telematics data.

- The Communication Agent component is responsible for periodically receiving and processing information over the cellular network from end user devices (e.g. on-board unit, smartphone, tablets) equipped with the Communication Manager, which is part of the MOBiAGENT. These periodic updates contain, but are not limited to, information about the current position of the device, its speed, heading, applications installed, and its communication capabilities.

The MOBiAGENT, instead, is a Smartphone application which provides end users with an interface to MOBiNET. End users are able to login-to the MOBiNET platform via the MOBiAGENT. Once logged in, they can search for applications and end-user services within MOBiNET[11].

In a similar way as MOBiNET, BONVOYAGE specifically plans to design a tool aimed at providing tariff schemes which, on the one hand, encourage the use of specific classes of mobility and delivery services (e.g., those with a lower environmental impact, type of good), and, on the other hand, create new business opportunities for the transport operators, which can offer special prices for multimodal travel allowing them to increase the exploitation of their transport resources. One of the innovative goals of BONVOYAGE, in comparison with MOBiNET, is to integrate the tariff scheme tool in the multi-objective optimization framework, thus allowing dynamic changes and re-negotiations during the trip. All security issues, with respect to user preferences and transactions are going to be taken into account, too.

FP7 PEACOX

The PEACOX project is aimed at providing travellers with personalized multi-modal navigation tools persuading them to travel and drive in an eco-friendlier way. This has been done in order to address the urgent need for more sustainable travel choices capable of reducing the ecological impact of road traffic. In this respect, PEACOX enriches navigation systems with the following features.

[11] D31.3.1, Architecture refinement and integration, *FP7 MOBiNET*, 2014.

- PEACOX integrates automated travel mode detection based on real-time GPS data into the trip planning functionality, thus minimizing the need for explicit user input.
- PEACOX automatically detects the users' trip purposes through the analysis of behavioural patterns, thus allowing to tailor trip suggestions to such purposes.
- PEACOX builds dynamic user models allowing personalized recommendations based on prior trip choices and individual preferences.
- PEACOX develops advanced door-to-door emission models providing accurate feedback on the ecological/carbon footprint and exposure levels in the planning phase as well as during travelling and car driving activities.
- PEACOX resorts to persuasive interface strategies in order to give feedback about the ecological impact of individuals' behaviour as well as to make the ecological friendliest behavioural pattern visible and attractive.

The figure below illustrates the high-level system architecture of PEACOX.

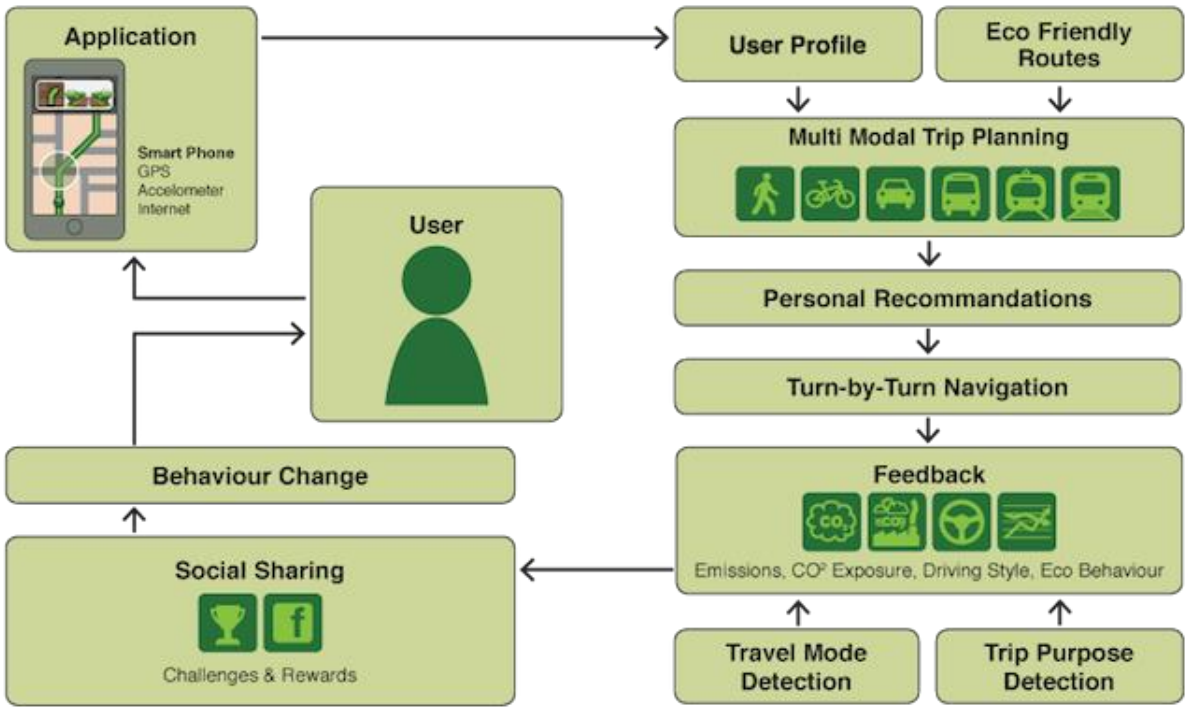


Figure 18: The PEACOX architecture

In particular, the PEACOX platform consists of two components: the journey planner application and the navigation client. Open Street Map (OSM) is used within the journey

planner application, whereas the navigation client uses the TomTom maps[12].

In comparison with PEACOX, BONVOYAGE delivers significantly improved services as it offers multi-modal trip planning functionality over Europe-wide large-scale transportation networks and it also addresses the problem of multi-objective optimization, thus providing the users with optimal travel solutions that are computed by taking into account several personalized optimality criteria. Moreover, the BONVOYAGE platform integrates a tariff scheme tool for handling transactions between service providers and end users.

FP7 SMARTMUSEUM

The overall objective of the SMARTMUSEUM project is to develop a platform for enhancing on-site personalised access to digital cultural heritage through adaptive and privacy-preserving user profiling. Using on-site knowledge databases, global digital libraries and visitors' experiential knowledge, the platform makes possible the creation of innovative multilingual services for increasing interaction between visitors and cultural heritage objects in a future smart museum environment, taking full benefit of digitized cultural information.

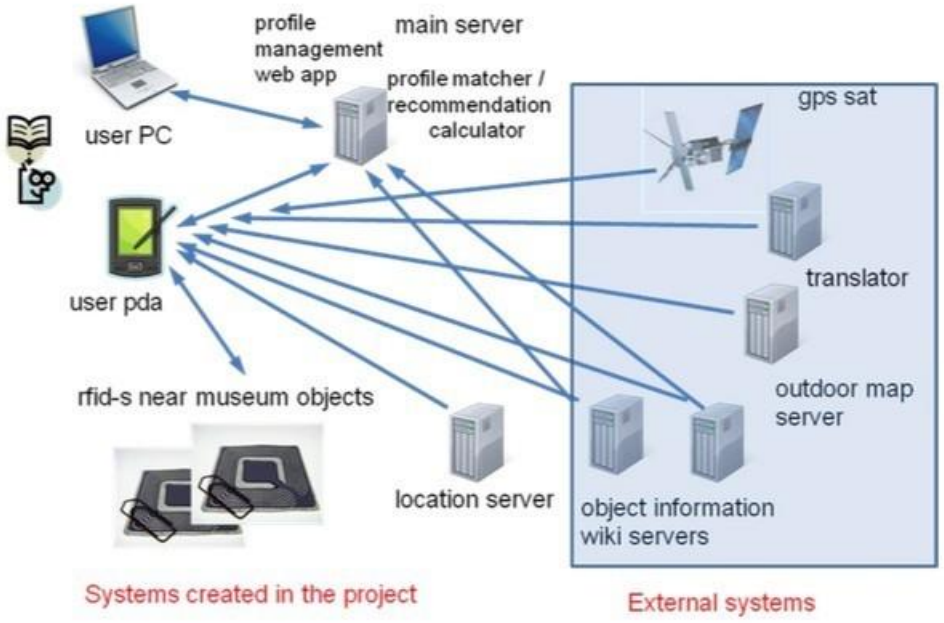


Figure 19: The SMARTMUSEUM architecture

[12] D6.3.1, System Design and Interface Definition, *FP7 PEACOX*, 2013.

The main functional goals of the project are the following.

- To give the user as good suggestions for visit (outside or inside) as possible, basing the suggestions on (i) user profiles of a visitor and previous visitors and (ii) machine-processable semantic information about objects.
- To give the user as good/suitable information about an object the user wished to know about as possible.
- Allow active end user participation: adding object information via wikis, giving bad/good/super marks to objects, adding comments to visited objects.
- Allow users interested in communicating with other users find matching profiles (visiting same location, same interests, ...).
- Preserve privacy of users: tracking identified users is not ok unless the user explicitly makes it possible, user should be able to see, understand and change his/her own profile.

The project has led to the development of: (i) a user PDA software, for temporary profile storage (before sending to server) and behaving as a route presenter, as a place-of-interest presenter and as an RFID tag writer for museum administrators; (ii) a central profile engine/suggestion calculator, for storing general user profile information and for running the algorithms aimed at finding similar profiles as well as at providing recommendations/suggestions; (iii) a user profile management web application enabling interested users to view the profile and edit the profile preferences; and (iv) a simple location server for finding nearby outside objects, from which the profile engine/suggestion calculator filters necessary information[13].

In this respect, BONVOYAGE certainly takes into account the state-of-the-art techniques related to user profiling (including those featured by SMARTMUSEUM), with the aim of achieving the personalization of the services offered by the platform, that is, of meeting, as far as possible, specific user preferences, needs and expectations in terms of travel schedule, travel duration, travel cost, transport means, travel reliability, etc. Personalization is performed, on the one hand, on the basis of an automatic mapping of each user to the most appropriate user profile corresponding to given parameters which are used in the framework of the optimization tasks, and, on the other hand, on the basis of the automatic interpretation of the feedback provided by each user, as well as by users

[13] D1.1, SMARTMUSEUM architecture and use scenarios, *FP7 SMARTMUSEUM*, 2008.

belonging to the same profile. Wearable electronics and eHealth devices are also going to be used to provide real-time automatic feedbacks under the form of participatory sensing, to monitor the wellness of the travellers and possibly change or adapt the on-going trips.

OpenTripPlanner

OpenTripPlanner is the leading open-source ITS for the purposes of multimodal trip planning as well as transportation network analysis[14].

It is accessible by means of both a web interface and an API for third-party applications, thus allowing users to search for itineraries in terms of pedestrian, bike, public transport, and car components. In this respect, OpenTripPlanner offers a truly multi-modal service.

Moreover, OTP relies on open data standards: namely, the General Transit Feed Specification (GTFS) for transit schedule data, OpenStreetMap (OSM) for street collecting network information, and GTFS-Realtime for monitoring vehicle position, possible delays, and alert data. In particular, the GTFS-Realtime updates are applied during the very itinerary optimization process.

OpenTripPlanner Internal Architecture

At the core of OpenTripPlanner, there is a library of Java code that finds efficient paths through multi-modal transportation networks built from the above-mentioned open data. Several different services are built upon this library. A brief description of the main related services follows.

The OpenTripPlanner Routing API is a RESTful web service that is in charge of responding to journey planning requests with itineraries in a JSON or XML representation. Such an API can be combined with OpenTripPlanner's standard Javascript front end in order to provide users with trip planning functionality in a familiar map interface. Otherwise, developers can write their own applications talking directly to the API.

The OpenTripPlanner Transit Index API is an additional RESTful web service that provides information derived from the GTFS feeds received in input. Examples include routes serving a particular stop, upcoming vehicles at a particular stop, upcoming stops on a given trip, etc.

[14] http://www.opentripplanner.org/

Another interesting and powerful tool embedded in OpenTripPlanner is the so-called OpenTripPlanner Analyst, which is a functional block capable of applying the routing engine to transportation network analysis rather than end-to-end trip planning. The related web services provide network analysis results such as travel time maps and isochrones such as standard web Mercator tiles or GIS rasters. Being separate from the above-mentioned Routing API, the Analyst allows to exploit OpenTripPlanner also with the aim of producing travel time maps and other visualizations of transit service.

The BONVOYAGE optimal trip planning algorithms is obviously designed (i) taking into account the current state-of-the-art results offered by OpenTripPlanner and (ii) with the aim of delivering improved performances and ensuring full multi-modality.

Synoptic comparison chart showing the innovation introduced by BONVOYAGE

This section is aimed at illustrating a synoptic view of BONVOYAGE and the above-mentioned projects, showing which of them exhibit only some of the features listed below and how BONVOYAGE, instead, thanks to its modular architecture, is characterized by all of such features. The features we refer to are the following: (1) capability to address large-scale transportation networks; (2) capability to manage multi-modal transport; the presence of (3) a user-profiling tool, (4) a multi-objective optimization tool, and (5) a tariff scheme tool; (6) personalized door-to-door multi-modal optimal trip planning of FEV in urban areas; (7) capability to manage passenger transport and (8) freight transport; (9) the presence of a feedback loop in the architecture; (10) privacy and security; (11) the presence of an information-centric network; (12) the interoperability among heterogeneous transport operators.

The table below shows that BONVOYAGE is indeed beyond the State of Art as (i) it is the first project addressing simultaneously all of the above-mentioned problems, and (ii) it is aimed at deploying improved services especially as regards dynamic large-scale personalized multi-modal optimal trip planning supported by a secure information-centric network ensuring interoperability among heterogeneous data sources.

Relevant Features	Co-Cities	CONVERGENCE	eCOMPASS	MOBINCITY	MOBiNET	PEACOX	SMARTMUSEUM	OTP	BONVOYAGE
Large-Scale Transportation Networks	✓	✗	✗	✗	✓	✗	✗	✗	✓
Multi-Modality	✓	✗	✓	✗	✗	✓	✗	✓	✓
User-Profiling Tool	✗	✗	✓	✗	✗	✓	✓	✗	✓
Multi-Objective Optimization Tool	✗	✗	✓ (just a route planner)	✗	✗	✓	✗	✓	✓
Tariff Scheme Tool	✗	✗	✗	✗	✓	✗	✗	✗	✓
Personalized Door-to-Door Optimal Trip Planning of FEV in Urban Areas	✗	✗	✗	✓	✗	✗	✗	✗	✓
Passenger Transport	✓	✗	✓	✓	✓	✓	✗	✓	✓
Freight Transport	✗	✗	✗	✗	✗	✗	✗	✗	✓
Feedback Loop	✓	✗	✗	✗	✗	✓	✗	✗	✓
Privacy and Security	✗	✓	✗	✗	✓	✗	✓	✗	✓
ICN	✗	✓	✗	✗	✓	✗	✗	✗	✓
Interoperability	✓	✗	✗	✗	✓	✗	✗	✗	✓

5 Internal Interfaces architecture

The BONVOYAGE reference architecture described in Section 4 follows a straightforward top-down design approach, starting from use cases and requirements towards functionalities and functional modules. The interfaces between the functional modules exposes the set of functionalities in charge of each of them. In this section, details regarding the information exchanged by the module through the provided functionalities are provided. The atomic information exchanged by the functional modules are a set of Data Objects.

5.1 Data Objects

The next step of the top down approach described in Section 4 is the identification of the so called **Data Objects**, that is an atomic piece of information exchanged between the functional modules, through the related provided functionalities. Each Data Object can be an **Input** parameter or an **Output** parameter of a given functionality (see Figure 12).

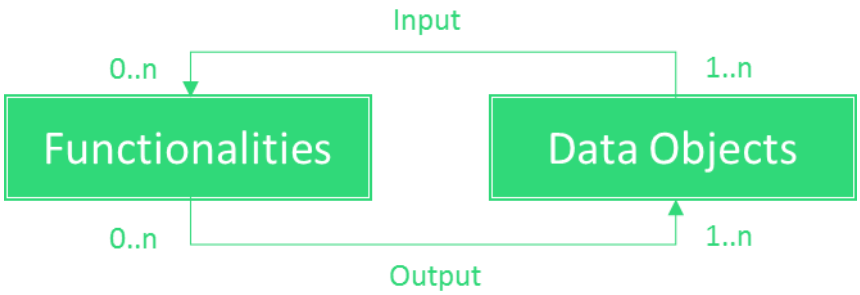


Figure 12: Relationship between Functionalities and Data Objects

More specifically, each functionality requires zero or more input data objects and produces zero or more output data objects. A functionality must have at least one input (or output) data object and each data object must be an input (or an output) of at least one functionality. In BONVOYAGE, we have identified a set of 18 Data Objects described below:

1. **USER**. This object contains all profile-agnostic information about users of the platform.
2. **USER_PROFILE**. This object contains all the user profile related information, dealing with: the user (e.g. age, gender, etc.), his preferences (e.g. class category, best price choice), his historical data (stress level, adopted transport modes, selected travel solutions, etc.), his statistics (number of visits, number of purchased tickets, number of feedbacks, etc.), information related to his membership (collected points, membership configuration, etc.), and his achievements, in terms of calories,

emissions or money, which allows the user to accumulate points from achieved targets.

3. **USER_STATUS**. This object contains current information about the actual user status such as: GPS coordinates, current stress level, current transport mode or current location.
4. **EXTERNAL_SERVICE_PROVIDER**. This object contains all the information related to the partner of BONVOYAGE platform transport operators, to the services they offer and the related conditions (e.g. promotions, discounts).
5. **TRANSPORT_OPERATOR**. This object contains all profile-agnostic information about transport operators. Moreover, it contains specifically technical information on how to exchange information with the operator.
6. **TRANSPORT_OPERATOR_PROFILE**. This object contains information about the transport operator the platform keeps track of. For instance, transports made by a single freight transport operator (both company and single driver) and of related results (e.g. volumes). Freight transport operator features (e.g. number of tracks, past experiences) and feedbacks of those users who did a research on available freight services.
7. **TRANSPORT**. This object contains all the information about a moving user or group of users. It may also refer to a parcel or some good being transported.
8. **TRANSPORT_STATUS**. This object contains information on the status of the parcel (e.g. location in which location the parcel is) provided by the freight transport information provider.
9. **TRAVEL_INFORMATION_RESPONSE**. This object contains real-time information such as traffic situation and transport status, information from sensors, and map tiles with associated information.
10. **TRAVEL_INFORMATION_REQUEST**. This object contains information about the list of sensors to monitor, SOS request for road side assistance, list of routes to be monitored, list of dynamic events like road events (road segment delay, temporary closure, etc.) or trip events (delay, cancellation, etc.)).
11. **TRAVEL_SOLUTION_RESPONSE**. This object contains all the information about the optimized route with some updates, as well as the list of travel chucks.
12. **TRAVEL_SOLUTION_REQUEST**. This object contains the following information:
    - List of query parameters, such as: origin, destination(s), via points, one-way or return, date and time (leave after and/or arrive before), number of travellers, size of package, minimum/maximum number of alternatives to be output, etc.;
    - List of user objectives, such as: selection preference path (e.g.: shortest, faster, less foreign exchange), selection favourite transportation (e.g.: bus, subway, train, tram), identification preference level of different public transport / private (e.g., taxi, tram, bus, walk, train, subway, car, bicycle, etc. each scored 1 to 5);

- List of user constraints, such as: selection of routes to be avoided (e.g. toll roads, highways), selection of vehicles owned (car, motorcycle, bicycle, etc.), selection of access to transportation (car sharing, bike sharing, cars, motorcycles, bicycles, etc.);
- List of user commitments, such as: existing routes (accepted from an earlier query), tickets already reserved/bought and if they are refundable, progress (current position in route).

13. **PLATFORM_SPECIFIC_FILTER_PARAMETERS**. This object describes the possible set of platform-specific parameters that can be added to a request for travel information. For instance, a travel solution can be additionally filtered based on user attributes, based on past history, on geographic crossing with ongoing transports, on platform's alert conditions, etc. This is used as well for filtering the information that will be monitored and interacting with the platform to tell it what we are interested in, or what information we want to subscribe. In particular, this object is directly fed to the DISCOVER_INFORMATION functionality.
14. **TRANSPORT_DATA_SOURCE**. This object contains information related to the transport company, such as its name, the service identifier, the service URL, etc.
15. **TRANSACTION**. This object represents an official, signed electronic document exchanged by actors of the platform. For instance, it can contain all the details related to the purchased tickets/travel solutions, or a delivery note exchanged when transport of goods is correctly carried out.
16. **FEEDBACK**. This object represents a generic input from the user to the platform to convey feedback about other functionalities and/or data objects of the platform itself. Examples of information contained in this data object are:
    - Category - the category to which the feedback refers to;
    - MOS - a 1 to 5 score to evaluate the feedback;
    - Comment - a text free string;
    - Channel - e-mail, sms, etc.
17. **POINTER_TO_DATA_OBJECT**. This object is used as a reference to other objects, to facilitate exchanging of data objects between functionalities that need to pass generic objects to each other.
18. **PLATFORM_RESPONSE**. This object is used whenever the platform informs the user about an action that occurred either as a result of user inputs or because of triggered alert or notifications.

Each data object has been assigned (as part of an input and/or an output) to each functionality as depicted in the following table:

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
ADD_INF - ADD_INFORMATION	POINTER_TO_DATA_OBJECT USER	PLATFORM_RESPONSE
ADD_OBJ - ADD_OBJECTIVE	USER_PROFILE	USER_PROFILE
ADD_PIN - ADD_PLATFORM_INFORMATION	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	PLATFORM_RESPONSE
ADD_PSG - PASSENGER_ADD	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
APP_UFB - PUT_APP_USER_FEEDBACK	USER_PROFILE	FEEDBACK
AUTHO - AUTHORIZATION	USER USER_PROFILE	PLATFORM_RESPONSE
BIT_NOT - SET_BIDS_NOTIFICATION	TRANSPORT_OPERATOR	PLATFORM_RESPONSE
BLD_PRC - BUILD_PRICES	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	PLATFORM_RESPONSE
BLD_TPR - BUILD_TARIFF_PROFILE	USER_PROFILE	USER_PROFILE
CAL_TRP - CALCULATE_TRIP_SOLUTION	TRAVEL_SOLUTION_REQUEST USER_PROFILE	TRAVEL_SOLUTION_RESPONSE
CNT_TRP - CONTROL_TRIP_SOLUTION	TRAVEL_INFORMATION_REQUEST USER_STATUS TRANSPORT PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE PLATFORM_RESPONSE
CPR_SRC - CLIENT_PROFILE_SEARCHING	TRANSPORT_OPERATOR USER	PLATFORM_RESPONSE
CRT_OPR - CREATE_OPTIMIZED_ROUTE	TRAVEL_SOLUTION_REQUEST TRAVEL_INFORMATION_REQUEST	TRAVEL_SOLUTION_RESPONSE
CSH_BOK - CAR_SHARING_BOOK	TRAVEL_SOLUTION_RESPONSE PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRANSACTION
CTR_CRE - COLLECTIVE_TRAVEL_CREATE	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
CTR_UPD - COLLECTIVE_TRAVEL_UPDATE	TRAVEL_SOLUTION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE
CUS_TIC_PUR - CUSTOMISED_TICKET_PURCHASE	USER_PROFILE TRAVEL_SOLUTION_RESPONSE	TRANSACTION
DEF_BIO - DEFINE_BONUS_IDENTIFICATION/OBLIGATION	USER_PROFILE	USER_PROFILE
DEF_STP - DEFINE_STATIC_PARAMETERS	USER_PROFILE	USER_PROFILE
DEL_DSC - DELETE_DISCOUNTS	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	PLATFORM_RESPONSE
DEL_OBJ - DELETE_OBJECTIVE	USER_PROFILE	USER_PROFILE
DIS_INF - DISCOVER_INFORMATION	TRAVEL_INFORMATION_REQUEST TRAVEL_SOLUTION_REQUEST	TRANSPORT_DATA_SOURCE
DLV_INF - DELIVER_INFORMATION	POINTER_TO_DATA_OBJECT	PLATFORM_RESPONSE

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
	USER	
DSP_DRV - DISPLAY_DRIVER_INFORMATION	TRAVEL_SOLUTION_REQUEST	USER_PROFILE
DSP_FRG - DISPLAY_FREIGHT_SERVICE	TRANSPORT PLATFORM_SPECIFIC_FILTER_PARAMETERS	PLATFORM_RESPONSE
DSP_FRR - DISPLAY_FREIGHT_RESPONSIBLE	TRANSPORT PLATFORM_SPECIFIC_FILTER_PARAMETERS	PLATFORM_RESPONSE
EXP_PIN - EXPOSE_PLATFORM_INFORMATION (Please map to External APIs block/module and not anymore to Data Interfacing Module which is to be removed)	TRAVEL_INFORMATION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRANSPORT_DATA_SOURCE
EXS_REM - EXTRA_SERVICE_CANCELLATION	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
FAV_DRV - MARK_FAVOURITE_DRIVER	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
FAV_FRG - MARK_FAVOURITE_FREIGHT	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
FGT_OPT - FREIGHT_OPERATOR	TRANSPORT_OPERATOR	TRANSPORT_OPERATOR_PROFILE
FIL_INF - SET_FILTER_INFORMATION	TRANSPORT	PLATFORM_RESPONSE
GET_AWA - GET_GIFTS	USER_PROFILE	USER_PROFILE
GET_CIS - GET_CIRCULATION_STATUS	TRAVEL_INFORMATION_REQUEST	TRAVEL_INFORMATION_RESPONSE
GET_FBF - GET_FEEDBACK_ON_FREIGHT	TRANSPORT_OPERATOR	TRANSPORT_OPERATOR_PROFILE
GET_MYS - VIEW_MY_SCORE	USER_PROFILE	USER_PROFILE
GET_OPR - GET_OPTIMIZED_ROUTE	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
GET_SCR - GET_SCORE	USER_PROFILE	USER_PROFILE
GET_SRK - VIEW_SCORE_RANK	USER_PROFILE	USER_PROFILE
GET_STA - GET_STATISTICS	TRANSPORT_OPERATOR	TRANSPORT_OPERATOR_PROFILE
GET_TSS - GET_TIMESCHEDULE_SERVICE	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
GET_UFB - GET_TRAVEL_SOLUTION_USER_FEEDBACK	USER_PROFILE	FEEDBACK
GET_USC - GET_USER_SCORE	USER_PROFILE	USER_PROFILE
GTR_CRE - GOODS_TRAVEL_CREATE	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
GTR_UPD - GOODS_TRAVEL_UPDATE	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
INF_VIS - INFORMATION_VISUALIZATION	POINTER_TO_DATA_OBJECT	PLATFORM_RESPONSE
ITR_CRE - INDIVIDUAL_TRAVEL_CREATE	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
ITR_UPD - INDIVIDUAL_TRAVEL_UPDATE	TRAVEL_SOLUTION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
LEI_LOC_PUR - LEISURE_LOCAL_SERVICES_PURCHASE	TRAVEL_SOLUTION_RESPONSE PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_REQUEST
LPT_TIC - LPT_TICKET	TRANSACTION	PLATFORM_RESPONSE
LPT_VAL - LPT_VALIDATION	TRANSACTION	PLATFORM_RESPONSE
MAP_LAY - MAP_LAYER	TRAVEL_INFORMATION_REQUEST	TRAVEL_INFORMATION_RESPONSE
MOB_SER_PUR - MOBILITY_SERVICES_PURCHASE	TRAVEL_SOLUTION_RESPONSE PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_REQUEST
MOD_DSC - MODIFY_DISCOUNTS	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	PLATFORM_RESPONSE
MOD_SAP - MODIFY_SEATASSIGN_PARAMS	USER_PROFILE TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
MON_DVR - MONITOR_DELIVERY_ROUTE	TRANSPORT PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRANSPORT_STATUS TRAVEL_INFORMATION_RESPONSE
NVG_OPR - NAVIGATION_OPTIMIZED_ROUTE	TRAVEL_SOLUTION_RESPONSE	TRANSPORT TRANSPORT_STATUS
NVG_TZR - NAVIGATION_TRACEABILITY_TOOL	TRAVEL_SOLUTION_RESPONSE	TRANSPORT TRANSPORT_STATUS
ONT_VIS - ONTRIP_VISUALIZATION	TRANSPORT	TRANSPORT_STATUS
PAC_TRA - PARCEL_TRACKING	TRANSPORT	TRANSPORT_STATUS
PAR_OFF - PARTNERS_OFFERS	EXTERNAL_SERVICE_PROVIDER USER_PROFILE	USER_PROFILE
PAR_SER - PARTNERS_SERVICES	PLATFORM_SPECIFIC_FILTER_PARAMETERS	EXTERNAL_SERVICE_PROVIDER
PHT_DVN - PHOTO_DELIVERY_NOTE	USER EXTERNAL_SERVICE_PROVIDER	TRANSACTION
PRF_CTE - PROFILE_CREATE	USER	USER_PROFILE
PRF_DTE - PROFILE_DELETE	USER_PROFILE	USER_PROFILE
PRF_UTE - PROFILE_UPDATE	USER_PROFILE	USER_PROFILE
PRO_USE_PUR - PROFILED_USER_PURCHASES	TRANSPORT_OPERATOR	USER_PROFILE
PRV_VAS - PROVIDE_VIRTUAL_ASSISTANCE	USER_STATUS TRANSPORT	PLATFORM_RESPONSE
PSS_CTE - PASSENGER_CREATE	USER	USER_PROFILE
PSS_UTE - PASSENGER_UPDATE	USER_PROFILE	USER_PROFILE
PUB_INF - PUBLISH_INFORMATION	POINTER_TO_DATA_OBJECT USER	PLATFORM_RESPONSE
PUR_TIC - PURCHASE_TICKET	TRANSACTION	USER_PROFILE
PUT_BID - PUT_BID	TRAVEL_SOLUTION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE
PUT_SCR - PUT_SCORE	USER_PROFILE	USER_PROFILE
PUT_UFB - PUT_TRAVEL_SOLUTION_USER_FEEDBACK	USER_PROFILE FEEDBACK	USER_PROFILE
REM_PSG - PASSENGER_REMOVE	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
RMV_INF - REMOVE_INFORMATION	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE PLATFORM_SPECIFIC_FILTER_PARAMETERS	PLATFORM_RESPONSE
ROU_VIS - ROUTE_INFO_VISUALIZATION	TRAVEL_SOLUTION_RESPONSE PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE
RST_USC - RESET_USER_SCORE	USER_PROFILE	USER_PROFILE
SAL_TPP - SALES_2	USER	USER_PROFILE
SAL_USR - SALES _1	USER	USER_PROFILE
SCORE - SCORE	USER_PROFILE	USER_PROFILE
SEL_TRS - SELECTED_TRAVEL_SOLUTION	USER_PROFILE	USER_PROFILE
SET_FBF - SET_FEEDBACK_ON_FREIGHT	TRANSPORT_OPERATOR FEEDBACK	TRANSPORT_OPERATOR_PROFILE
SET_SPL - SET_SCORE_POLICY	USER_PROFILE	USER_PROFILE
SET_USC - SET_USER_SCORE	USER_PROFILE	USER_PROFILE
SGN_DVN - SIGN_DELIVERY_NOTE	USER EXTERNAL_SERVICE_PROVIDER	TRANSACTION
SHR_INF - SHARE_INFORMATION	POINTER_TO_DATA_OBJECT USER	PLATFORM_RESPONSE
SHW_PRG - SHOW_PROGRESS	USER_PROFILE	USER_PROFILE
SND_DVN - SEND_DELIVERY_NOTE	USER EXTERNAL_SERVICE_PROVIDER	TRANSACTION
SRC_DRV - SEARCH_DRIVER	TRAVEL_SOLUTION_REQUEST	TRAVEL_SOLUTION_RESPONSE
SRC_ENG - SEARCH_ENGINE	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	PLATFORM_RESPONSE
SRC_FRG - SEARCH_FREIGHT	TRAVEL_SOLUTION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE
SRC_LOC - SEARCH_LOCATION	TRAVEL_INFORMATION_REQUEST	TRAVEL_INFORMATION_RESPONSE
STP_INF - PT_STOP_INFORMATION_VISUALIZATION	USER_STATUS TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE TRAVEL_INFORMATION_RESPONSE
STP_VIS - PT_STOPS_LOCATION_VISUALIZATION	TRAVEL_SOLUTION_RESPONSE USER_STATUS	TRAVEL_INFORMATION_RESPONSE
SUB_INF - SUBSCRIBE_INFORMATION	POINTER_TO_DATA_OBJECT USER	PLATFORM_RESPONSE
SVE_DRV - SAVE_DRIVER	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
SVE_FRG - SAVE_FREIGHT	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
SVE_OPR - SAVE_OPTIMIZED_ROUTE	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
SVE_SRC - SAVE_SEARCH	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	USER_PROFILE
SWI_CUR - SWITCH_CURRENCY	TRANSACTION	TRANSACTION

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
	USER_PROFILE	USER_PROFILE
SWI_LAN - SWITCH_LANGUAGE	USER_PROFILE	USER_PROFILE
SYN_INF - SYNC_INFORMATION	POINTER_TO_DATA_OBJECT POINTER_TO_DATA_OBJECT	PLATFORM_RESPONSE
TAR_TRA - TARIFF_TRANSFER	TRANSACTION	PLATFORM_RESPONSE
TCH_UFB - PUT_TRAVEL_CHUNK_USER_FEEDBACK	USER_PROFILE FEEDBACK	USER_PROFILE
TIC_COD_CHA - TICKET_CODE_CHANGES	TRANSACTION PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRANSACTION
TIC_CRE - TICKET_CREATION	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	TRANSACTION
TIC_DET - TICKETS_DETAILS	USER_PROFILE PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRANSACTION
TIC_MOD - TICKET_MODIFICATION	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
TIC_REI - TICKET_REIMBURSEMENT	USER TRANSACTION	PLATFORM_RESPONSE
TRC_TOO - TRACEABILITY_SUPPORT_TOOL	TRAVEL_SOLUTION_RESPONSE	TRANSPORT TRANSPORT_STATUS
TRS_EXT - TRAVEL_SOLUTION_EXTENSION	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
TRS_FIN - TRAVEL_SOLUTION_FINALIZATION	TRANSACTION	PLATFORM_RESPONSE
TRS_MOD - TRAVEL_SOLUTION_MODIFICATION	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
TRS_REM - TRAVEL_SOLUTION_CANCELLATION	TRAVEL_SOLUTION_RESPONSE	TRAVEL_SOLUTION_RESPONSE
TRV_MEM - TRAVEL_SETTING_MEMORANDUM	TRAVEL_SOLUTION_RESPONSE USER_PROFILE	PLATFORM_RESPONSE
UPD_INF - UPDATE_INFORMATION	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE PLATFORM_SPECIFIC_FILTER_PARAMETERS	PLATFORM_RESPONSE
UPD_OPR - UPDATE_OPTIMIZED_ROUTE	TRAVEL_SOLUTION_REQUEST PLATFORM_SPECIFIC_FILTER_PARAMETERS	TRAVEL_SOLUTION_RESPONSE
UPD_USC - UPDATE_USER_SCORE	USER_PROFILE	USER_PROFILE
UPL_DSC - UPLOAD_DISCOUNTS	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	PLATFORM_RESPONSE
UPL_INF - UPLOAD_INFORMATION	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE PLATFORM_SPECIFIC_FILTER_PARAMETERS	PLATFORM_RESPONSE
UPL_TPR - UPLOAD_TRAVEL_PROFILE	USER_PROFILE	USER_PROFILE
USE_SHR - USE_SHARED_INFORMATION	POINTER_TO_DATA_OBJECT USER	PLATFORM_RESPONSE
VAL_PRC - VALIDATE_PRICES	TRANSPORT_OPERATOR TRANSPORT_DATA_SOURCE	TRANSPORT_DATA_SOURCE

FUNCTIONALITY	INPUT DATA OBJECTS	OUTPUT DATA OBJECTS
VER_INF - VERIFY_INFORMATION	POINTER_TO_DATA_OBJECT USER USER_PROFILE	PLATFORM_RESPONSE

Table 17: Input and Output Data Objects of each functionality

5.2 From conceptual architecture to implementation

The top-down design of the functional architecture defines interfaces for each functionality in terms of input and output data objects. Of course, no information about their implementation is provided at this stage of the architectural design, but the already ongoing detailed design and implementation work, demanded to the relevant WPs, is following a combination of top-down and bottom-up approach.

The top-down approach, as we have seen, starts from use cases and requirements and results in a functional architecture (described in Section 4) composed by modules, each exposing a set of functionalities that operates on a given set of input and output data objects.

The bottom-up approach considers existing software components that have been adopted (as a starting point) within the BONVOYAGE project and/or have been extensively developed throughout this first year of activities, and guides the implementation work in order to guarantee that the aforementioned functionalities and the related interfaces are in place.

The combination of the two approaches allows integrating existing or ongoing work of the bottom-up strategy, with the innovative path traced by the top-down strategy.

In order to find the best map between the as-is (bottom-up) and the to-be (top-down), minimizing the impact of external unforeseen deviations from the plan, implementation work of BONVOYAGE will follow an iterative and incremental approach. In iterative steps the BONVOYAGE reference scenarios (see next Section for more details) will be implemented, starting from the existing software and architectural solution and evolving, through a series of short release cycles, toward the reference functional architecture by adding new features and updating the existing ones.

In the next paragraph a first set of components have been identified as the starting point to deliver an instance of the BONVOYAGE architecture able to successfully support the core of our reference scenarios.

The here presented first set defines system components that will be implemented and adopted in a first iteration of the incremental development approach. Refinement of these

components and additional ones will be designed and implemented at successive iterations, based on the functional architecture and its interfaces.

Name	**Internames**
Purpose	
This component implements low-level networking functionalities and servers offered by Internames, designed for supporting request/response and publish/subscribe communication models in a multi-realm network architecture. Internames include: • **Internames Service Layer**, that is an adaptation layer exposing networking functionalities (i.e., BV-ANNOUNCE, BV-SUBSCRIBE, BV-NOTIFY, BV-REQUEST, and BV-RESOLVE) to high-level applications, through technology-independent API (namely BV-ISL-API) • **Name Resolution Service** and **Internames Rendezvous Node**, that enable request/response and publish/subscribe communication models in a multi-realm network architecture • **ETSI M2M Interface**, which provides a simple interaction between BONVOYAGE and sensing data exposed through the ETSI M2M standard.	
Communication	
The communication to the Internames network will be provided by HTTP endpoints allowing other services to access the provided functionalities.	

Service 1	
Name	BV-ANNOUNCE
Input data	Content Name (e.g., NDN_ROME, /bv/gtfs/national/italy/train/trenitalia/)
Output data	ACK of confirmation

Service 2	
Name	BV-SUBSCRIBE
Input data	Content Name (e.g., /bv/gtfs/national/italy/train/trenitalia/)
Output data	ACK of confirmation

Service 3

Name	BV-NOTIFY
Input data	Content Name (e.g., /bv/gtfs/national/italy/train/trenitalia/)
Output data	ACK of confirmation

Service 4	
Name	BV-REQUEST
Input data	Content Name (e.g., /bv/gtfs/national/italy/train/trenitalia/)
Output data	Requested data (Transport information i.e., time tables, data from a sensor)

Service 5	
Name	BV-SEARCH
Input data	Meta data (i.e., bus of Rome)
Output data	Content names

Name	**TravelCentricServices – Information Discovery**
Purpose	
The component allows the user to discover information that different Transport Information Providers offer within a specified geographical area. The component is based on a distributed Discovery Service backend assigned to the "BONVOYAGE" tenant. Users (including Service Providers) can specify an interested area in terms of a GPS tile, data type, etc. and will get the URIs (HTTP and NDN) of the travel centric information offered by Transport Information Providers in the GPS tile. For instance, in case of GTFS data type, the component return the URI of GTFS files having at list one stops in the GPS tile.	
Communication	
The public communication with the service will be provided via a REST interfaces using HTTP/JSON.	

Service 1	
Name	BV-INFORMATION-DISCOVERY

Input data	A JSON object with these fields: - *coordinates* - *tenantId=BONVOYAGE*: (mandatory) id of the tenant; - *datatype* - *optional fields*

Output data	A JSON object with this fields:
	- *tiles*: a set of area-tiles
	- uriList: the list of URIs of the Travel Information Provider resources discovered in the set of area-tiles.
	  ○ *ndnName*: the ndn name of the file.
	  ○ *httpUrl*: the http URL of the file.

Name	**Real-time intermodal routing**
Purpose	
The component establishes a tool for intermodal travel optimization. It will contain an orchestrator for parallel and/or cooperative intermodal shortest-path optimization algorithms and implementations of both known and novel intermodal travel optimization algorithms. From a request for a new travel, the component will produce optimal travel routes (service 1). For the component to be aware about the current real-time situation must also receive such information as asynchronous real-time events (service 3). The component does not include a service for knowing how real-times event affects travels that previously have been calculated (and are booked or started). However, service 2 allows for re-optimization of such a travel.	
Communication	
The real-time intermodal routing services will provide SOAP endpoints for other system components to use the services.	

Service 1	
Name	BV-TRAVEL-SOLUTION-REQUEST
Input data	Travel solution request (Query parameters, travel objective, travel constraints)
Output data	Travel solution response

Service 2	
Name	BV-TRAVEL-SOLUTION-UPDATE
Input data	Travel solution request (Query parameters, travel objective, travel constraints, commitments)
Output data	Travel solution response

Service 3	
Name	BV-PROCESS-REAL-TIME-EVENTS
Input data	Travel information (Dynamic event relating to the intermodal travel network)
Output data	ACK of confirmation

Name	User feedback and profile management
Purpose	
This component aims to manage user behavioural profiles and, according to these profiles, to address specific needs for service personalization in other components of BONVOYAGE (e.g. Integration and adaption or Intermodal routing). The component implements basic functionalities for data retrieval from the BONVOYAGE Multimodal Mobility Database (MMD); data analysis for data driven, user behavioural profile definition; user profiling procedures; profile based definition of driving parameters for the components that customise their services for the user's need and preferences. There are three services: • The first provides user profile from User ID • The second one updates the data base and user ID from user's stress level and User's transport mode • The last one performs off line clustering associating each user's ID to a user's class	
Communication	
The services are provided via standard interfaces (such as REST services using HTTP/JSON)	

Service 1	
Name	BV-PROFILE
Input data	USER_ID: The BONVOYAGE identifier associated to a registered user
Output data	PROFILE_ID: The BONVOYAGE identifier associated to a group of users begin similar to USER_ID from the behavioural point of view

Service 2	
Name	BV-USL-UTMR-MMD_UPDATE
Input data	USER_ID; USL_OUTPUT: from the component User Stress Level (USL) UTMR_OUTPUT: from the component User Transportation Mode Recognition (UTMR)
Output data	BV-MMD_UPDATE

Service 3	
Name	BV-CLUSTERING
Input data	MMD
Output data	Updated_MMD

Name	Integration and adaptation service
Purpose	
The service is a combined effort of WP6 and WP5 that leverages integration of technology dependent interfaces to obtain adaption of external services. The aim is to integrate and personalise external services for the use within the BV platform. The component should be flexible enough to integrate and allow personalisation of different types of services. The personalisation will be done using information provided by the User feedback and profile management component. The interfaces for the services need be flexible enough to easily connect and integrate a variety of existing services with the minimum development effort. The interfaces for the internal use of external services will be encapsulated based on SOA paradigm. The exact number and variety of services to be integrated needs to be defined based on the scenarios (on the one hand) and ease and availability (on the other hand). Examples are payment of tickets for operators or partner services of the fidelity program.	
Communication	
The communication interfaces need to be flexible to support different external services.	

Name	Mobile App
Purpose	
The purpose of the mobile app is the interaction with the end users. The application includes in an initial version the following 5 modules: route information, notification, user preferences, feedback and user sensing. The route information enables users to request routes from the BV platform another taking into account the users personal needs and preferences in terms of schedule, duration, costs, transport means, reliability, etc. The route information provides the user all required information about the trip. The push module enables the mobile application to react on dynamic, real-time conditions that interrupt and affect the ongoing trip. The user feedback module collects unattended and attended feedback functionality taking into account new trends such as smart wearables. The user sensing collects information about user as described below.	
Communication	
The mobile application consists of the mobile app running on an Android phone and the server component. The server passes all communications to the phone. The server is responsible to prepare all requests and responses for the mobile application and takes care of the communication between server and client (authentication, security and interrupts). The listed services are accessible and usable via the server component offering REST services. But most of the services are requests that require responses from other BONVOYAGE components (e.g. real-time intermodal routing service).	

Service 1	
Name	BV-MOBILE_TRAVEL SOLUTION-REQUEST
Output data	Travel solution request
Input data	Travel solution response

Service 2	
Name	BV-MOBILE-NOTIFICATION
Output data	Action set by user (e.g. re-routing travel solution request)
(Expected) input data	Dynamic and real-time interrupts

Service 3	
Name	BV-SET-USER-PROFILE-PREFERENCS
Output data	UER PROFILE DATA (e.g. preferences, membership information)
(Expected) Input data	ACK

Service 4	
Name	BV-FEEDBACK
Output data	Feedback-data
(Expected) Input data	ACK

Service 5	
Name	BV-USER-STATUS
Output data	User status (Transport mode + stress level + GPS position)
(Expected) Input data	ACK

Name	User Sensing Service (USS)
Purpose	
This component aims at recognizing in real time the following parameter of a user: transportation mode, user stress level by using an empatica E4 watch and the location of the user. The component is running on the smartphone of the user and the data can be accessed via BV-USER-STATUS service of the mobile application. The user sensing service is encapsulated and can also be used with other mobile applications. The first service aims at recognizing in real time which transportation mode (still, walk, run, bike, rail, road, …) the user is using. The service contains 4 sub-services that will be called in the following order: • "Sensor reading" that reads raw data of different sensors of the smartphone (typically, accelerometer, magnetometer, gps, …), and store them into buffers. • "Features": computes some relevant features from the previous buffers • "Classifier": calls ***M*** classifier(s) (= algorithm) with in input a subset of the previous features and give ***M*** predictions of the transportation mode. • "Post-Classify": Fuses the ***M*** predictions into one unique prediction of the transportation mode The second service provides the stress level of the user. It uses data provided by the empatica E4 watch (ppg, acceleration, EDA, skin temperature) estimates the stress level of the user. The service requires the watch and a smartphone with Bluetooth Low Energy chip. The smartphone must have an internet connexion. The third service delivers the current location of the user based on the positioning services of the smart phone.	
Communication	
The User Sensing Service component is integrated into the Mobile App and its services can be accessed via the BV-USER-STATUS service of the app.	

Service 1	
Name	BV-USER-TRANSPORTATION-MODE-RECOGNITION (UTMR)
Input data	
Output data	Transportation mode

Service 2	
Name	BV-STRESS-LEVEL-VALUE
Input data	
Output data	Stress level

Service 3	
Name	BV-USER-LOCATION
Input data	
Output data	GPS Coordinates

6 External interfacing architecture

Other chapters of this deliverable derive a functional architecture for the BONVOYAGE platform by starting from use-cases, from user requirements and from the logical interfacing between the various platform's key functions.

This chapter focuses on how the interaction of the platform with external data sources impacts the design, together with the peculiar nature of such large-scale sources of transport data.

6.1 Challenges

In the following we summarize the main challenges BONVOYAGE is facing in integrating large-scale, dynamic data, which span across Europe, in a technological framework that adheres to (or better, sustains) the most recent EU directives. [15]

6.1.1 Real-time data

Real time information on the transportation network is needed to communicate changes to travellers and professional users. One of the challenges for the provision of dynamic information is the integration of data gathered from heterogeneous sources that differ in data structure, type and format.

The European Commission identifies this challenge as a one of the main obstacles in setting up cross border or pan-European services. The ITS Directive and Action Plan addresses this challenge. Detailed regulations for services to make data available at single National Access Points (NAP, see later sections) have started. These access points shall make both static and real time data available and they shall include metadata and discovery services. There is a possibility to standardize the metadata in order to facilitate access to data sources in several countries.

[15] *Low latency analytics for streaming traffic data with Apache Spark Altti Ilari Maarala, Mika Rautiainen, Miikka Salmi, Susanna Pirttikangas and Jukka Riekki Department of Computer Science and Engineering, University of Oulu, Finland*

R. Mian, H. Ghanbari, S. Zareian, M. Shtern, and M. Litoiu, "A data platform for the highway traffic data," in Maintenance and Evolution of Service-Oriented and Cloud-Based Systems (MESOCA), 2014 IEEE 8th International Symposium on the, Sept 2014, pp. 47–52.

A. Maarala, X. Su, and J. Riekki, "Semantic data provisioning and reasoning for the internet of things," in International Conference on the Internet of Things, Oct 2014, pp. 13–18.

Despite easy access through a national access point, the challenge remains that the real time data differ in format, richness, location coding and other quality items due to lack of standardization and different registration technologies. The services connecting to data from different real time sources needs to deal with this. Data from multiple sources needs to be consolidated to get precise and reliable support for the decision making process. Besides, these data streams require high communication capacity and reliability.

Low latency and large amount of data means other key challenges to be faced for data querying, processing, storing and analysis. A couple of examples can illustrate this.

One example from the City of Oslo is the real time service for public transport. The output on the API is the number of minutes for the next unit (bus, tram, train) to arrive at a specific stop. The data is in the SIRI format and are available at an open site on the Internet. These data cover all routes and all stops. In another city it may be that the similar service offers another format, access point or data type (like location of the units or expected travel times between stops or other).

For the road traffic real time data in Oslo (and nation-wide Norway) the sensor applications transform the raw data into the DATEX 2 format and present them for re-use at a national access point; the so-called DATEX node. This service is operated by NPRA. Such transformation of data represents a quality risk. Content and timeliness and position can be affected and result in misleading data. Additional quality and probability checks may stop the publishing of false data. Quality documentation is often not readily available.

Moreover, other options for real time feeding[16] are available throughout Europe, such as GTFS in real time, which allows public transport companies to provide updates in real time about their fleets. For instance, GTFS real time specification currently supports the following types of information:

- Trip updates - delays, cancellations, changed routes
- Service alerts - stop moved, unforeseen events affecting a station, route or the entire network
- Vehicle positions - information about the vehicles including location and congestion level

[16] https://developers.google.com/transit/gtfs-realtime/?hl=en#how-do-i-start

There is on-going work in EU, related to the ITS Directive (2010/40/EU), in order to define legislation for the interoperability and continuity of multimodal travel information services, see chapter 6.1.3. This legislation will be adopted in 2016 and apply from a date two years later. Transition periods is expected to be allowed. This delegated act deals also with data format standards at the national access points (NAP). It will probably make it obligatory to use profiles from NeTEx (CEN TC278) for public transport schedule data and SIRI (CEN TC278) for the real time data. The timeline for this legislation and for the work on format profiles prevents BONVOYAGE to select NeTEx as a viable option as exchange format for public transport data. The project has submitted inputs to the EU expert group for the said legislation.

6.1.2 Data from smartphones and sensors

Apart from real time information on the transportation network described above, data coming from users can be used as well, in order to optimize travel planning solutions.

In BONVOYAGE, these data will be collected from two main sources:

- Sensors embedded in the user's Smartphone
- Wearable sensors (connected watch, wristband, jacket…)

Smartphone sensors are gyrometer, magnetometer, accelerometer, GPS, etc., and they will provide information on user's movement, speed, position.

Wearable sensors can provide information about user's cardiac rhythm and various spectral characteristics of the cardiac activity [like power in high frequencies (HF) versus low frequencies (LF) and very low frequencies (VLF); LF/HF ratio], breath rhythm, skin galvanic response, sweating, skin temperature, etc.

Data from user's smartphone sensors will be used to determine which current transport mode and position. This information will enable to check if the user is well within the planned transport mode and to follow up the user along the travel time. If necessary, BONVOYAGE can notify the user and re-plan the travel. Also, by cumulating knowledge on user's transport modes during a time span, preferred transport modes can be estimated in order to enrich the user profile. BONVOYAGE can use this additional information to propose tailored transport mode switches to user and increase his/her satisfaction level.

Regarding data from wearables sensors, they will be useful to identify the user's stress level related to each transport mode. This information can be included in the user profile and used by the platform to preferentially propose the transport modes with low stress level and improve the user's well-being during his/her travels. Also, in case of unforeseen events, the

user's stress level, which is monitored in real time, can be used to perform travel re-planning, by proposing a transport mode which, based on user's profile, will mitigate stress. These functionalities will be based on custom classification algorithms developed by the project. From sensors data, these algorithms will extract and select "features" characterizing the most relevant part of the raw data. In a second step, algorithms compute which of these features that are most correlated to the output signal, i.e. different predefined classes of transport modes or stress level. For this, a calibration step of classification algorithms is required in order to build the mathematical model of the different classes. This will require creation of two specific databases (one for stress level and the other one for transport mode).

6.1.3 EU Directive and ITS cluster

The Directive 2010/40/EU on the "Framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport" establishes a legal framework for developing specifications to make ITS interoperable across borders. Under this Directive, the European Commission has to adopt, within July 2017, specifications (i.e. functional, technical, organizational or services provisions) to address the compatibility, interoperability and continuity of ITS solutions across the EU. The six priority action areas set out by the Directive are:

- Priority action (a): "the provision of EU-wide multimodal travel information services" (This priority action is currently under development: a public consultation has been launched http://ec.europa.eu/transport/themes/its/consultations/2015-its-mmtips_en.htm)
- Priority action (b): "the provision of EU-wide real-time traffic information services (Commission Delegated Regulation (EU) 2015/962 of 18 December 2014).
- Priority action (c): "data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users" (Commission Delegated Regulation (EU) No 886/2013 of 15 May 2013).
- Priority action (d): "the harmonized provision for an interoperable EU-wide eCall" (Commission Delegated Regulation (EU) No 305/2013 of 26 November 2012).
- Priority action (e): "the provision of information services for safe and secure parking places for trucks and commercial vehicles" (Commission Delegated Regulation (EU) No 885/2013 of 15 May 2013).
- Priority action (f): "the provision of reservation services for safe and secure parking places for trucks and commercial vehicles" (This priority action has been shelved due to lack of sufficient interest in this area).

The delegated regulations on priority actions (b), (c) and (e) require the setting up of a single National Access Point (NAP) and its associated "discovery/search and browse" functionality, by each Member State. This will enable those interested in accessing the data to find it all in

one place. Data owners in the public and private sector will be requested to make their data accessible via the national access point.

Each National Access Point will offer a single point of access to the road and traffic data of a given territory or network, which are available for re-use by any potential user. Through the discovery services any user will be able to effectively access the data and find out what data is available (in relation to a specific topic or purpose), where it is stored (and possibly who owns it), how to use it (possible terms and conditions of re-use under specific contractual agreements).

The specifications for priority action (a) is in the final stage of preparation and will most probably refer to a national access point and in addition a “linking service” which will enable the service exchange between national travel planning services and the possibility to plan trips continent wide.

We believe that BONVOYAGE can play an important role in supporting this regulation and the implementation of the National Access Points as well as giving relevant input on how to establish an infrastructure for continent-wide travel planning.

6.2 Distributed design of the platform

A main limitation of centralized planners currently available in the market is that the scope of route searches is limited geographically to a region or a metropolitan area.

Although today, given the speed of networks and the storage capacity of commodity computer hardware, it would theoretically be possible to organize and exchange raw transit and schedule data for an entire continent, such that each routing instance has access to all raw schedule data, this is practically not feasible when:

- real time constraints are to be taken into account;
- user profiles are involved;
- different optimization schemes are to be applied depending on localities and region-specific constraints;
- rate of transit data updates is different between different regions;
- there exist some apprehension about openness of data on the part of the large, relatively cautious Transport Operators.

The European Community is acknowledging the difficulties arising from a strictly centralized solution to the problem of continent-wide future-proof ITSs.

It would be hard to convince transit authorities about their need to allocate funds to build planner instances with a continental scale, even though the costs of computational resources are becoming increasingly cheaper.

In the meantime, Google Transit remains the only viable option that offers good results for both local transit routes and routes across a nation or continent, and we would like to avoid a scenario where National Access Points, after an unsuccessful experience with their own multimodal planner, prefer to make a Google Transit based solution.

We need to eliminate these limitations by establishing several collaboration mechanisms between several multimodal planners, towards the realization of the National Access Points established in the EU 2010/40 directive.

This vision is depicted in the following Figure, which introduces the conceptual design of two key components of the architecture that mediate the access to external data-sources: the Distributed Route Planner and the National Discovery Services.

The crucial design decision we have taken is to create a distributed approach both to data discovery and to travel planning, and to deploy a logically distributed network of technical computing nodes, which carry out both functions in a locally optimized way, which are then orchestrated by the platform's Backend and offered to end-users.

On the "north-bound" interface of our architecture (i.e. above the NAPs) stays the Distributed Route Planner, a logically central service of our platform, which is deployed into several distributed nodes, in a many-to-many relationship with the NAPs. On top of the Distribute Route Planner sits the Application Backend, which offers aggregated intelligent travel services to mobile Applications.

On the "south-bound" interface of our architecture (i.e. below the NAPs) we want to have a technical coupling of our deploy architecture with the distributed architecture of the NAPs that are going to be installed through Europe, so as to have a one-to-one match, if possible, between nodes of the BONVOYAGE architecture which carry out the data discovery (via Discovery Services) and nodes which act as NAP. Below the several Discovery Services stay all data-sources, either static schedules from national transport operators or real-time such as sensors and crowd-sourced data from users, interconnected by traditional Internet URLs or Internames named resources.

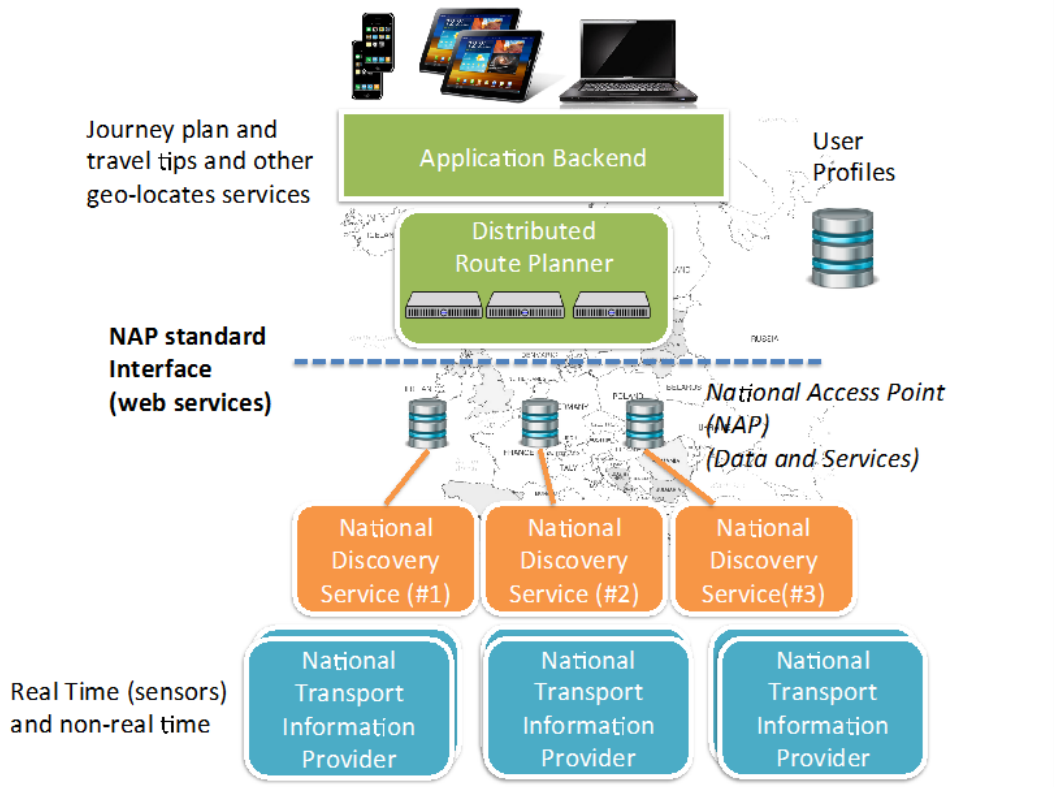


***Figure 13**: Bird's eye view of the distributed architecture*

As a result of the design of the "south-bound" part of the architecture (which deals with interfacing to external data-sources, the core argument of this chapter) we anticipate here that BONVOYAGE already offered a preliminary solution of its Internames concept plus a Nation-level distributed Discovery Service software stack to other fellow projects belonging to the H2020 Mobility for Growth Call, in the sector of Smart, Green and Integrated Transport. These projects created a so called ITS cluster that eases inter-projects cooperation in the ITS and connected vehicles domain. BONVOYAGE proposed to use its solution to collect and share transport data among participant projects.

6.2.1 Data flow architecture

Starting from the above high-level vision, in the following we add details of our design, focusing on how data flows between the components or modules, as they have been outlined in the previous chapter.

The following Figure 14 shows how the user's smartphone acts as gateway for collecting user-centric, user-generated (crowd-sourced) data and data coming from sensors that travel together with the user, and depicts both the design of the relevant components and how they convey data to the platform's module which is in charge of interfacing with data

sources, namely the Data Interfacing Service (see previous chapters). The Data Interfacing Service acts as a Metadata Handling Tool for the platform, as explained in the following.

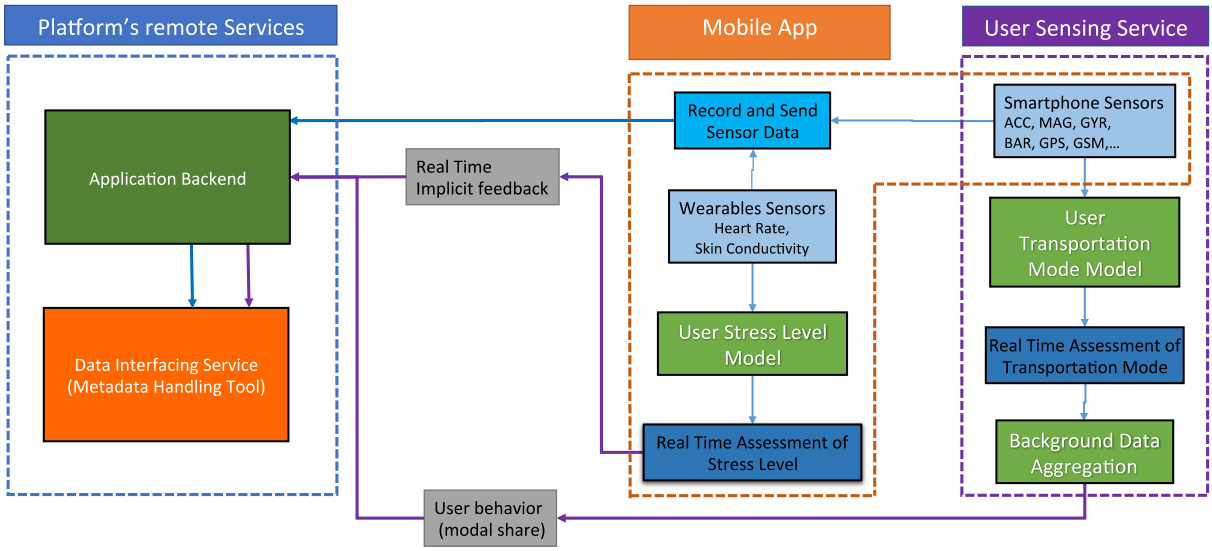


Figure 14**: **Data flow architecture: from App to platform

In Figure 14, we distinguish 3 parts

- On the left part, the BONVOYAGE platform, which is the remote end-point to connect to
- On the right part,
  - the BONVOYAGE Application (orange box)
  - the User Sensing Service (magenta box)[17]
- Light blue boxes refer to sensor data
- Green boxes refer to models or algorithms that exploit raw sensor data
- Dark blue boxes refer to Data
- Grey boxes refer to the 2 main functionalities the project wants to develop.

6.2.2 Real Time Implicit Feedback and User Behaviour

We will develop 2 main components (grey boxes)

- **Real Time implicit feedback** is almost directly the output of User Stress Level Model.

[17] The "BONVOYAGE App", is a classic Smartphone Application, in the sense that it is the user that starts and stops the app.
The "User Sensing Service", has to run continuously in the smartphone, even when the BONVOYAGE App is closed.
The idea is to simplify the development of these 2 bricks, and to make the development as independent as possible.
But in the end, the "User Sensing Service" should be a part of "BONVOYAGE App", which connects to the remote main platform.

- **User behaviour**: from “User Transportation Model” and “Background Data Aggregation” it is possible to infer information about “User behaviour”, for example her/his modal share. Below are given 2 examples of modal share.

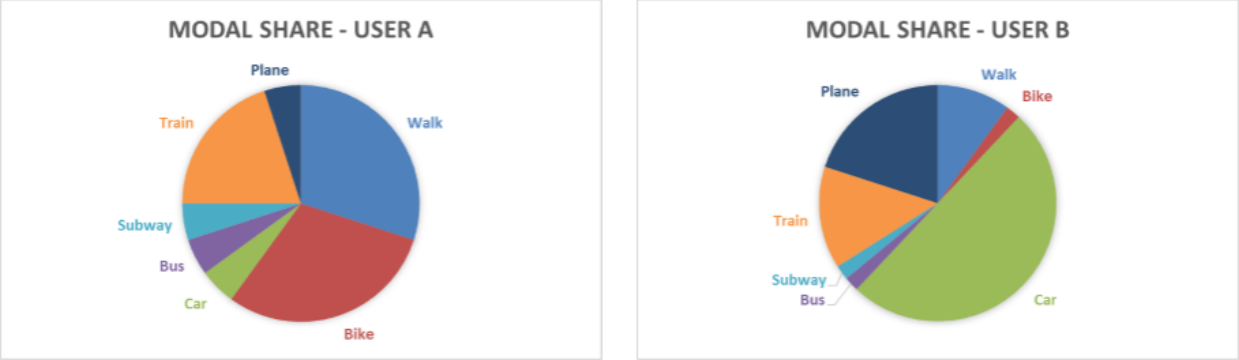


***Figure 15**: Different users have different modal-share profiles*

These components use raw data from different sensors (light blue boxes). There are 2 kinds of sensor data:

- smartphone sensors: accelerometer, magnetometer, gyroscope, gps, barometer
- wearable sensors: heart rate, skin conductivity

These raw data are going to be saved in the platform, because the User Profiler Tool will process them, in order to build the databases that are used to construct the algorithms and mathematical models.

As shown in the picture, the Data Interfacing Service ultimately is the end-point on the platform side, though all communication goes through the Application Backend. It is in charge of collecting data coming from sensors, as well as data coming from other external data sources.

The following sections describe details about data storage in the platform, and these data paths to and from the other external data sources.

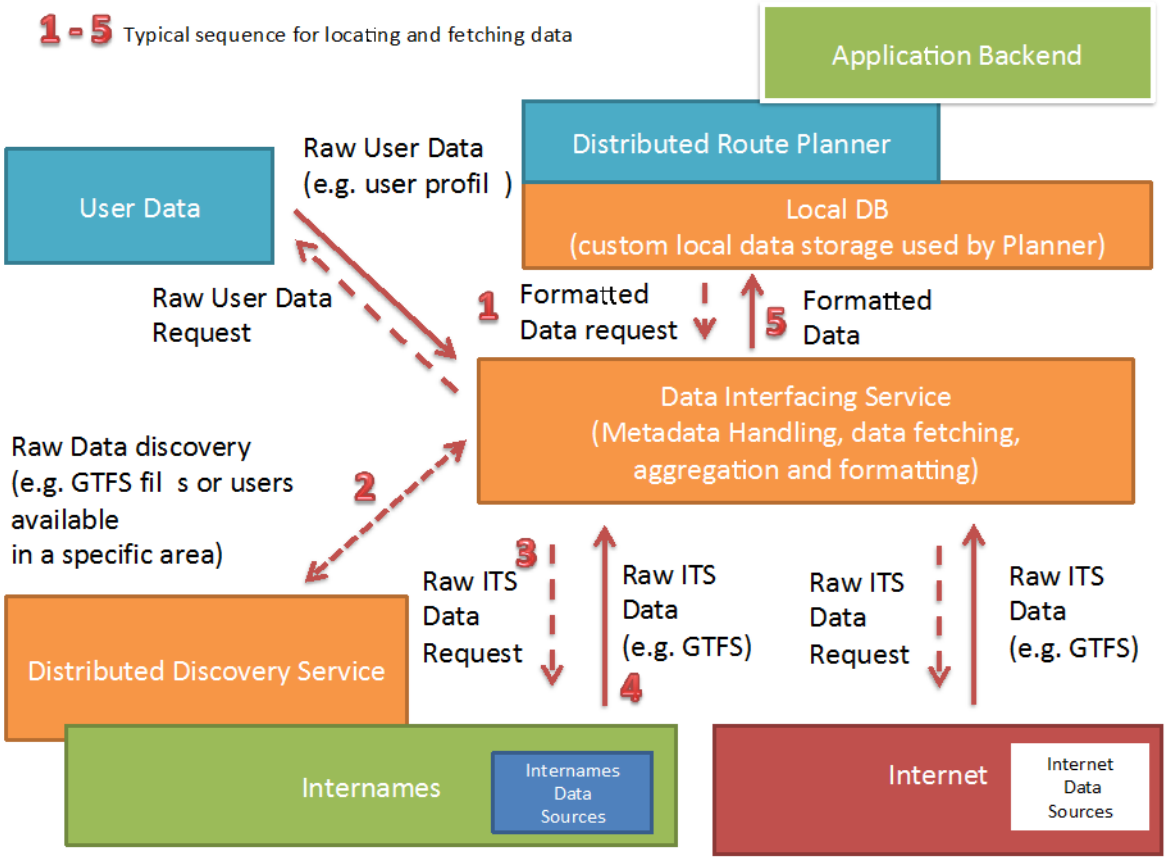


Figure 16**: **Data flow architecture: from platform to data sources

In Figure 16 above, we depict details of the different data flows.

The overall architecture can be described as follows:

- The Application Backend relies on the Planner.
- The Planner relies on a custom DB, local to the platform, which caches a local copy of data necessary to carry out the calculations of the Planner.
- The custom DB relies on a Metadata Handling Tool, which is the core of the Data Interfacing Service functional module and acts as a collector and dispatcher for requests to several heterogeneous data sources. Moreover, it is in charge of offering a homogeneous schema of the several sources.
- The Metadata Handling Tool relies on the Discovery Service in order to discover what data sources are available in a specific area for a specific transport/travel request or for a specific user.
- The Discovery Service relies on Internames for its communication and horizontal-scalability capabilities.
- External, heterogeneous sources of transport/travel information are offered either through traditional Internet URLs or through Internames named-objects.
- User data is offered through the interconnection between the frontend App and the Metadata Handling Tool (see previous Figure 14).

- The Metadata Handling Tool fetches data by means of direct connections with the specific data source.

6.2.3 Internames Communication System

Internames evolves from ICN's host(s)-to-name model to a name-to-name principle in which names identify both source and destination entities, and names are used to identify all entities involved in communication, not only content but also users, devices, network functions and services. The latter functionality enables easy re-location or duplication or anycast search of service (components) where and when they are needed. Internames also addresses what is probably the most crucial issue of ICN today, namely how to introduce ICN in current networks, easing migration/interworking from/with IP and deployment strategies. In fact, most people agree on the advantages that ICN could bring about, but are also concerned about ICN as a network layer solution, alternative to IP, when facing migration/deployment issues. Another possibility would be to deploy ICN as an overlay to IP, that is to say on top of IP, even if at the cost of increasing complexity and inefficiency. In any case, many argue that that question is not if ICN or similar concepts should be introduced or not, but where (in the OSI stack) and by whom. As recently put by Cisco's Service Provider Mobility CTO: "If the network operator industry fails to create an ICN-like architecture then someone like Google will and they will put it behind the SP's IP transport network". In our architecture, we do not rely on the deployment of ICN at large *in lieu* of IP, as we can always resort to an overlay solution, but we still work on how to facilitate the deployment of ICN at the network layer. With Internames, travel-centric contents and sensor-generated and user-generated data could be retrieved by using both request-response and publish-subscribe communication models. With the request-response scheme, data are retrieved synchronously. For instance, if a user is interested to fetch a specific travel-centric content (e.g., timetables provided by a transport operator for a given geographical area), it has to issue a request, which will be forwarded toward the node able to provide the corresponding answer. The publish-subscribe mechanism, instead, is based on an asynchronous interaction: a user issues a subscription request for a sensor-generated data (e.g., weather conditions); then, every time the sensor registers a new value (e.g., the temperature went below 0°C and the road may be icy), the considered source of information and the network itself are in charge of delivering that data to all the subscribed applications. Furthermore, any networking operation is exposed to the application layer through a standardized and scalable middleware interface, namely Internames Service Layer, which hides all the details of the underlay communication technology and simplifies the interoperability among coexistent and heterogeneous network domains. Therefore, high level applications will be able to use a set of API (useful to search the name of a content starting from a list of meta-

data, request a data, announce the availability of a content, make a subscription, and send a push notifications), through which triggering the corresponding networking operations, while ignoring how services/contents are executed/delivered in a heterogeneous network architecture.

6.2.4 Internet Data Sources

Transversal information available from Internet data sources will be provided to the Metadata Handling Tool. The data request comes from the Metadata Handling Tool (that will act as a data dispatcher), and the information delivery will be performed in asynchronous mode.

Data provided by internet data sources can be very diverse. We can categorize it, for instance, as:

- Government and political data, as resources for delivering data-sets, raw data and geo spatial.
- City-specific mobility data
- Data aggregators, sources that house data from all kind of other sources (i.e., APIs, marketplaces, social data sharing services, etc.).
- Social data, provided as APIs of the social networks.

6.2.5 Metadata Handling Tool

The Metadata Handling Tool component will use Internames to get dynamic information from transport operators, that is information which can change in a very dynamic environment, and provided in a specific format by stakeholders and transport operators.

Examples of the data retrieved from Internames Communication System are public data sources. For instance, provided by NPRA:

- Road traffic dynamic data
- Public transport stops and schedules
- OGC based road and traffic data
- Real time PT data Oslo
- Charging points for electric vehicles

The Internames Communication System connects to data stored in a big set of heterogeneous distributed databases. The requested information is delivered to the Metadata Handling Tool for its processing and enrichment.

The Metadata Handling Tool acts as an orchestrator of the Discovery Service and the data sources, in order to cope with the correct synchronization and multiple accesses to the data. The different types of transparency sought after in the Data Interfacing Service as a whole

are data distribution transparency, heterogeneity transparency, transaction transparency, and performance transparency. Data distribution transparency requires that the services that require information of the database should not have to know how the data is fragmented (fragmentation transparency), know where the data they access is actually located (location transparency), or be aware of whether multiple copies of the data exist (replication transparency). Heterogeneity transparency requires that the user should not be aware of the fact that they are using a different DBMS if they access data from a remote site.

The data interfacing services should be able to use the same language that they would normally use at their regular access point and the distributed DBMS should handle query language translation if needed. Transaction transparency requires that the DDBMS guarantee that concurrent transactions do not interfere with each other (concurrency transparency) and that it must also handle database recovery (recovery transparency). Performance transparency mandates that the DDBMS should have a comparable level of performance to a centralized DBMS. Query optimizers can be used to speed up response time.

6.2.6 Local DBs

The local database environment will provide persistent and static information to the above services, most importantly the distribute Planning tools and algorithms.

Planner issues requests and is expected to find data, with high availability, in the local DB.

Although the Planner and the Local DB are depicted in this picture as a logically centralized entity, because the picture itself focuses on the architecture of the interfaces towards external data, we have seen in the previous sections, there is a need for a distributed implementation of the Planner, too.

This is a major challenge of the project, and central to the implementation work packages WP5 and WP6.

6.2.7 Distributed Route Planner

The distributed route planner component exposes a set of services for invoking route planning functionalities. It contains a collection of different route optimization algorithms, operating at different level of aggregation and detail. To be able to provide routes based on the real-time situation, each route planning algorithm is continuously updated with new projected travel time estimates, delays and other incidences relevant to the geographical area and the modalities that the algorithms covers. The static and real-time data relating to the travel network is collected from the metadata handling tool.

The service is triggered by route request containing user data collected from the local DBs and provides intermodal routes optimized according to the request, the personalized user profile and the real-time situation. To be able to scale the service into a continent-wide route planner the service is distributed by means of multiple distributed access points. Each access point makes use of an orchestrator that is in charge of decomposition the request and distribute the sub-requests to appropriate solution algorithms. Hence, this allows also the solution algorithms to be distributed.

6.2.8 User Data

User Data provides information related to the user's profile and preferences, aligned with the data requested from the local databases services.

6.2.9 Distributed Discovery Service

The data Discovery Service, which we call OpenGeoBase, is the decentralized large-scale storage system used for building quite generic georeferenced services within the platform. OpenGeoBase exploits Internames to collect and make available georeferenced transport-related data. Basically, OpenGeoBase allows anyone to publish data relevant to a specific geographic area, ranging from transport schedules to sensor-generated or user generated real-time information, but also, point of interests, etc. Then, interested users/travel operators can search and retrieve all data available in such geographic area, which are needed to plan an optimal multimodal trip. Publishers are not forced to upload their data in a central repository but they can keep them in local, distributed repositories, under their control. OpenGeoBase logically puts together all individual repositories and make it easy for users to search for and retrieve the data they are interested in. We call slice a space in a set of Repositories and tenants the application owners (e.g. journey planners) that can rent a slice for their applications. Users of a tenant can Create, Read, Update and Delete data on tenant repositories. The database can grow without bounds by merely deploying new servers (horizontal scalability), and Internames takes care of routing the queries towards the best servers and cache the answers to popular queries to speed-up response time. By exploiting Internames's in-network multicasting and caching, massive information describing routes, prices, schedule plan, etc. can be quickly provided to millions of users, also under flash crowd conditions and severe events, such as interruption of a major road, extreme weather, disaster. By exploiting Internames security, the database can secure every piece of information in a customizable way and can include configurable policies as to who and when and where can access the information. As a result, OpenGeoBase is: i) distributed, not requiring a centralized entity, ii) scalable, capable of growing without bounds; iii) secure,

every piece of content can be secured in a customizable way and can include configurable policies as to who and when and where can access the information; iv) slice-able, several tenants and users can use it in parallel and independently; v) reliable: no single point of failure; vi) fast.

6.3 Technical details of data sources we have

6.3.1 EU-wide indexing of GTFS data

We have indexed all Google public GTFS files in our OpenGeoBase db.

Data is fetched from http://www.gtfs-data-exchange.com and then indexed by using an OpenGeoBase slice.

Discovery is quick in small areas of about 1000/2000 km^2. We are now trying to speed up also larger selections, e.g. all Italy or even better all Europe. The distributed database has 7 millions of entries and indexes about 1000 GTFS files.

A preliminary version of this integrated GTFS sources indexing effort is available at http://BONVOYAGE2020.eu/travelcentricservices.

Data is offered through a REST interface, which is better documented in the "Internal interfacing architecture" chapter, as a specific software component API.

6.3.2 City of Bilbao

Public administration, transport operators and other agencies has been using own data models, following diverse standards and own specification. This implies that the exploitation of this data should be done in ad-hoc basis, which is costly.

In this situation, there is a need of adopting a process for local data access in a uniform way, selecting a standardized communication protocol that allows geolocalized information reception.

Under this scenario, Bilbao implements within the Co-Cities project the Commonly Agreed Interface platform that uses a WFS (Web Feature Service) as standard for the access to geolocalized information. Bilbao data supported is:

- Static public transport:
  - ept:Route
  - ept:StopPoint
  - ept:Service
  - ept:Line
- Dynamic public transport:

    - ept:ProductionTimetable
    - ept:DatedTimetableVersionFrame
    - ept:JourneyPattern
    - ept:PointInJourneyPattern
    - ept:EstimatedCall
- Static parking:
    - edi:ParkingPoint
- Dynamic parking:
    - eti:CarParkDynamic
- Traffic:
    - enw:RoadNetLink
    - enw:RoadNetNode
    - eti:Activities
    - eti:ConstructionWorks
    - eti:GeneralObstruction
    - eti:MaintenanceWorks

Co-Cities uses different standards for transport and traffic information provision such us DATEX II, SIRI, Transmodel, EuroRoadS, IFOPT

Required operations for CAI access

- GetCapabilities: to get a list of data from the server, as well as operation WFS and their parameters
- DescribeFeatureType: to get information related to a specific data set.
- GetFeature: to get data, including its geometry and values of the attributes.

Not requires operations:

- LockFeature, Transaction y GetGMLObject.

All operations should include at least three parameters: service, version and request

6.3.3 City of Oslo

Oslo is the capital of Norway. The city has a population of close to 700.000 inhabitants, and is surrounded by the county of Akershus with 600.000 inhabitants. Together they form the larger Oslo area covered by the same public transport administration, Ruter AS.

In 2014, the public transport in Oslo and Akershus consisted of 319 million single journeys. In the capital 26 % of all trips are done using public transport and this number is steadily increasing.

The following transport modes are at the disposal of travellers using the public transport network in Oslo and Akershus: urban and interurban bus, metro, tram, train and ferry. In addition, the city of Oslo has recently established a new city bike service.

A real time information system greatly benefits drivers and travellers on public transport in the region. The system includes technology to prioritise buses and trams in intersections, as well as automatic display and announcements of the next stop.

The NPRA operates a national DATEX-node where all real time road and traffic data are available. Currently, travel times, CCTV images and information about incidents, road works and driving conditions are available free of charge. Static road data is available in the National Road Data Base (see information below).

Most of the public transport and the road information services, are not restricted to the Oslo area, but covers the entire country.

SOURCE NAME	DETAILS
Road traffic dynamic data	Description: DATEX II node for Norway
	Data Format: DATEX II v2.0
	Data type: Real time
	Data Owner: NPRA
	URL: http://data.norge.no/organisasjoner/statens-vegvesen
	How to get access: http://www.vegvesen.no/en/Traffic/On+the+road/Datex2
Public transport stops and schedules	Description: Open API for public transport routes and stops for Norway (not air transport)
	Data Format: GTFS
	Data type: Static data
	Data Owner: NRI/NPRA
	URL: http://labs.reiseinfo.no/2013/2/8/aapne-data-fra-nasjonal-rutedatabase.aspx
	How to get access: http://labs.reiseinfo.no/aapent_api.aspx
OGC based	Description: Dynamic and static data for road network and road traffic, searchable and with filtering

SOURCE NAME	DETAILS
road and traffic data	Data Format: Web Feature services (WFS, an open geospatial consortium standard) Several output formats supported, including JSON and GML. For map display, the service also provides WMS (Web mapping services)
	Data Type: Static and real time
	Data Owner: NPRA
	URL: https://www.vegvesen.no/kart/ogc/datex_2_0 /ows?service=WFS&request=GetCapabilities
	How to get access: See URL
Real time PT data Oslo	Description: Real time arrival time at all stops in Oslo Areas
	Data Format: SIRI, GTFS and REGTOPP
	Data Type: Static and Real time
	Data Owner: Ruter AS
	URL: http://data.norge.no/data/ruter/ruter-kollektivtrafikkdata http://reisapi.ruter.no/help http://sirisx.ruter.no/help
	How to get access: see URLs
Charging points for electric vehicles	Description: Location and availability for charging stations in Norway
	Data Format: JSON and more
	Data Type: Static and real time
	Data Owner: Nobil/Enova
	URL: http://info.nobil.no/index.php/api
	How to get access: http://info.nobil.no/images/downloads/nobil_api_documentation_v3.pdf
City bikes in Oslo	General information: https://oslobysykkel.no/information-in-english Map of bike rack locations: https://oslobysykkel.no/kart Open API with static and dynamic data (availability) will soon be made public

SOURCE NAME	DETAILS
Open transport related data for Norway	The public access point for available public data related to transport and communications in Norway: http://data.norge.no/kategori/transport-og-kommunikasjon?type=3
National road data base (NRDB)	General information on availability of data from the Norwegian road network: http://www.vegvesen.no/en/Professional/Roads+and+transport/National+Road+Data+Bank+NRDB

7 Scenarios to be validated and selected use cases

7.1 Introduction

All scenarios show most of the key innovations of BONVOYAGE, each to different degrees and under different viewing angles, so as to demonstrate that such key innovations are the building blocks of any modern ITS.

Key innovations:

- User profiling to assist the transport system at planning phase
- Real-time sensors and dynamic data assist the transport system at travel phase
- Name-based networking to assist transport operators and developers in exchanging and searching data
- Constraint-based optimization of the proposed solutions
- Distributed approach to scale continent-wide
- Design grounded on inter-modality

7.2 Scenario 1: Family travels from Oslo to Italy for tourism

The first scenario is about **inter-modal planning in the context of public transport**, and shows how BONVOYAGE:

- Scales up to continent wide trip planning.
- Is effective at selecting the optimal combination in case of groups in need of special care.
- Can provide users with real-time information on public transport status.
- Can re-plan by taking into account dynamic conditions.
- Exploits user-profile and constraints to formulate a tailored solution (tourism with several stops, plan for events in the area, reserve for strollers and heavy luggage, budget constraints and personalized tariffs).
- Enables users to purchase a multi-modal travel solution as well as leisure services (e.g. museum tickets).
- Enables users to subscribe to a fidelity programme and collect scores to be used to get awards.
- Enables users to fix a “mission” to be achieved during the journey.
- Allows users to share and suggest their travel itinerary to other BONVOYAGE users.
- Allows transport operators to offer promotions to users.

7.2.1 Scenario context

The family travels from Oslo to Italy for tourism, and kids need the stroller. They want to tour Northern Italy (Milan, Firenze, Pisa) and attend a specific paint exhibition in **Rome at a fixed date**. The exhibition is managed by the “Museum of Contemporary Art”, which has a partnership with one of the transport operators associated to BONVOYAGE.

Family has booked and purchased public transport tickets and museum tickets through BONVOYAGE. They are member of BONVOYAGE fidelity programmes and gain 400 scores when purchasing the cross-border multi-modal travel solution. They have reserved hotels in Milan, Firenze and Rome that are very close to the train stations, so that they can walk there.

7.2.2 Basic flow of events

Pre-Trip phase

a) The family sits down and plans the travel some months in advance. They use BONVOYAGE platform for planning the visit to Milano, Firenze Pisa and Roma in this sequence, indicating a specific date for the stay in Rome. They simply indicate the name of the event as point of destination when planning the itinerary. They select the train as generally preferred transport mode due to the closeness of the hotels to the train station.
b) BONVOYAGE takes the preferences for this trip and user profile (family with kids with stroller needs travelling for holidays) into account when proposing the various steps and possible alternatives.
c) The following steps get the highest ranking and are proposed to the family, which selects them, and they are stored in the platform as part of the user profile associated with the family, for later usage during the on-trip phase.
    1. Reach Oslo airport by taxi van able to accommodate the family and strollers and luggage. Solutions based on walk/tram/train are presented with lower ranking because they are not deemed comfortable for family travelling and, as expected, the family rejects them.
    2. Travel Oslo – Milan by airplane.
    3. Reach Milan hotel by taxi van.
    4. Reach Milan train station form hotel by either metro or on foot. They select on foot.
    5. Travel Milan – Firenze by train.
    6. Reach hotel in Firenze from train station on foot.
    7. Go back and forth and visit Pisa from Firenze by either bus or train. They have no specific preference for this leg of the trip and decide for the bus.
    8. Travel Firenze – Rome by train to enjoy the event in Rome.
    9. Reach hotel in Rome from train station on foot.
    10. Reach the exhibition by bus/metro. They leave the transport mode for this leg undecided, so as to be able to choose in real-time when they will be in Roma, based on the weather.
    11. Reach Fiumicino airport by taxi van.
    12. Go back via Rome - Oslo by airplane.
    13. Go back home with taxi van.
d) Additionally, before leaving from Oslo, they set a new mission on their BONVOYAGE App: to achieve a pre-set value of emission reduction by the end of their journey.

On-Trip Phase

e) The family starts the trip following the itinerary provided by BONVOYAGE. Everything goes as planned but due to an unexpected mechanical failure of the Firenze – Pisa 9:00 o'clock bus

(step 7) which is going to delay the planned leg of the trip, several users, including our tourist family open the BONVOYAGE App and:

7.a. Inform the system that there are unexpected events occurring, which hinder the planned Firenze – Pisa travel by bus.

7.b. Search for alternatives, and BONVOYAGE offers a new solution based on the first train departing to Pisa.

7.c. BONVOYAGE is able to process the crowd-sourced information about the event occurring, and send alerts about it to interested users.

7.d. The family visits Pisa from Firenze by train.

7.e. The family comes back to Firenze by bus

f) From Firenze, the rest of the travel follows as initially planned but when the family returns to the Oslo airport (step 13), BONVOYAGE receives information that a tunnel is closed and there are huge delays on the roads, so:

13.a. BONVOYAGE suggests the alternative of train + bus.

13.b BONVOYAGE signals the possibility of a family discount fare for the train.

13.c The family proceeds to the train platforms on foot and goes back by a combination of train and bus till the nearest bus stop to their house.

Post-trip phase

g) Once at home, they share and recommend their travel itinerary to other BONVOYAGE users with a similar “families with children” profile.

h) At the end of the journey, family receives promotions/discounts from the partners of BONVOYAGE on similar events/travels, based on travel solution they eventually enjoyed, the specificities of their “family” profile and the estimated CO2 consumption.

7.3 Scenario 2: Business trip from Grenoble to Bilbao

The second scenario is about **inter-modal planning between traveling with private car, shared cars and public transport**, and shows how the private transports can seamlessly blend with the public ones, when assisted by sensors and real-time data.

This scenario focuses on:

- Receiving and processing data from sensors, either deployed on the road or from users’ mobile devices.
- Conveying timely alerts to users, about incidents and dynamic events, which influence the plan.
- Inter-modal optimization of resources by car-pooling, both in a multiple-sources-one-destination and in a one-source-multiple-destinations cases.

7.3.1 Scenario context

Cristelle, a researcher from Grenoble needs to attend a meeting in Bilbao. Her user profile in BONVOYAGE is a “business” profile and she is usually happy with driving her private car as

much as possible. BONVOYAGE originally offers the fastest solution, and the driver is planning to reach Lyon airport by car and then fly to Bilbao.

7.3.2 Basic flow of events

Pre-Trip Phase

a) Cristelle plans her door-to-door trip, from her house in Grenoble to the meeting venue in Bilbao, some days in advance. In BONVOYAGE she has a driving profile, but for this specific trip she also indicates flight is allowed. Based on her profile and needs, the trip is planned as follows:
    1. BONVOYAGE offers her to pool her private car with other colleagues/persons (interested in travelling the Grenoble – Lyon route
    2. She accepts and she is warned that during on-trip phase the system may ask her to stop by and collect other passengers in Grenoble.
    3. She will then fly Lyon – Bilbao.
    4. At Bilbao airport she selects the option to pick up a car from a car-sharing service.
    5. BONVOYAGE ask whether she intends to pool the shared car with other colleagues/persons interested in travelling within Bilbao.
    6. She answers she is willing to pick up other passengers that may show up at Bilbao airport and need to reach destinations or exchange points with public transport located nearby her destination, where her business meeting takes place.

On-Trip Phase

b) Cristelle takes the car and she is on her trip when BONVAYAGE detects a high stress level on the road, due to an accident on the main freeway.
    1. BONVOAYGE plans a backup solution, and suggests going back to Grenoble train station **before entering the freeway**, park the car and take the train to Lyon airport.
    2. The driver and the other person sharing the ride reach the train station.
    3. When they park the car and leave it, BONVOYAGE is able to automatically detect the modal change, and informs about the schedule of next train.
    4. Travel continues by train to Lyon.
    5. The train operator is notified about the accident on the freeway and tries (to the best possible extent) to extend the train service to Lyon airport in order to cope with increase of demand.
c) During the trip, say when Cristelle is collecting her luggage at the airport, she is notified that another passenger, who either was on the same flight or has got to Bilbao at the same arrival time, is going to a destination that happens to be in the same urban macro-area of the conference she will attend.
    1. Cristelle accepts to pick new person up in the previously-reserved shared car. BONVOYAGE consequently makes a local trip planning update matching the needs of the two passengers.
    2. The new passenger is left at a bus station near the conference, while Cristelle continues up to their hotel in the neighbourhood of the conference venue.
    3. Information about parking lots availability is used by BONVOYAGE to suggest where to best park the car.

In a sense, Scenario 1 and Scenario 2 complement each other and demonstrate that the future ITSs are asked to support customer-friendly a blend of public and private transport, for increased sustainability, ability to absorb peaks in service utilizations and optimal coverage of the territory.

7.4 Scenario 3: International freight transport from Bilbao

The third scenario is about ability of BONVOYAGE to exploit exogenous constraints in the **ranking of optimal a long-range travel solution**. It showcases the planning of a freight delivery on an international transit route that spans from Bilbao to Oslo.

7.4.1 Scenario context

End users which, in this scenario, are transport companies who plan freight services by passing to the system all the needed information (i.e. origin, destination, weight and other preferences and needs such as: refrigerator, dangerous, time constrains, etc.)

Transport companies that offer freight transport services and publish available information on BONVOYAGE.

Optimization of the travel solutions, from the point of view of the transport operator, based on:

- Contractual (Transport operator & client) Factors:
  - freight characteristics;
  - time delivery;
- External factors:
  - traffic regulation of countries;
  - real time events (traffic, accidents).

7.4.2 Basic flow of events

Pre-trip phase

a) Transport Operator wants to calculate the most efficient route based on characteristics of freight to be delivered, constraints and preferences. The transport operator requests the calculation of a route from Bilbao to Oslo indicating time constraints (delivery time).
b) The transport operator sets San Sebastian as the stop point for consolidations of good in international deliveries. Besides the transport operator requires the calculation of an intermediate/stopping point. The transport operator wants a link for booking services related to the on-trip phase.
c) The transport operator also asks the platform to offer alternative multimodal solutions, thus seeking for more efficient routes.
d) BONVOYAGE provides road-based alternatives according to the requirements set by the transport operator and taking into account driving and traffic restrictions. BONVOYAGE estimates the efficiency of each leg and provides route details.

1. From Bilbao origin to San Sebastian.
2. From San Sebastian to stops at Bedburg parking area
3. From Bedburg to Hirtshals
4. At Hirtshals take the ferry to arrive at Larvik
5. The driver then has to continue from Larvik to destination in Oslo

e) BONVOYAGE also offers information about multimodal alternatives. There is a ship that goes from Pasaia to Amberes port on Mondays and Fridays at 12:00. (Fridays can be interesting due to weekend driving restrictions in Europe)
   1. From Bilbao to San Sebastian
   2. From San Sebastian to Pasaia port
   3. From Pasaia port to Amberes port by ship
   4. From Amberes to Hirtshals
   5. At Hirtshals take the ferry to arrive at Larvik
   6. The driver then has to continue from Larvik to destination in Oslo

f) Transport operator selects the route that better fits its needs and books additional services if needed. BONVOYAGE also offers the possibility to look for transport service providers that made e.g. the route from Bilbao to San Sebastian.

g) Transport operator wants to be notified with information on incidents, or novel restrictions that can cause update of the planned route.

On-trip phase

a) The A-10 is cut off between Orleans and Paris and secondary roads should be followed delaying the trip. BONVOYAGE is able to detect the situation and advise the transport operator offering the recalculation of a new route.

b) The truck has an incident (e.g. breaks down). BONVOYAGE is able to provide on trip assistance (such us SOS services) . In addition, a re-planning of the route can be required.

Post-trip phase

Transport operator is informed, by means of trusted communications that guarantee un-tampered and certified notifications, of the real route followed by the driver, occurred incidents (if any) and the confirmation of the delivery.

7.5 Scenario 4: Exploiting the platform from outside

The fourth scenario demonstrates that BONVOYAGE is **conceived as an open platform** and that interfaces with data sources are based on an innovative networking that collects and distributes, where needed, data as soon as they are published. This facilitates both transport operators and developers of added-value applications that exploit the BONVOYAGE platform, and creates new business opportunities, opposing the centralized, one-player-solves-it-all tendency.

7.5.1 Scenario context

Expedia has become the world's biggest travel agent. The third-largest travel agent is also an online company: Priceline. The scale of Expedia and Priceline means they can negotiate better prices, than their smaller rivals. Google Maps has quickly become one of the widest journey planning apps on the market. The smaller online travel operators find it increasingly hard to compete with the big ones.

Emerging small travel operators would like to offer advanced transport services at regional, city or private scales in order to increase their market share and visibility.

- *Regional scale*
  A travel agent with an extended and well-established network of partner hotels and resorts wants to propose to vacationers a set of tours made available by heterogeneous transport operators.

- *City scale*
  A company would like to be able to contact parking lots owners and be informed about their availability without having to (i) establish many different business relationships, (ii) deal with different data formats, and (iii) constantly polling the external servers.

- *Private scale*
  Often, when major sporting events or concerts take place, public transportation goes overloaded and people prefer resorting to private cars or try to organize parallel, private-owned buses and shuttles. A smart App developer would like to create a software that collects info about people offering their own vehicle with free seats, for short periods, and on a very specific area or itinerary, but realizes this is a complex goal to accomplish because, unfortunately, today technologies are not able to effectively offer user-to-user vehicle-sharing services.

Despite their valuable proposals, such small entrepreneurs travel operators may incur in serious difficulties in offering their services. They, instead, would like to get rid of technical burdens that impede a fair competition, as everyone would benefit from an **ecosystem of competing online travel operators**. Major obstacles are the difficult inter-operability with official journey planning services (like the Municipality public bus service), absence of inter-operability with other similar services that would provide wider and multimodal coverage, and the amount of investments required to design (and set up) a centralized server holding the required information in a secured way.

7.5.2 Basic flow of events

With BONVOYAGE, the three above business initiatives are fully supported. For instance, in the third case of a small, private scale App for sharing of transports, the flow of events is as follows:

Actors

- CityBus App (Institutional Journey Planner service)
- Transport Operator (Busses of City)
- Mike (User with bike)
- Ann (User)
- Larry (Software Developer)

Story

Today, Ann exits her lessons at 10:00. She needs to reach the city centre and be back for the afternoon lessons at 14:00.

Mike works at the campus Café. He gets every day to the University early morning and leaves late afternoon.

1. Larry has developed an App that facilitates publishing bike sharing information to BONVOYAGE information channels, and computing availability of free, shared bikes in the area of interest.
2. Mike has entered a permanent publication, using Larry's App, in the BONVOYAGE system that he makes his bike available from 9:00 to 15:00 at the campus for others to pick up, since he does not need it in that time interval.
3. Ann has entered a permanent profile, using Larry's App, about her time constraints of her late afternoon bus, the one she uses to go back to the nearby town where she commutes.
4. Ann uses Larry's App to check for a bike. She gets a positive notification that she can pick one up, but has to be back at campus by 15:00.
5. Larry's App interoperates with CityBus App too: Ann is thus presented just the bikes that are compatible with her late afternoon bus.
6. Ann picks up Mike's bike at 10.15, goes downtown to do her shopping and is back at campus at 13.30. She will take the 17:00 bus home.
7. Mike exits from his work shift at the campus Café at 16:00. He finds his bike parked at the sharing point. When he picks it up to go home (he lives a few blocks away) he finds a handwritten note attached to the bike's handlebar: "Thank you! Ann".

More in general, all four Scenarios presented above are supported because BONVOYAGE is designed from grounds up as a distributed system able to:

- Exploit and nurture local specificities of the various transport systems available in the area.
- Facilitate large-scale integration, search, sharing and delivery of transport solutions and related data among transport providers, travel service operators, applications and users; this is one of the main problems nowadays: how to collect transport information not only from big airlines/train operators but also from all the millions, small scale, bus/local transport/private providers.

- Allow transport providers to keep their data and services in their premises, with their formats and interfaces, rather than transfer them to a third, centralized party (e.g. Google) and/or to comply with specific format (e.g. GTFS).
- Allow travel operators or applications to get data directly from the transport providers rather than from a third party.
- Allow anyone to easily publish transport solutions, including private citizens (e.g. for car sharing purposes, hitching a lift).
- Allow anyone to set up access restriction and privacy policies on published data and then verify the owner and the authenticity of published data.
- Allow anyone to easily exploit all such information (e.g. anyone can develop an application and become an online travel platform provider).

7.6 Scenarios as a composition of selected use-cases

Scenario 1 – Tourist trip

UC_03_01 Intermodal journey planner for passengers with special needs/requirement

UC_02_01 Passenger planning an intermodal journey with public transports

UC_02_65 Transport operator providing public transport information on time schedule, geographic coordinates and available commercial offers to BONVOYAGE platform

UC_02_71 Transport operator providing BONVOYAGE platform with the list of disabled passengers for a specific transport mean

UC_02_10 Passenger displaying the nearest collective/public transport stations to his point of departure and arrival

UC_02_68 Transport operator checking tariff profile offers and promotions

UC_02_69 Transport operator modifying tariff profile offers and promotions

UC_02_03 Passenger needing to re-plan his journey path due to unforeseen events

UC_02_70 Transport operator providing BONVOYAGE platform with rules to be followed for pricing building

Scenario 2 – Business trip

UC_02_03 Passenger needing to re-plan his journey path due to unforeseen events

UC_02_15 Passenger searching stops and routes of public transports, providing BONVOYAGE his localisation

UC_02_66 Transport operator providing BONVOYAGE platform with information on planned delays on its transport means

UC_02_13 Accessing to restricted areas through alternative travel solutions purchase

UC_02_70 Transport operator providing BONVOYAGE platform with rules to be followed for pricing building

Scenario 3 – International freight transport from Bilbao

UC_04_11B Multimodal route optimization for freight

UC_04_02 Transport Operator sending goods through an external transport provider

UC_04_03 Transport provider looking for available freight services

UC_04_08 Setting an alert to be notified with new information

UC_01_03 Private or professional driver requiring road assistance through BONVOYAGE

Scenario 4 – Exploiting the platform from outside

UC_02_46 Service provider questioning BONVOYAGE platform to receive information about time schedule of BONVOYAGE transport operators

UC_02_57 Technology provider managing authorisations for different profiles of system users operating on different channels

UC_02_28 Passenger changing the default preferred language

7.7 Selected use-cases analysis

In this section we will analyse the sub set of 19 selected use cases, showing the rationale of the selection process. We adopted the analysis tool introduced in Section 4.

As first step, we decided to use the **Optimization Problem** functionality to have a first sub set of use cases to start with. The results of the optimization problem were a selection of 17 use cases (over a total of 94) that allows to match all the mandatory requirements:

Selected Usecases istogram by weighted sum of addressed requirements						
Weighted sum	Use cases (# funct. by priority 0-3)	Group 00	Group 01	Group 02	Group 03	Group 04
92.00	1) UC_03_01 (5,3,6,9)				X	
67.00	1) UC_04_01 (9,7,0,5)					X
46.00	1) UC_02_03 (3,1,3,6)			X		
43.00	1) UC_02_65 (3,0,2,7)			X		
39.00	1) UC_02_15 (0,2,1,3)			X		
38.00	1) UC_04_03 (3,5,0,10)					X
30.00	1) UC_02_66 (1,0,2,6) 2) UC_02_68 (2,0,2,4) 3) UC_02_69 (2,0,2,4) 4) UC_02_70 (3,0,2,6) 5) UC_02_71 (1,0,4,4)			X X X X X		
22.00	1) UC_04_04 (5,2,0,0)					X
21.00	1) UC_00_01 (0,1,4,0)	X				
9.00	1) UC_02_10 (0,2,0,4)			X		
6.00	1) UC_02_28 (0,1,0,0) 2) UC_02_57 (0,0,1,0)			X X		

Figure 17**: **Use case selection as result of the Optimization Problem

Among these 17 use cases, we decided to pick the most of them that are related with the scenarios described in the previous sections. More in particular, 14 of 17 have been chosen, as shown in the table below:

Scenarios	Use Case
1	**UC_02_01**
1 & 2	**UC_02_03**
1	**UC_02_10**
2	**UC_02_13**
2	**UC_02_15**
4	**UC_02_28**
4	**UC_02_46**
4	**UC_02_57**
1	**UC_02_65**
2	**UC_02_66**
1	**UC_02_68**

Scenarios	Use Case
1	UC_02_69
1 & 2	UC_02_70
1	UC_02_71
1	UC_03_01
3	UC_04_02
3	UC_04_03
3	UC_04_08
3	UC_04_11

Table 18: Use Cases for each scenario, the highlighted are the ones selected by the Optimization Problem

It is worth to note that even if the UC_04_01 is high ranked in the Optimization Problem solution, it is out of the scope of the considered scenarios. For that reason it has been discarded, even if from a requirements and a functional point of view the analysis tool report it as one of the most important.

Adopting the **Use Case Ranking** tools, we ranked the use cases on the base of their impact on requirements and functionalities. We chose the following weights for the different types of priorities:

Functionality's Priority	Requirement's Priority	Weight
3	Mandatory	6
2	1	3
1	2	1
0	3	0

Table 19: Use case ranking priorities' weights

The ranked list of use cases is reported in the figures below:

Weight	Usecase (# of functionalities by priority: 0/1/2/3)
75	UC_03_01 (5/3/6/9)
65	UC_02_01 (2/2/3/9)
59	UC_04_11 (5/5/2/8)
58	UC_04_11B (5/4/2/8)

***Figure 18**: Use case ranking based on weighted functionalities' priorities. UC_02_01 and UC_04_11 are top ranked.*

Weight	Usecase (# of requirements by priority: Mandatory/Priority 1/Priority 2/Priority 3))
92	UC_03_01 (10/10/2/1)
71	UC_04_11 (6/11/2/2)
63	UC_04_11B (5/10/3/1)
46	UC_04_01 (7/1/1/2) UC_02_01 (3/9/1/1)
43	UC_02_65 (5/4/1/2) UC_02_03 (5/4/1/1)
40	UC_04_13 (5/3/1/1) UC_02_08 (6/1/1/0)
39	UC_01_01 (4/5/0/0) UC_02_15 (6/1/0/0)
36	UC_04_02 (5/1/3/2)
33	UC_04_03 (5/0/3/5)
30	UC_02_66 (3/4/0/2) UC_02_68 (3/4/0/2) UC_02_69 (3/4/0/2) UC_02_70 (3/4/0/2) UC_02_71 (3/4/0/2)
27	UC_02_67 (2/5/0/2)
24	UC_02_53 (3/2/0/2) UC_02_72 (2/4/0/3)
23	UC_02_47 (3/1/2/1)
22	UC_02_46 (3/1/1/1) UC_02_56 (3/1/1/1) UC_02_48 (3/1/1/2) UC_02_49 (3/1/1/1)

***Figure 19**: Use case ranking based on weighted requirements' priorities. Excluding the already selected use cases, UC_04_02 and UC_02_46 are the best ranked for this criteria.*

Considering the already selected use cases, the use cases UC_02_01, UC_02_46, UC_04_02 and UC_04_11 where the best ranked. The only use cases selected just for the sake of the scenarios are the UC_02_13 and UC_04_08.

Finally, in order to understand the impact on the mapped requirements and the needed functionalities to be developed, we used the **Use Case Selection** tool. Selecting the 19 use cases, the overall statistics are:

Selected requirements statistics				
Coverage	**Mandatory**	**Priority 1**	**Priority 2**	**Priority 3**
46.2% (96/208)	82.7% (43/52)	42.4% (28/66)	25.5% (13/51)	30.8% (12/39)

Selected functionalities statistics					
Workpackage	**Coverage**	**3**	**2**	**1**	**0**
WP3	100.0% (9/9)	100.0% (7/7)	100.0% (2/2)		
WP4	40.5% (15/37)	85.7% (6/7)	0.0% (0/2)	33.3% (1/3)	32.0% (8/25)
WP5	55.3% (26/47)	100.0% (6/6)	66.7% (6/9)	75.0% (3/4)	39.3% (11/28)
WP6	48.5% (16/33)		57.1% (4/7)	57.9% (11/19)	14.3% (1/7)
Total	**52.4% (66/126)**	**95.0% (19/20)**	**60.0% (12/20)**	**57.7% (15/26)**	**33.3% (20/60)**

Figure 20**: **Report on requirements and functionalities covered by the use cases selected to support the scenarios

The overall statistics, shows how the selected sub set of uses covers 83% of the mandatory requirements, 95% of the high priority functionalities, while requiring to implement the 46% of the overall functionalities.

The usage of the analysis tool can provide a valuable feedback on the decision regarding the implementation strategies. These decisions are particularly crucial, since the selection of the functionalities must take into account from one hand the necessity to cover the most important requirements and, on the other hand, the cost in terms of effort needed to implement the related functionalities. All these decisions must also privilege the implementation of those functionalities that are innovative and really can do a step forward in the field of the Intelligent Transport Systems.

On the light of the above considerations, the selected sub set of use cases can be considered a good starting point to concentrate the project demonstrator implementation efforts. Indeed, it is worth to note that in order to develop a fully working demonstrator, some other use cases will be considered to guarantee a proper operation of the platform. Examples of these use cases are: UC_00_01, UC_00_02, UC_02_02; UC_02_04, UC_02_06, UC_02_11, UC_02_14, UC_02_18, UC_02_19, UC_02_22, UC_02_23, UC_02_27, UC_02_34, UC_02_39, UC_02_40, UC_02_42, UC_02_45, UC_02_59, UC_02_63. Adding these use cases allows to cover 89% of the mandatory requirements, 100% of the high priority functionalities, while requiring to implement the 65% of the overall functionalities.

ANNEX

A. User requirements

i. A.1 Functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU10	**User registration**	Capability of BONVOYAGE platform to allow the user to register to BONVOYAGE in order to access and use the platform functionalities. For the (simple) registration, the user must provide: 1) Surname; 2) Credentials: email and password; 3) Authorization to geolocation. At the moment of the registration, the user has the possibility to provide the following additional, optional information: 4) nickname, default preferred language, profile picture, icon; 5) user category (few options with ability to click multiple), with the possibility of skipping. [Categories will include: Bike lovers; Heavy Vehicles drivers (including both truck drivers as well as bus drivers); Luxury (5 star tourists looking for luxury travel conditions); Backpacker (hostel tourists); Low cost; Families; - Business; Schools (students groups); Eco-friendly (CO2 saving and naturalistic itineraries); Groups (tourists groups); Religious groups (religious tourism); Romantic (romantic travels for couples, scenic tours); Single; Adventure (adventure travels); Disabled travellers (with disabilities - also specifying the kind of disability); Food (wine and food travels); Art and culture (artistic itineraries); Music (itineraries for music events); Sport (itineraries for sporting events); Pregnant; Elderly; Day tripper (one day round trip); Special needs]. This information shall be provided according to EU privacy regulation. 6) additional data (e.g. .: tax code, VAT number) required to make the payment with billing. The user has also the possibility to link the account to the social networks (e.g. Gmail).	Account/Profile	Account/registration	Mandatory	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU11	**User login**	Capability of BONVOYAGE platform to allow the user to log-in to the platform in order to access and use its functionalities (mandatory log-in). Log-in is possible only with BONVOYAGE credentials (at least in the initial phase - to assess future BONVOYAGE super partes that integrates access credentials with other App).	Account/Profile	Account/registration	Mandatory	All
BU20	**Privacy**	Capability of BONVOYAGE platform to ask the user the authorization to share his information during the installation. BONVOYAGE platform must give the user the possibility to provide the authorisation also in next steps / phases.	Account/Profile	Account/registration	Mandatory	All
BU30	**Base account definition/setting**	In every moment after completion of the initial basic registration, capability of BONVOYAGE platform to allow the user to update his account with the following additional, optional information:- Name;- Mobile phone number;- Nickname, photo, icon identification; - insertion and save of addresses / favourite places; - list favourite events/favourite places; - fidelity programmes of BONVOYAGE transport operators and service providers (e.g. Star Alliance awards);- age range; - employment.Account update can be done whenever the user wants to. Each information shall be sided by a box explaining why that information is required and how BONVOYAGE will use that information to determine the most suitable solution for the user (e.g., personalised discounts/promotions).In his account page, the user will have the possibility to display fidelity points accumulated.	Account/Profile	Account/registration	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU40	**Status**	Capability of BONVOYAGE platform to allow the user to: - Link status / emoticons to the profile; - Share status on social networks.	Account/Profile	Profile updating	Priority 2	All
BU50	**Profile loyalty categorisation/setting**	Capability of BONVOYAGE platform to categorize the user in different fidelity profile groups based on scores collected.	Account/Profile	Profile ranking	Priority 1	All
BU60	**Social network "Friends" (contact) link**	Capability of BONVOYAGE platform to allow the user to "invite" friends by inserting mail /mobile phone / contact Social Network (Optional requirements - if there are API).	Account/Profile	User (other) connection	Priority 2	All
BU70	**BONVOYAGE "Friends" (contact) link**	Capability of BONVOYAGE platform to allow the user to enter contacts to identify other friends on BONVOYAGE (finding friends on BONVOYAGE and establishing "friendship" on BONVOYAGE).	Account/Profile	User (other) connection	Priority 2	All
BU71	**BONVOYAGE Contacts Network**	Capability of BONVOYAGE platform to propose the user other people with whom establish a friendship based on the following key criteria: - number of mutual friends; - user categories.	Account/Profile	User (other) connection	Priority 2	All
BU80	**Define profiles for the definition of the travel solutions**	Capability of BONVOYAGE platform to manage search engine parameters in order to give preference to defined travel solutions according to a pre-defined user profile.	Account/Profile	User profile	Priority 1	All
BU90	**Differentiate travel solutions for profiling**	Capability of BONVOYAGE platform to diversify travel solutions according to different user profiles.	Account/Profile	User profile	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU100	**Identity Management**	Capability of BONVOYAGE platform to manage a customer identity.	Account/Profile	Identity management and application profile management	Mandatory	All
BU110	**Word of mouth**	Capability of BONVOYAGE platform to allow the user to use the chat to exchange message with other BONVOYAGE users.	Communication	Messenger	Priority 2	All
BU120	**Sending/receiving message**	Capability of BONVOYAGE platform to allow the user to send/receive message to/by other users through a dedicated messages box.	Communication	Messenger	Priority 2	All
BU130	**Info-mobility notification reception**	Capability of BONVOYAGE platform to send push notification with mobility-related information (e.g. traffic status, public transport disruption).	Communication	Notification	Mandatory	All
BU140	**Push notification suggesting transport or events tickets purchase**	Capability of BONVOYAGE platform to send the user push notification containing suggestions and / or proposals to purchase transport services or additional services targeted to the user: - Local Public Transport (LPT) ticket (for destination city LPT); - taxi; - car sharing; - museum tickets.	Communication	Notification	Priority 1	All
BU150	**Notification reception setting**	Capability of BONVOYAGE platform to allow the user to filter the notification/information to be received (e.g. .: notifications only peak times; updates and news; changes timetables and routes).	Communication	Notification	Priority 2	All

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BU151	**Newsletter service**	Capability of BONVOYAGE platform to send to the user a periodic newsletter so that he can be informed about new services offered by BONVOYAGE partners. Possibility for the user to un-subscribe from the newsletter reception.	Communication	Newsletter	Priority 3	All
BU160	**You add me on travel**	Capability of BONVOYAGE platform to allow the user to: - share route information (e.g.: travel time, estimated time of arrival) and location with "your friends" on the App BONVOYAGE; - share address associated with contact phone / smart phone (which then becomes the starting address / travel destination); - share information on the place reserved on the means of transport with their friends; - share favourite places with other applications that require location information; - share user location with other Apps; - share his travel solution with other users in order to share group tickets. (every sharing request shall be implicitly/explicitly accepted, ignored or refused by the beneficiary)	Info-mobility	Information sharing /picking-up	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU170	**Information on the state of the circulation**	Capability of BONVOYAGE platform to allow the user to share : - real time information on road traffic status (public transportation, road status, road works, roadblocks, accidents, road closures, etc.) with other BONVOYAGE users, adding the information on BONVOYAGE platform. The information on road works can be shared by the user with local law enforcement agencies, as BONVOYAGE platform is connected with them. Possibility for the user to share these data with all the community, or with defined clusters of users or with identified users (own "friends"). Possibility for the user to share information with other BONVOYAGE users (travellers).	Info-mobility	Information sharing /picking-up	Priority 1	All
BU171	**Real time information on the status of the circulation detected by BONVOYAGE**	Capability of BONVOYAGE platform to detect real time information / input from sensors/devices according to their time and space validity.	Info-mobility	Information sharing /picking-up	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU180	**Public transports information**	Capability of BONVOYAGE platform to allow the user to share real time information on public transports traffic / status (e.g. delays, strikes, itinerary changes, etc.) with other BONVOYAGE users, adding the information on BONVOYAGE platform. Possibility for the user to visualise information shared by other BONVOYAGE users concerning: - Public transportation Status (e.g .: train / bus not started yet, late / early, filling rate, cleanness); - Public transport lines (e.g.: delay, strike, problems of access); - Line of bus, metro on "where you are" (e.g.: delay, line out of service, accidents, change track, change path, driver assessment, the wrong path); - Stops / stations of public transport nearby.	Info-mobility	Information sharing /picking-up	Priority 1	Individual transport; Collective transport
BU190	**Other information**	Capability of BONVOYAGE platform to allow the user to visualise and share information on: - Planned measures on rail / bus / metro, strikes; - Weather (e.g. snow, rain); - Checkpoints; - Places (e.g. restaurant schedule).	Info-mobility	Information sharing /picking-up	Priority 2	All

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BU200	**Radar interception**	Capability of BONVOYAGE platform to allow the user to set a filter system (km , number of hours) to visualise information on: - transportation; - state of the traffic - accidents (e.g. .: 100 km from the place of departure). These are features for user on the go. The user is informed of his choice with a pre-set time in advance (time defined by the user) about accidents along the way. This information will be received by the user through a push notification.	Info-mobility	Information sharing /picking-up	Priority 1	All
BU210	**Search travel information for others**	Capability of BONVOYAGE platform to allow the user to search routes / information for others BONVOYAGE users included in the user "my contacts" list (on his smart phone) and then send the result to the interested contact (e.g. to organize a trip on behalf of other person).	Info-mobility	Information sharing /picking-up	Priority 2	Individual transport; Collective transport
BU220	**Pictures**	Capability of BONVOYAGE platform to allow the user to associate a picture to an information shared (picture will be sent only to the person with whom the user he is chatting or associated to the user status of Social Network).	Info-mobility	Information sharing /picking-up	Priority 3	All
BU230	**Itineraries / favourite places Localization**	Capability of BONVOYAGE platform to geolocate routes / sites inserted by the user in the "preferred route list".	Geolocalization	Users and location localisation	Priority 3	All
BU240	**User localisation**	Capability of BONVOYAGE platform to geolocalise the user.	Geolocalization	Users and location localisation	Mandatory	All
BU241	**Events or denomination based search**	Capability of BONVOYAGE platform to allow the user to indicate an event or a denomination instead of the origin / destination address.BONVOYAGE provides a list of pre-defined categories for possible denominations (e.g. Museums, restaurants, others).	Geolocalization	Users and location localisation	Priority 1	All

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BU250	**Services/events localisation**	Capability of BONVOYAGE platform to calculate and give the user information on location and distance of: - Car services (gas stations, parking); - Transport (bus stations, train, airports, etc.); - Public services (schools, universities, hospitals, police, post offices); - Shopping and services (supermarkets, shops, pharmacies, travel agencies; - Food and drink, restaurants; - Cultures and entertainment (theatres, cinemas, museums); - Hotels; - Outdoors (beaches, golf courses); - Natural features (islands, lakes, forests). Possibility for the user to define the area of the location (e.g.: 5/15 minutes by walk / drive). Capability of BONVOYAGE platform to localize service / event on the map.	Geolocalization	Other services localisation	Priority 1	All
BU251	**SOS Services request**	Capability of BONVOYAGE platform to allow the user to require and receive road side assistance (if necessity) through BONVOYAGE platform. The user can send a request for assistance simply pushing a bottom on his BONVOYAGE App.	Support	Other services	Priority 1	All
BU260	**Basic visualisation**	Capability of BONVOYAGE platform to allow the user to visualise Maps (Google Map as well). The Maps include: routes, stations and P.O.I (points of interest) for the passenger (e.g. dining place, gas station…), considering a standard radius from his current position. freight transport operators, like ports, stations, inter-ports. On the displayed map, capability of BONVOYAGE platform to allow the user to receive signal/suggest and display possible points of interest for the user.	Maps	Online maps visualisation	Priority 3	All

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BU261	**Indoor navigation**	Capability of BONVOYAGE platform to allow the user to visualise maps of indoor areas of buildings and infrastructures (e.g. airports, stations).	Maps	Online maps visualisation	Priority 3	All
BU270	**Information visualisation**	Capability of BONVOYAGE platform to allow the user to visualise other shared information on the map (e.g. incidents).	Maps	Online maps visualisation	Priority 1	All
BU280	**Information visualisation selection**	Capability of BONVOYAGE platform to allow the user to select information that will be visualised in the map.	Maps	Online maps visualisation	Priority 1	All
BU290	**Route maps**	Capability of BONVOYAGE platform to allow the user to save maps and the chosen routes and view it offline	Maps	Off-line maps visualisation	Priority 3	All
BU291	**Maps with disabled parking stops**	Capability of BONVOYAGE platform to allow the user to show in the map the disabled parking spaces.	Maps	Maps visualization	Priority 2	Individual transport
BU300	**User maps and itineraries sharing**	Capability of BONVOYAGE platform to allow the user to visualise and share maps and itineraries of other BONVOYAGE users.	Maps	Other maps capabilities	Priority 2	All
BU310	**Travel maps sharing (Social network)**	Capability of BONVOYAGE platform to allow the user to visualise and share maps and itineraries of others BONVOYAGE users through social networks.	Maps	Other maps capabilities	Priority 2	All

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BU320	**Planning - Inter-modal travel solution Settings**	Capability of BONVOYAGE platform to allow the user to:- Select preference path (e.g.: shortest, faster, less foreign exchange);- Select favourite transportation (e.g.: bus, subway, train, tram, trucks / heavy vehicles);- Select of routes to be avoided (e.g. toll roads, highways);- Identify preference level of different public transport / private (score 1-5): taxi, tram, bus, walk, train, subway, car, bicycle.- Select vehicles owned (car, motorcycle, bicycle);- Select access to transportation: car-sharing, bike-sharing, cars, motorcycles, bicycles;- Select of P.O.I (points of interest) for freight transport operators, like ports, stations, inter-ports;- Insert geographical coordinates of the arrival/destination point as input for travel solution planning.	Moving	Planning	Priority 1	All
BU321	**Planning - Travel solution Returning**	Capability of BONVOYAGE platform to find and rank feasible solutions according to the following selection criteria: - The best k solution (with k fixed) are returned; - Identification of the preferred solution among the k returned.	Moving	Planning	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU330	**Planning inter-modal travel solution through filter**	Capability of BONVOYAGE platform to allow the user to search for a travel solution using the following filters: - price (price ranges, e.g.: 0-100 €, 100-200€, etc.); - class category (first class, second class, etc.); - hour range for departure and return trip (e.g. only morning; only evening; from hour XX to hour XX); . total journey duration; - comfort; - environmental impact/foot print (e.g. CO2 grams); - total travel time; - in-vehicles time; - number of changes; - offers; - meals; - feedback score; - services (Wi-Fi, non-smoker, gym, animals allowed). - special needs (in this case the user shall specify if the special needs relate to: disabled people; user with a baby chair; bikes to carry during the trip; pets to carry during the trip; luxury (this can also be a preference, but in this case, is treated as a need e.g.: limo and luxury for the honeymoon).	Moving	Planning	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU340	**Travel itinerary search and planning(high priority search modality and information to be displayed)**	Capability of BONVOYAGE platform to allow the user to make a research for a travel itinerary as follows:- search vehicle available for the selected route (with notification of any changes)- search for "mes" in the destination list / stations- insert an event run by BONVOYAGE partners as origin / destination of a journey (e.g. .: show run by a museum)- insert as a destination the geolocation of another BONVOYAGE (user subject to their consent).Possibility for the user to include in the travel itinerary search the following information:- commercial operators/merchants name (e.g. .: shop, restaurant);- number of passengers;- passengers age-range;- disabilities.BONVOYAGE will calculate and return a number of different multi-modal travel journeys for the selected itinerary taking into account: the preferences of public or private transport expressed during the user registration; category of membership of the user; previous actual mobility behaviour in similar circumstances and behavioural profiling based on user feedbacks (if provided).BONVOYAGE will calculate solutions for- home town-destination by car;- home town-resort destination by local travel / national / transnational public transports.	Moving	Travel itinerary	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU341	**Travel itinerary search and planning (lower priority search modality and information to be displayed)**	In addition to the high priority search modality (BU 340), BONVOYAGE platform shall give the opportunity to the user to search for a travel itinerary through the Fast alphabet selector. In addition to the high priority information, the user shall have the possibility to include and display in the travel itinerary search the following information: - favourite stations; - animal transport; - extra luggage; luggage deposit; insurance; lounge access. The user shall have the possibility to ask for a different sorting within the list of solutions created by BONVOYAGE on the basis of the user account/profile. The user shall have the possibility to save search criteria (recent research) (option to be selected by the user - no default). All the information / options above will not have to be included within the prototype.	Moving	Travel itinerary	Priority 2	All
BU350	**Additional information about the trip**	During the request of the travel solution. capability of BONVOYAGE platform to allow the user to enter information on:- the travel scope (e.g.: work, pleasure);- number of people (e.g.: alone, with friends, in couple, with children older than 1 year/8 years, etc.); - day time (early in the morning, late night, etc.).	Moving	Travel itinerary	Priority 1	All
BU360	**Search stops and public transport**	Capability of BONVOYAGE platform to allow the user to search route, stops and arrival times at each stop of the bus lines, metro and tram.	Moving	Travel itinerary	Mandatory	Collective transport

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
	routes					
BU370	**Travel time calculation (before and during the journey)**	Capability of BONVOYAGE platform to: - check the travel schedule of public transport selected (by entering the number train / bus line); - calculate the time required to reach the stop / place of destination (user already on board the means of transport); - calculate connecting time; - calculate in-vehicles time.	Moving	Travel itinerary	Mandatory	All
BU371	**Trip monitoring and control**	Capability of BONVOYAGE platform to allow the user to check that the actual trip is in line with the selected one while travelling. The current status of the trip and involved resources (in terms of transport modality) are monitored according to possibly different policy (e.g., fixed time, on demand, etc.). If a considerable deviation from the planned trip is detected or some resources become available or no more available, then - a new set of feasible solution is recomputed - the best k solutions (with k fixed) are returned This will be possible through the intervention of a virtual assistance (as described in requirements BU 990).	Moving	Travel itinerary/Planning	Priority 1	All

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BU380	**Travel solution information display**	During the travel solution search phase, capability of BONVOYAGE platform to allow the user to choose to visualize travel solutions ranked by:- departure time- arrival time- length of the journey.Capability of BONVOYAGE platform to allow the user to display the following information for each travel solution:- departure time- arrival time- length of the journey- source> destination- codes of public transport (more than one if there are changes)- cost "from" and the number of loyalty points obtainable- departure time - arrival time- duration of the trip; number of changes; in-vehicles time; environmental impact; how the solution contributes to achieve the pre-defined mission- travel "priority" solutions (determined by clustering declared -preferences based on user previous trips)- walking routes visualisation.Travel solution will be also prioritised and ranked based on their correspondence to the user profile (this latter is determined by declared user category, declared preferences, actual user mobility behaviour detected by BONVOYAGE platform on the basis of actual trips made by the user).Travel solution display will also include walking routes.	Moving	Travel solution and associated information visualisation	Mandatory	Collective transport
BU390	**Route visualisation**	Capability of BONVOYAGE platform to allow the user to: - Visualise the itinerary; - Visualise the route (map) followed by transport (user already on board); - Visualise points of interest for car drivers: picnic areas, camping sites, landmarks, tunnels, accident-prone areas; -Visualise specific road information for particular user categories (e.g. for the heavy vehicles drivers): width, permitted axel load, height in tunnels, gradient of slope/curvature, snow flow standard; restoring areas, parking area where the truck drivers can relax or sleep; - Visualise points of interest for car drivers and heavy vehicles drivers (e.g. dedicated areas along the roads where change snow chains).	Moving	Travel solution and associated information visualisation	Priority 1	All
BU400	**Non-existent route**	Capability of BONVOYAGE platform to send notification of unavailable travel solutions for the route start-selected (the notification can be related also to a single phase of the travel).	Moving	Travel solution and associated information visualisation	Priority 1	All

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BU410	**Display trains stops**	Capability of BONVOYAGE platform to allow the user to: - visualise stations train stop; - visualise trains departing / arriving programmed.	Moving	Travel solution and associated information visualisation	Mandatory	Collective transport
BU420	**LPT display stop**	Capability of BONVOYAGE platform to allow the user to: - visualise stops of urban public transport; - visualise interconnection with other modes of public transport.	Moving	Travel solution and associated information visualisation	Mandatory	Collective transport
BU430	**Display of departure / arrival time in selected the station / LPT stop**	Capability of BONVOYAGE platform to allow the user to visualise for each station the departure time of the selected train / Local Public Transport line.For the selected line, capability of BONVOYAGE platform to allow the user to visualise the time of arrival to the chosen destination.	Moving	Travel solution and associated information visualisation	Mandatory	Collective transport
BU440	**Define searching engine for travel solutions**	Capability of BONVOYAGE platform to select travel solutions aligned to a specific user profile and to reject solutions that are not in line with this profile.	Moving	Travel solution search parameters	Priority 1	All
BU450	**Defining objectives to be achieved in a given time interval**	Capability of BONVOYAGE platform to allow the user to define a target: calories, emissions, money. Each target reached allows the accumulation score/points (e.g.: more heat = more points; less emissions = more points, more money saved = more points). (preferential requirement).	Moving	Objective/Target	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU460	**Mission/Travel monitoring**	Capability of BONVOYAGE platform to allow the user to track and visualise information on: - progress towards achieving the objectives; - time remaining at the end of the time pre-set for the achievement of (mandatory requirement)	Moving	Objective/Target	Priority 1	All
BU470	**Mission/Travel cancellation**	Capability of BONVOYAGE platform to allow the user to delete the objective (of the mission)	Moving	Objective/Target	Priority 1	All
BU480	**Travel solution choice**	Capability of BONVOYAGE platform to allow the user to select the travel solution that he prefers, after that he has visualised all the possible and alternative travel solutions elaborated.	Moving	Travel solution and related services selection	Mandatory	All
BU490	**Car-pooling / car sharing service choice and booking**	Capability of BONVOYAGE platform to: - allow the user to book a car sharing service (by re-sending to the site manager of car sharing service selected) in route planning; - allow the user to share the booked car sharing service with other BONVOYAGE users that are interested in the same service to cover the same itinerary (entirely or partially). Possibility for the user to use his own car and share it with other users (car-pooling) to cover a specific route, instead of booking a car sharing service.	Moving	Travel solution and related services selection	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU491	**Users aggregation for car sharing services**	When a different users are interested in the same car sharing service to cover the same itinerary, capability of BONVOYAGE platform to match the users based on: - their profile; - the feedback on reliability they have previously received by other BONVOYAGE users. When BONVOYAGE matches the user, capability of BONVOYAGE platform to send each user a push notification that: - proposes other users with which it would be recommended to share the car sharing service; - shows other users profile and feedback.	Moving	Travel solution and related services selection	Priority 1	All
BU500	**Travel solution finalisation**	After selection of travel solution and additional related services, capability of BONVOYAGE platform to allow the user to make a final confirmation of travel solutions and services he wants to purchase.Capability of BONVOYAGE platform to allow the user to select his preferred currency for purchase (this option is not to be included in the platform prototype).	Moving	Travel solution and related services selection	Mandatory	All
BU510	**Credit/Debit card purchase**	Capability of the BONVOYAGE platform to allow the user to purchase a ticket for: - travel solution; - single travel document (even Local Public Transport); - event (e.g. museum, guided tour); through credit /charge card.	Moving	Ticket purchase	Mandatory	All

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BU520	**eWallet purchase**	Capability of the BONVOYAGE platform to allow the user to purchase a ticket for: - Travel solution; - single travel document (even Local Public Transport); - event (e.g. museum, guided tour) through eWallet.	Moving	Ticket purchase	Mandatory	All
BU530	**PayPal purchase**	Capability of the BONVOYAGE platform to allow the user to purchase a ticket for: - Travel solution; - single travel document (even Local Public Transport); - event (e.g. museum, guided tour) through PayPal account.	Moving	Ticket purchase	Mandatory	All
BU540	**Receiving ticket travel solution**	Capability of BONVOYAGE platform to allow the user to select the mode of reception of the ticket and the ID code of the travel solution (smart phone or other mobile device): SMS, email, 2D code, QR code.	Moving	Ticket purchase	Mandatory	Individual transport; Collective transport
BU550	**Purchase notification**	Capability of BONVOYAGE platform to allow the user to receive SMS or email notification of the purchased of travel solution. For freight transport, the transporter must receive order confirmation and the customer (the user who required the freight transport service) must receive an invoice for the purchased service.	Moving	Ticket purchase	Mandatory	All
BU560	**Law/Rules searching and condition of sale**	Capability of BONVOYAGE platform to allow the user to search for information on commercial conditions connected with the resolution of the purchased travel solution (e.g.: refund / return ticket, compensation) before and after the trip.	Moving	Ticket purchase	Priority 2	All
BU570	**Create travel ticket**	Capability of BONVOYAGE platform to create the travel document associated to the purchased travel solution.	Moving	Travel document creation	Mandatory	All

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BU580	**Integrated ticketing**	Capability of BONVOYAGE platform to produce multimodal / multi-service integrated ticketing.	Moving	Travel document creation	Priority 1	All
BU590	**Provide information related to the identification code history of the ticket**	Capability of BONVOYAGE platform to allow the user to search and track a travel document "history" (e.g. visualization of original travel identification code and additional travel change booking code with timestamp related to year, date and hour of original purchase and changes occurred.).	Moving	Travel document history	Priority 3	All
BU600	**History visualisation**	Capability of BONVOYAGE platform to allow the user to : - Visualise historical travel solution purchased and possibility to send the historian email; - View Detail tickets (e.g .: date, origin, destination and cost of the ticket, train codes, trip duration, number changes, number of adults, number children, passengers details with detail on site and reservation code, QR code and booking number references; reduced environmental impact - to be verified against eco-passenger).	Moving	Historical purchase	Priority 2	All
BU610	**Ticket Wallet**	Capability of BONVOYAGE platform to allow the user to insert the ticket purchased within another Wallet App on smart phones and to integrate with display historical App	Moving	Historical purchase	Priority 3	All
BU620	**Consult data sale system**	Capability of BONVOYAGE platform to access to sales basic information to support audits, information provision to Public Security Authorities, complaints management.	Travel document and sales	Consult data related to the sailing system	Priority 3	All
BU630	**Travel setting memorandum**	Capability of BONVOYAGE platform to allow the user to activate reminder by: - Inclusion in the travel calendar; - Receipt notification to 1h before departure; - Receive notification in station (with list of booking codes).	Moving	Reminder/Memo	Priority 3	All

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BU640	**Passengers choice**	When planning the trip, capability of BONVOYAGE platform to allow the user to: - select the type of passengers (e.g. elderly, adults, children); - specify number of passengers (groups etc.); to be included in the travel solution.	Moving	Travel options purchase	Mandatory	Individual transport; Collective transport
BU650	**Tariff choice**	Capability of BONVOYAGE platform to allow the user to select the best rate (e.g. fidelity card).	Moving	Travel options purchase	Priority 2	All
BU660	**Best price management**	Once the BONVOYAGE has returned all the available travel solutions for the itinerary selected by the user, capability of BONVOYAGE platform to allow the user to visualise and select the best price (with related services) of the week or of the month	Moving	Travel options purchase	Priority 1	All
BU670	**Class Choice**	Capability of BONVOYAGE platform to allow the user to choose the preferred class/tariff	Moving	Travel options purchase	Priority 1	All
BU680	**Select the favourites seats**	Capability of BONVOYAGE platform to allow the user to : - Visualise the layout of public transport available seats (with seats bookable); - Select the seat on public transport.	Moving	Travel options purchase	Priority 2	Collective transport
BU690	**Discounts/Promotions**	Capability of BONVOYAGE platform to allow the user to visualise discounts/promotions available and to buy them. The list of possible promotions shall be ranked according to user profile defined as: - the commercial profile assigned at the registration moment; - the behavioural profile emerged by analysing data about the user and the feedbacks provided.	Moving	Travel options purchase	Priority 1	All
BU700	**Provide general terms of purchase**	Capability of BONVOYAGE platform to allow the user to get information on general terms of purchase (e.g. possibility to reimburse ticket) related to a specific transport operator, during the travel ticket purchase phase.	Passengers "Protection "	General terms of purchase	Priority 3	All

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BU710	**Modify/delete travel seat purchased**	Capability of BONVOYAGE platform to allow the user to modify/delete travel seats booked.	Moving	Modify/delete travel options purchased	Priority 2	Collective transport
BU720	**Modify/delete travel services purchased**	Capability of BONVOYAGE platform to allow the user to modify/delete services purchased and associated to the travel solution.	Moving	Modify/delete travel options purchased	Priority 2	All
BU730	**Other transport services purchase**	Capability of BONVOYAGE platform to allow the user to buy other transport services: - taxi; - car sharing, bike sharing.	Moving	Other mobility services purchase (to ultimate door to door travel)	Mandatory	Individual transport; Collective transport
BU740	**Highway, stop and parking subscription**	Capability of BONVOYAGE platform to allow the user to buy tickets for parking, highway etc.	Moving	Other mobility services purchase (to ultimate door to door travel)	Priority 3	Individual transport; Collective transport
BU750	**Access restricted traffic area/zone purchase**	Capability of BONVOYAGE platform to allow the user to buy access for restricted area/zone.	Moving	Other mobility services purchase (to ultimate door to door travel)	Priority 3	All
BU760	**Waiting list**	Capability of BONVOYAGE platform to allow the user to enter a request to be included in a waiting list when the service the user wants to buy is not available.	Moving	Other mobility services purchase(to ultimate door to door travel)	Priority 3	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU770	**Leisure services Purchase**	Capability of BONVOYAGE platform to allow the user to buy recreational other services: - Activity 'Food & Beverage' e.g.: McDonald / Fast food - Retail Stores - Electronic payment of tolls and parking - Other self-service management - Supermarkets - Museums, tourist tours	Moving	Other ancillary services purchase	Priority 2	Individual transport; Collective transport
BU780	**Local services purchase**	Capability of BONVOYAGE platform to allow the user to buy municipal services.	Moving	Other ancillary services purchase	Priority 3	All
BU790	**Booking services partner from integrated operators in BONVOYAGE**	Capability of BONVOYAGE platform to allow the user to book services from partners of transport operators integrated into the BONVOYAGE platform.	Moving	Partner services purchase	Priority 1	All
BU800	**Travel solution purchased modification**	Capability of BONVOYAGE platform to allow the user to: - modify reservation or travel solution purchased (where available by the operator); - change the booking keeping the same route; - change the travel solution purchased.	Moving	Travel solution modification	Priority 2	All
BU810	**Passengers extensions**	Capability of BONVOYAGE platform to allow the user to add passengers to a pre-identified travel solution.	Moving	Travel solution modification	Priority 3	Collective transport
BU820	**Travel extension**	Capability of BONVOYAGE platform to allow the user to add a new travel solution to a pre-identified travel.	Moving	Travel solution modification	Priority 2	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU830	**Passengers cancellation**	Capability of BONVOYAGE platform to allow the user to delete passengers included in a pre-identified travel solution (including international trains reservations and purchases made abroad).	Moving	Travel solution modification	Priority 2	Collective transport
BU840	**Travel cancellation**	Capability of BONVOYAGE platform to allow the user to delete a travel solution from a pre-identified travel.	Moving	Travel solution modification	Priority 2	All
BU850	**Cancellation extra services**	Capability of BONVOYAGE platform to allow the user to delete additional services from a travel solution.	Moving	Travel solution modification	Priority 2	All
BU860	**Travel solution purchased Reimbursement**	Capability of BONVOYAGE platform to allow the user to: - require the reimbursement of travel solution purchased; - require partial repayments of a LPT service not enjoyed through contacts BONVOYAGE (online, free BONVOYAGE phone number)	Moving	Reimbursement	Priority 1	All
BU870	**LPT ticket validation**	Capability of BONVOYAGE platform to allow the user to validate the Local Public Transport ticket at the beginning of the travel (included in travel solution purchased) on Smart Card support, through a payment card with EMV, NFC technology, bar code technology	Ticket LPT	LPT ticket Validation/Fare	Priority 2	Collective transport
BU880	**LPT Ticket tariff**	Capability of BONVOYAGE platform to validate and calculate the tariff of the Local Public Transport ticket at the end of the travel (included in travel solution purchased) on Smart Card support, through a payment card with EMV, NFC technology, bar code technology.	Ticket LPT	LPT ticket Validation/Fare	Priority 2	Collective transport
BU890	**Local Public Transport Travel document validation**	Capability of BONVOYAGE platform to produce travel document that can be validated through Smart Card, EMV credit card, NFC and bar code technology.	Ticket LPT	Validation and tariff payment	Priority 3	Collective transport
BU900	**Local Public Transport Travel document tariff payment**	Capability of BONVOYAGE platform to produce travel document whose tariff can be paid through Smart Card, EMV credit card, NFC and bar code technology.	Ticket LPT	Validation and tariff payment	Priority 3	Collective transport

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU910	**Synchronization to and from calendar**	Capability of BONVOYAGE platform to allow the user to:- Synchronise his calendar events from mobile; - Synchronise travel and events purchased on BONVOYAGE platform on the user smart phone calendar.	Events	Event visualisation/Information	Priority 2	All
BU920	**Synchronization from social network**	Capability of BONVOYAGE platform to allow the user to visualise Events (from Social Network).	Events	Event visualisation/Information	Priority 2	All
BU930	**Events information**	Capability of BONVOYAGE platform to allow the user to visualize information on events (e.g. tours with guides - where - when - Price - Review - related events) for cities and for selected date (optional requirement).	Events	Event visualisation/Information	Priority 2	Individual transport; Collective transport
BU940	**Historical**	Capability of BONVOYAGE platform to allow the user to visualise Events historic purchases.	Events	Event visualisation/Information	Priority 2	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU950	**Personalized events/suggestions**	According to the profile associated to the user, capability of BONVOYAGE platform to suggest potential travel (and related planned trip) to the user. For example, if a user typically travels on the weekend, BONVOYAGE will propose a list of possible travel solutions for the following weekend. Suggestions will be eventually sent by BONVOYAGE through push notification: - at the end of a trip actually performed by the user; or - periodically (periodicity will be established by technology providers). This feature will be only available for specific user categories, set-up by technology providers through an administration console (based on marketing choices).	Events	Event visualisation/Information	Priority 2	Individual transport; Collective transport
BU960	**User Sending feedback**	Capability of BONVOYAGE platform to allow the user to: - Send notifications on possible problems of the App (e.g.: problems with maps, places missing; feedback if misplaced); - Send feedback on how to improve the App; - Evaluate the user experience of the App (cities, companies of mobility and transport supported by the JPA, information provided from the app, accuracy estimated time of arrival at destination, accurate arrival times for public transport, correct information on location and online, finding points of interest, suggestions).	Feedback	Feedback (general)	Priority 2	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU961	**User sending feedback on a received travel solution**	Capability of BONVOYAGE platform to allow the user to: -insert and share his feedback on the travel solution he obtained for a specific itinerary; -visualize feedback on a specific travel itinerary uploaded and shared by other users. Feedback can be provided by the user only if he has concretely experienced a travel solution. Feedback can be provided in two ways: - by the user in a proactive way (from the Feedback functionality Tab of BONVOYAGE platform); - upon request of BONVOYAGE system (BONVOYAGE sends the user - through email - a request to evaluate his travel experience).	Feedback	Feedback (travel solution)	Priority 1	All
BU970	**Follow me**	Capability of BONVOYAGE platform to allow the user to:- Receive assistance during journey to deliver an opinion and satisfaction degree on development of the trip concerning the overall travel solution and/or each single uni-modal step (e.g. during the travel, when a change of vehicle happen; on-line support).- Receive assistance by activating the function of rescheduling with the possibility of providing a negative feedback if applicable.- Enable indoor and outdoor maps visualisation (based on requirement BU261).	Feedback	Feedback (structured)	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU980	**Vertical Support and re-planning of the trip in the event of unforeseen**	Capability of BONVOYAGE platform to allow the user to: -send requests for help to re-plan trip in case of unforeseen circumstances; -receive support to re-plan the travel itinerary (hint alternative route) through the intervention of a virtual assistance [very ambitious requirement]. Virtual assistance can be activated in any moment by the user, except when he acts in a proactive way (as described in requirement BU961). Virtual assistance is always active by default for the heavy vehicles category.	Feedback/ Planning	Feedback (structured)	Priority 1	All
BU981	**Vertical Support and re-planning of the trip in case of high user stress level**	While the user is travelling, capability of BONVOYAGE platform to: - receive information on the user stress level detected and processed by wearable sensors and communicated to BONVOYAGE platform; - automatically re-plan and propose the user an alternative travel solution if the user stress level is high. Once the travel is over, capability of BONVOYAGE platform to: - register the user stress associated to the travel solution and related transport modes; - propose the user travel solutions that do not include transport modes that may cause him / her a high stress level (for future requested travel solutions).	Feedback/ Planning	Feedback (structured)	Priority 1	All
BU990	**Collecting score**	Capability of BONVOYAGE platform to allow the user to gather points/scores based on: - Travel solutions purchased (e.g. based on low environmental impact of the purchased travel solution); - Quantity and type of information mobility shared with other users; - Achievement of objectives. Possibility to gather scores from external services providers having a partnership with at least one of the BONVOYAGE partner operators.	Membership and Collecting points	Score	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1000	**Score visualisation**	Capability of BONVOYAGE platform to allow the user to check his score, with his list of purchases / points earned, and its position in the ranking. Possibility for the user to visualise the ranking of the other users (general rank and rank weekly) to determine the user "reliability".	Membership and Collecting points	Score	Priority 1	All
BU1010	**Award**	Capability of BONVOYAGE platform to allow the user to obtain awards (e.g. transports or car sharing, bike sharing free tickets). Awards proposition to the user will be based on these preferences (where possible). Possibility for the user to receive an award as BONVOYAGE scores from external services providers having a partnership with at least one of the BONVOYAGE partner operators.	Membership and Collecting points	Score	Priority 1	All
BU1020	**Receiving and obtaining promotions/discounts**	Capability of BONVOYAGE platform to allow the user to:- receive promotions from the partners of BONVOYAGE, associated with specific classes of users (ex .: over 60);- receive offers from the partners of BONVOYAGE, for sites designated as favourites.- obtain reductions for TLP (e.g. .: older passengers (over 60) discount).- receive promotions/discounts according to the profile (commercial and/or behavioural) associated to the user;- disable the promotion receptions (through a specific settings functionality);- receive promotions / discounts or buy (at full price) tickets for events (e.g. museums, tourist tours).	Partnership	Promotions	Priority 1	All
BU1030	**Preferred language switch**	Capability of BONVOYAGE platform to allow the user to switch the default preferred language (whenever he wants and also during a journey).	Support	Language support (also during the journey)	Mandatory	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1040	**Currency switch**	Capability of BONVOYAGE platform to allow the user to access a currency converter proposing the local (geo-referred) currency as first option (the converter shall automatically display the starting currency - usually used by the user - and the currency used to calculate the converted value). (In the pilot will be used only Euro, so this requirement will not be included in the Pilot)	Support	Currency converter	Priority 2	All
BU1050	**Freight services list**	Capability of BONVOYAGE platform to allow the user (professional sector) to search for and provide a list of freight services (demanded or offered) by basic input parameters such as: origin; destination; date (range); time of delivery service (range)	Info-freight	Information picking up	Mandatory	Transportation of goods
BU1060	**Available Freight Services filters**	Capability of BONVOYAGE platform to allow the user (professional sector) to filter and sort out available freight services (demanded or offered) by specific parameters criteria: - Freight special characteristics (dangerous goods, cold chain...) - Max Km of route deviation. - Available space/max. Weight and/or volume - Cost - Eco-friendly service	Info-freight	Information picking up	Mandatory	Transportation of goods
BU1070	**Freight service information**	Capability of BONVOYAGE platform to display a complete description of the available freight services (demanded or offered) selected by the user: - Origin/destination; - Pick up/Departure date/time; - Delivery/Arrival date/time; - Type of vehicle/Special conditions (e.g. refrigerated room, careful handling); - Freight/Available space description: weight/volume/size... - Freight tracking availability; - Other Preferences and constrains (e.g. specific limitations applicable to the service).	Info-freight	Information picking up	Mandatory	Transportation of goods
BU1110	**Contact info of freight service's responsible**	Capability of BONVOYAGE platform to allow the user (professional sector) to visualise the contact information related to the freight service's (demanded or offered) responsible for communication purposes: - Email address - Phone number - BONVOYAGE User profile (if registered)	Info-freight	Information picking up	Mandatory	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1130	**Search save**	Capability of BONVOYAGE platform to allow the user to save the current search in the history in both a customized list or a favourites searches list.	Info-freight	Search History	Priority 2	Transportation of goods
BU1140	**Search automatic save**	Capability of BONVOYAGE platform to: - automatically save all performed searches and they will be accessible through a "search history" section; Capability of BONVOYAGE platform to allow the user to: - activate an automatic save for the last 10 destinations searched (this option is applied by default for heavy vehicles drivers).	Info-freight	Search History	Priority 3	Transportation of goods
BU1150	**Favourite freights list**	Capability of BONVOYAGE platform to allow the user (professional sector) to mark freight services (demanded or offered) as favourite or saving them in a list.	Info-freight	Services list	Priority 3	Transportation of goods
BU1170	**List of couriers**	Capability of BONVOYAGE platform to allow the user to search for and provide a list of couriers for parcel delivery service by basic input parameters such as: origin; destination; date; delivery time	Couriers	Couriers information	Mandatory	Transportation of goods
BU1180	**Filter the couriers**	Capability of BONVOYAGE platform to allow the user to filter and sort out courier services by specific parameters criteria: - Freight special characteristics (careful handling...) - Cost - Eco-friendly service	Couriers	Couriers information	Mandatory	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1190	**Favourite couriers**	Capability of BONVOYAGE platform to allow the user to make one courier as favourite or saving it in a "preferred courier" list.	Couriers	Couriers information	Priority 3	Transportation of goods
BU1200	**Contact info of the courier**	Capability of BONVOYAGE platform to allow the user to get the contact info of the courier (location, e-mail, phone/fax number) to communicate with.	Couriers	Couriers information	Mandatory	Transportation of goods
BU1210	**Courier profile**	Capability of BONVOYAGE platform to allow the user to save a complete profile of the courier (to avoid input the info every time he wants to search).	Couriers	Couriers information	Priority 2	Transportation of goods
BU1220	**Modifying a bid**	Capability of BONVOYAGE platform to allow the user (freight transport operator) to modify or remove a bid once it is placed.	Freight exchange	Bid Modification	Priority 3	Transportation of goods
BU1230	**Notifying about the result of an auction**	When auction ends, capability of BONVOYAGE platform to allow the user to inform the user about the result to the users who placed a bid.	Communication	Notifications	Priority 3	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1260	**Setting an alert on info-mobility update**	Capability of BONVOYAGE platform to allow the user to set and receive an alert with new info-mobility about freight services instantly or from time to time (e.g.: every day in the morning), when data is available from transport/traffic information providers sources.	Communication	Notifications	Priority 1	Transportation of goods
BU1280	**Alerts from performed search**	Capability of BONVOYAGE platform to allow the user to set an alert from a performed search.	Communication	Notifications	Priority 3	Transportation of goods
BU1290	**Editing an alert**	Capability of BONVOYAGE platform to allow the user to edit a previously created alert.	Communication	Notifications	Priority 3	Transportation of goods
BU1300	**Route optimization for freight**	Capability of BONVOYAGE to calculate the most efficient route based on one hand on the delivery profile and transport operator preferences and needs and in the other one in external constraints and restriction such us traffic and delivery regulation, driving conditions, weather, traffic status, real time incidents, etc. including multimodal alternatives	Route Optimization	Route planning	Priority 1	Transportation of goods
BU1310	**Saving the optimized route**	Capability of the BONVOYAGE platform to allow the user to save the calculated optimized route.	Route Optimization	Route planning	Priority 2	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1320	**Modifying the optimized route**	Capability of BONVOYAGE platform to allow the user (professional sector) to modify the generated optimized route by changing some parameters and recalculating it.	Route Optimization	Route modification	Priority 2	Transportation of goods
BU1330	**Route optimization for freight delivery in case of unforeseen event**	In case of an unforeseen event (e.g. traffic), capability of BONVOYAGE platform to notify the user (professional sector) about the incident and allow the user to re-calculate an alternative route.	Route Optimization	Recalculation	Priority 1	Transportation of goods
BU1340	**Stopping point in route optimization for freight**	Capability of BONVOYAGE platform to allow the user (transport operator) to include fixed stop points for consolidation of goods, delivery of goods as well as request the calculation of stop points on trip for driver rest, swapping. This requirement also include to allow the user visualise location (and availability) of on road parking facilities and loading/unloading areas.	Route Optimization	Route planning	Priority 1	Transportation of goods
BU1350	**Navigation from optimized route**	Capability of BONVOYAGE platform to allow the driver to start navigation from the calculated optimized route	Route Optimization	Navigation	Mandatory	Transportation of goods
BU1360	**Notifications to the clients**	When the a driver is on trip following a delivery route in the navigator, capability of BONVOYAGE platform to allow the user (transport operator) to send a notification to the client when the driver is in his/her distribution area by SMS, e-mail, BONVOYAGE app...	Route Optimization	Notifications	Priority 1	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1370	**User sending feedback on the quality of the services**	Once the freight service has been provided, capability of BONVOYAGE platform to ask the user for assessing the service scoring aspects related to the quality, reliability, usability, user experience as well as providing free text for additional comments	Feedback	Freight Services	Priority 1	Transportation of goods
BU1390	**System showing "history" of the freight transport operator**	Capability of BONVOYAGE platform to allow the user to keep track of transports made by a single freight transport operator (both company and single driver) and of related results (e.g. volumes). Freight transport operator features (e.g. number of tracks, past experiences) and feedback are shown as results of the research a user has made on available freight services.	Feedback	Driver	Priority 2	Transportation of goods
BU1420	**Navigation from received route**	Capability of BONVOYAGE platform to send and receive by e-mail details of a delivery service (origin/destination/delivery time/delivery note) or a pre-calculated optimized route and allow the user to follow it	Traceability support tool	Navigation	Priority 2	Transportation of goods
BU1430	**Delivery route monitoring**	Capability of BONVOYAGE platform to let the Transport Operator monitors in real time the delivery route for outsourcing delivery services.	Traceability support tool	Traceability	Mandatory	Transportation of goods
BU1440	**Delivery note traceability**	Capability of BONVOYAGE platform to allow the user to include and edit electronic delivery notes created by the transport operator. If the transport operator can't create electronic delivery notes, the possibility to send all required information so the BONVOYAGE platform can generate an electronic delivery note with a field for signature.	Traceability support tool	Delivery note	Priority 1	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU1450	**Parcel monitoring**	Capability of BONVOYAGE platform to allow the user to check and receive information of the status/location of the parcel until the delivery service is finished.	Traceability support tool	Parcel path	Mandatory	Transportation of goods
BU1460	**Delivery notification**	Capability of BONVOYAGE platform to send a notification about delivery finalisation. This is a pre-condition for requirement "User sending feedback on the quality of the services".	Traceability support tool	Delivery	Mandatory	Transportation of goods
BU1470	**Edit and save electronic sign**	Capability of the BONVOYAGE platform to display attached delivery notes and to edit the signature field on the screen of the smartphone to allow electronic signature (e.g. username and password) of the client. The signature could be saved.	Traceability support tool	Electronic sign	Priority 1	Transportation of goods
BU1480	**Sending delivery notes**	Capability of BONVOYAGE platform to allow the user to send signed electronic delivery notes or attach a photo of the physical delivery notes (with stamps)	Traceability support tool	Delivery note	Priority 1	Transportation of goods

ii. A.2 Non-functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BU421	**Display modality**	Capability of BONVOYAGE platform to allow the user to visualise information through universal design elements in Graphic User Interface (GUI)	Moving	Travel solution and associated information visualisation	Mandatory	All
BU1160	**Courier data**	Capability of BONVOYAGE platform to allow the user to update data and info of the courier by checking different sources like last services, personal feedback from other users.	Couriers	Couriers information	Priority 3	Transportation of goods
BU1240	**Data and communication security and integrity**	Capability of BONVOYAGE platform to ensure the user that all data and all communication among users are protected by international security standards so that users have the possibility to verify that information they receive has not been tampered with.	Communication	Security	Priority 1	All
BU1270	**Alerts to email**	Capability of BONVOYAGE platform to send the alerts not only through BONVOYAGE platform, but to an email address.	Communication	Notifications	Priority 2	Transportation of goods

B. Service providers requirements

iii. Functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP10	**Questioning on-time schedule provided by the transport operators (timetable and its variations over time - VCO)**	If data is available, capability of BONVOYAGE platform to provide transports time schedule (provided by transport operators) to external service providers that connect to BONVOYAGE platform to search for those specific information. Time schedule includes all the necessary information to provide the travel solution to the users: - point of departure, - point of arrival - time of departure - time of arrival - intermediate itinerary/stops - available service classes - ancillary services - available seats - seats map - tariffs - commercial offers - discounts (if available) - possibility to select a seat - periodicity	Public transport timetable and other information	Timetable upload	Priority 2	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP20	**Questioning on information / updates on progress of the vehicle flow provided to the platform BONVOYAGE**	If real time data is available, capability of BONVOYAGE platform to provide an updated time schedule to an external service providers when there are delays occur or are planned on the medium-long term.	Public transport timetable and other information	Timetable upload	Priority 2	All
BSP30	**Questioning on inventory Modification**	Capability of BONVOYAGE platform to provide a modified list of services offered by a transport operator in relation to a specific transport mean (e.g. seats, related services, commercial properties - seat reserved to impaired people). Modifications to the list of services are made by transport operators.	Public transport timetable and other information	Services list	Priority 2	All
BSP40	**Questioning on information related to the vehicle geographic coordinates**	Capability of BONVOYAGE platform to provide to external service providers the effective geographic coordinates (point of departure, intermediate points, point of arrival) provided by a transport operator to exactly identify the departure, arrival, intermediate location of a public transport.	Public transport timetable and other information	Geographic coordinates	Priority 2	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP50	**Questioning on BONVOYAGE client profile**	Capability of BONVOYAGE platform to interact with external service providers to provide them customer personal data. [For this requirement it is necessary to understand if it is compatible with privacy legislation. Besides, data enriches a system like BONVOYAGE, so it shall evaluated if BONVOYAGE data shall be shared with external entities. In any case, this data shall not include user profile data].	Personalisation	Receive/Understand client commercial profile	Priority 3	All
BSP60	**Questioning on transport "booked" passengers list (for public transport subjected to mandatory reservation).**	Capability of BONVOYAGE platform to provide a public transport passengers list (for public transport subjected to reservation) to an external service provider. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 3	Individual transport; Collective transport
BSP70	**Questioning on transport "booked" passengers list**	Capability of BONVOYAGE platform to provide to external service providers a public transport passengers list (for public transport not subjected to reservation) to an external service provider. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 3	Individual transport; Collective transport

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
	(for public transport not subjected to mandatory reservation).					
BSP80	**Questioning on passengers list to be "re-protected"**	Capability of BONVOYAGE platform to provide to external service providers the list of public transport passengers to be re-booked. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 3	Individual transport; Collective transport
BSP90	**Questioning on "re-protected" passengers list**	Capability of BONVOYAGE platform to provide to external service providers the list of "re-booked" public transport passengers. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 3	Individual transport; Collective transport
BSP100	**Questioning on disabled passengers list**	Capability of BONVOYAGE platform to provide to external service providers the list public transport disabled passengers. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 2	Individual transport; Collective transport
BSP110	**Questioning on passengers list entitled to special services**	Capability of BONVOYAGE platform to provide to external service providers the list of passengers having rights to special services. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 2	Individual transport; Collective transport

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP120	**Information on the state of the circulation**	Capability of BONVOYAGE platform to provide to external entities or companies information on the status of the road traffic .	Info-mobility	Information sharing /picking-up	Priority 2	All
BSP130	**External service platform**	Capability of BONVOYAGE platform to allow an external Service to fetch selected data from the BONVOYAGE platform by means of well-documented service platform in a standard format. The project is to decide which categories and data-selection we allow for external release.	Data Interfacing	Data transfer service platform	Mandatory	All
BSP180	**Setting alerts**	Capability of BONVOYAGE platform to allow external service providers to set alerts in the BONVOYAGE platform for to be informed with new information.	Communication	Notifications	Priority 2	Transportation of goods
BSP190	**Questioning on available transport service providers**	Capability of BONVOYAGE platform to provide information on available transport service providers for delivery of goods.	Freight information	Freight information providing	Priority 1	Transportation of goods
BSP200	**Questioning on available goods to be delivered**	Capability of BONVOYAGE platform to provide information on available goods (e.g. origin, destination, date departure, date arrival, goods specifications) to be delivered.	Freight information	Freight information providing	Priority 2	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP210	**Place a bid**	Capability of service providers that connect to BONVOYAGE platform to place bids for available freight services to be delivered.	Freight exchange	Freight exchange bid	Priority 3	Transportation of goods
BSP220	**Asking for an optimal route for freight**	Capability of BONVOYAGE platform to provide to an external service provider with an optimal route for freight based on the characteristics, preferences and needs indicated by the user and external factors that influence on the route	Optimal freight route	Freight route	Mandatory	Transportation of goods

iv. Non-functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BSP140	**Real-time information lag**	Capability of BONVOYAGE platform to provide real-time information (e.g.: occupancy of loading/unloading areas, events occurred) with a maximum lag of 2 minutes. Time lag does not only depends on BONVOYAGE platform. However, if BONVOYAGE is not able to provide required information in this time lag, it will display service providers an error message. BONVOYAGE must have data available	Communication	Information provision	Mandatory	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
		to provide them to service providers.				
BSP150	**Easy handbook**	Capability of BONVOYAGE platform to provide an easy to understand handbook with the instructions to connect the service provider system with the BONVOYAGE service platform with samples based on use cases and short stories provided (web services invocation, registration steps…)	Communication	Handbook	Priority 3	All
BSP160	**Speed data transaction**	Minimum speed data transaction between the service provider system and the BONVOYAGE platform should be 2 seconds without considering network reaction time on the calculation algorithm.	Communication	Transactions	Priority 1	All
BSP170	**Data and communication security and integrity**	Capability of BONVOYAGE platform to ensure that all data and all communication towards the service providers are protected by international security standards so that nobody has the possibility to tamper information provided by BONVOYAGE.	Communication	Security	Mandatory	All

C. Technology providers

i. Functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BT10	**Authorisation profile management**	Capability of BONVOYAGE platform to manage authorisations for different profiles of system users operating on different channels. [System users refer to transport, travel operators and other service providers connecting to BONVOYAGE platform]	Personalisation	Identity management and application profile management	Mandatory	All
BT20	**Upload travel profile**	Capability of BONVOYAGE platform to include a new user travel profile to be used for travel solution research and travel document purchase.	Personalisation	Receive/Understand client commercial profile	Priority 1	All
BT30	**Define bonus identification/obligation**	Capability of BONVOYAGE platform to define rules to grant bonus through the combination of a pre-defined set of parameters/rules.	Personalisation	Receive/Understand client commercial profile	Priority 1	All
BT40	**Modify parameters used by the algorithms for the seat assignments**	Capability of BONVOYAGE platform to modify algorithm parameters used to determine seating allocation.	Travel solution, prices and commercial offers	Management of the algorithm parameters for the seat assignment	Priority 3	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BT50	**Provide information related to the service/ticket sold**	Capability of BONVOYAGE platform to display sales reports (according to hour, day, month, year, channel, sale point, electronic wallet).	Travel document and sales	Sales reporting	Priority 2	All
BT60	**Provide financial reporting for the profiling clients**	Capability of BONVOYAGE platform to retrieve periodic reports of purchases made by a profiled customer. Retrieved information relates to both invoiced and not-invoiced costs.	Travel document and sales	Financial reporting	Priority 1	All
BT70	**Purchase of a multi-modal travel solution**	In case of multimodal ticket purchase, capability of BONVOYAGE platform to lead the user through the purchase process step-by-step, allowing him to buy separately tickets for transport mode operated by different transport operators. When the user purchases the single ticket, BONVOYAGE immediately transfers the amount to the concerned transport operator, relating to the payment solution used.	Travel document and sales	Fare distribution	Priority 1	All
BT80	**Automatically notification of the presence of the inhibited trains**	Capability of BONVOYAGE platform to acquire information on the presence of public transport that cannot be reserved due to incomplete re-booking or to other situations that require operator intervention to restore reservation functionalities. [Decision made by transport operators. It is necessary to understand how this decision can be made available to BONVOYAGE platform].	Other functionalities	Other functionalities	Priority 3	Collective transport

ii. Non-functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BT71	**Purchase of a multi-modal travel solution in a pre-set amount of time**	In case of multimodal ticket purchase, capability of BONVOYAGE platform to allow the user to complete the purchase transaction within a pre-set amount of time.	Travel document and sales	Fare distribution	Priority 1	All

D. Transport information providers

i. Functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BTIP10	**Receive time schedule provided by the transport operators (timetable and its variations over time - VCO)**	Capability of BONVOYAGE platform to receive, upload and manage a time schedule provided by a transport information provider. Time schedule includes all the necessary information to provide the travel solution to the users: point of departure, point of arrival, time of departure, time of arrival, intermediate itinerary/stops, available service classes, ancillary services, available seats, seats map, tariffs, commercial offers, discounts (if available), possibility to select a seat, periodicity.	Public transport timetable and other information	Timetable upload	Mandatory	All
BTIP20	**Receive information / updates on progress of the vehicle flow provided to the platform BONVOYAGE**	Capability of BONVOYAGE platform to receive, upload and manage information (provided by transport operators) on delays planned on the medium-long term in order to: provide adequate information to the customer; offer effective travel solutions (new travel solutions following rescheduled timetables) in order to provide the user with a new updated travel solution.	Public transport timetable and other information	Timetable upload	Mandatory	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BTIP30	**Inventory Modification**	Capability of BONVOYAGE platform to receive and manage a modified list of services offered by transport operators (e.g. number of seats, type of seats, seats reserved for categories, ancillary/related services, commercial properties; extra luggage; luggage deposit; insurance; lounge access). Modifications to the list of services are made by transport operators.	Public transport timetable and other information	Services list	Priority 1	All
BTIP40	**Provide information related to the vehicle geographic coordinates**	Capability of BONVOYAGE platform to receive, upload and manage the effective geographic coordinates (point of departure, intermediate points, point of arrival) provided by a transport operator to exactly identify the departure, arrival, intermediate location of a public transport.	Public transport timetable and other information	Geographic coordinates	Mandatory	All
BTIP50	**Upload tariff profile offers and promotions**	Capability of BONVOYAGE platform to receive from transport operators information on tariffs profile, offers and promotions targeting different users and/or internalising negative externalities such as pollution and congestions. BONVOYAGE acquires rules defined by the transport operator for tariffs range to whom offers relate.	Travel solution, prices and commercial offers	Tariffs/promotion modification	Mandatory	All
BTIP60	**Cancel tariff profile offers and promotions**	Capability of BONVOYAGE platform to receive from transport operators instructions on tariffs profile, offers and promotions to be deleted.	Travel solution, prices and commercial offers	Tariffs/promotion modification	Mandatory	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BTIP70	**Modify tariff profile offers and promotions**	Capability of BONVOYAGE platform to receive from transport operators instructions on tariffs profile, offers and promotions to be modified (according to modifications decided by transport operators), while tracking all the operators involved in the process.	Travel solution, prices and commercial offers	Tariffs/promotion modification	Mandatory	All
BTIP80	**Define type of pricing (OD, per km, zone)**	Capability of BONVOYAGE platform to receive from transport operators rules to be followed for price building, based on necessary elements for tariffs, offers and promotions definition. All prices modifications shall be validated by the interested transport operator before operating.	Travel solution, prices and commercial offers	Price building	Mandatory	All
BTIP90	**Provide disabled passengers list**	Capability of BONVOYAGE platform to receive from transport operators the list of disabled people that have booked a seat on their transport means. BONVOYAGE will be also able to upload this list in its database and to manage it in order to have a correct and complete information on available disabled seat on a specific transport mean and provide correct information on available disabled seats to users (thus avoiding over-booking). [It is necessary to understand how BONVOYAGE interacts with transport	Passengers list	Passengers list providing	Mandatory	Individual transport; Collective transport

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
		operator platform].				
BTIP100	**Provide passengers list entitled to special services**	Capability of BONVOYAGE platform to receive, upload and manage the list of passengers having rights to special services provided by transport operators. [It is necessary to understand how BONVOYAGE interacts with transport operator platform].	Passengers list	Passengers list providing	Priority 3	Individual transport; Collective transport
BTIP120	**Information format**	Data shall be published on BONVOYAGE in a standard format by all the information provider. Each information provider shall autonomously convert its data into the standard format before publishing it on BONVOYAGE.	Data Interfacing	Data Formats specification	Mandatory	All
BTIP150	**TIP sending notifications**	Capability of the BONVOYAGE platform to let the Transport Information Provider to send notifications to the users (e.g.: sales, last-minute changes…)	Communication	Notifications	Priority 1	All
BTIP190	**Monitoring statistics of use**	Capability of BONVOYAGE platform to monitor the statistics of the users who have seen information related to the TIP (e.g.: How many users have consulted your company information last month)	Statistics	Statistics	Priority 3	All
BTIP200	**Provide information related to freight services**	Capability of BONVOYAGE platform to receive, upload and manage information about freight services (offered or demanded)	Info Freight	Freight Exchange	Priority 2	Transportation of goods

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
		Thus, if the information is deleted from the source, it automatically will be deleted from BONVOYAGE.				
BTIP210	**Provide information related to transport service providers**	Capability of BONVOYAGE platform to receive, upload and manage information about transport service providers for freight delivery (company, routes, timetable, special characteristics such us cold chain, contact details…)	Info Freight	Freight Service Information	Priority 1	Transportation of goods
BTIP220	**Sending bids to the TIP**	Capability of the BONVOYAGE platform to send the placed bids in the freight exchange auction to the Transport Information provider	Freight exchange	Sending bids	Priority 3	Transportation of goods
BTIP230	**Parcel track**	Capability of BONVOYAGE platform to allow the freight transport information provider to notify / to provide to BONVOYAGE platform information on the status of the parcel (in which location the parcel is)	Traceability support tool	Parcel path	Mandatory	Transportation of goods

ii. Non-functional requirements

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BTIP130	**Speed data transaction**	Minimum speed data transaction between the transport information provider system and the BONVOYAGE platform should be ~~3~~ 2 seconds without considering network reaction time on the calculation algorithm.	Communication	Information	Priority 1	All
BTIP140	**Easy handbook**	Capability to provide a how-to-use handbook to connect the transport information provider system / data to BONVOYAGE, and how to relate keywords with information to feed BONVOYAGE. Easy to understand handbook with the instructions to connect with the BONVOYAGE service platform with samples based on use cases and short stories provided (service platform information , web services invocation, registration steps…)	Communication	How-to-use	Priority 3	All
BTIP160	**Information Provenance**	The transport information provider shall have the possibility to bind its identity to the data it publishes	Communication	Security	Mandatory	All
BTIP170	**Information Confidentiality**	The information provider shall have the possibility to restrict the audience of data it publishes to certain categories of users only	Communication	Security	Priority 1	All

ID	TITLE	DESCRIPTION	CLUSTER	SUB-CLUSTER	PRIORITY	DOMAIN
BTIP180	**Information Mobility**	Capability of BONVOYAGE platform to allow the information provider to publish information coming from data sources that are mobile and temporarily connect and disconnect from the network	Communication	Mobility	Priority 1	All

E. FUNCTIONALITIES

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
ADD_INF	ADD_INFORMATION	This function allows the user to add new information such as traffic situation and transport status. The information is associated with the identity of the publisher and can be shared through the SHARE_INFORMATION functionality.	BU170, BU171, BU180	Mobility information management
ADD_OBJ	ADD_OBJECTIVE	This function allows the user to define an objective: calories, emissions or money.	BU450	Travel objective and target management
ADD_PIN	ADD_PLATFORM_INFORMATION	This function connects the BONVOYAGE platform with an Information Provider, taking care of (a) possible format conversion and (b) heterogeneous connecting technologies	BTIP120, BTIP130	Data Interfacing service
ADD_PSG	PASSENGER_ADD	This functionality is used to add a passenger to a travel solution	BU810	Travel solution management
APP_UFB	PUT_APP_USER_FEEDBACK	This functionality allows the end user to send a feedback notification on possible problems of the App (e.g.: problems with maps, places missing; feedback if misplaced), on how to improve the App, or to evaluate their quality of experience while using the App (cities, companies of mobility and transport supported by the JPA, information provided from the app, accuracy estimated time of arrival at destination, accurate arrival times for public transport, correct information on location and online, finding points of interest, suggestions).	BU960	Mobility information management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
AUTHO	AUTHORIZATION	Yes or No as output based on the customer authorization preferences, once it is required a particular function/operation with a Media (Laptop, Smartphone etc.)	BU100, BT10	Profile and account management
BIT_NOT	SET_BIDS_NOTIFICATION	This function activates/deactivates notification alerts for the Transport Information Provider when a bid takes place for a FREIGHT_SERVICE published by him	BTIP220	Passenger, freight and travel management
BLD_PRC	BUILD_PRICES	This function designs non-linear tariff schemes for multimodal transport networks to promote dynamically the use of socially desirable mobility services (e.g. those with low environmental impact) and incentivize the use of the most efficient (e.g. in terms of congestion externalities given the load capability) bundle of travel options.	BTIP80	Travel solution management
BLD_TPR	BUILD_TARIFF_PROFILE	This function designs the tariff profile associated to the user profile, the selected travel solution All data / information related to user 's travel solutions (historical travel solutions purchased and tickets details)	BTIP80	Membership management
CAL_TRP	CALCULATE_TRIP_SOLUTION	This function computes a family of optimal or near-optimal route alternatives from a given origin to one or more destinations. The function takes into account a number of query parameters, user constraints, and user commitments and uses these as constraints in the search. The user objectives are instead combined in the objective function to determine the quality of the solutions. The alternatives returned must be sufficiently different from each other, according to some predefined indicators.	BU171, BU320, BU330, BU340, BU341, BU350, BU360, BU370	Planning and travel itinerary management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
CNT_TRP	CONTROL_TRIP_SOLUTION	This function receives a set of routes to monitor and the occurring dynamic events and decodes whether one or more such routes are "sufficiently" affected by the events. In which case, it will return a request to the affected user(s) whether to calculate a new set of route alternatives. During the processing phase, monitored routes that are sufficiently affected by the dynamic events are identified: a. Routes that are not possible anymore b. Routes that will be delayed c. Routes that can be improved	BU171, BU370, BU371	Planning and travel itinerary management
CPR_SRC	CLIENT_PROFILE_SEARCHING	This function helps the transport operator to contact the costumer through personal contacts	BSP50	Profile and account management
CRT_OPR	CREATE_OPTIMIZED_ROUTE	This function allows the user to create an optimized route taking into account real time information like the traffic situation and the weather. The should be provided all the STOPPING_POINTS, each one should include: - Location - Available schedule - Estimated time to spend - Contact information: So the consignee will be notified (BV notification, SMS or mail) when the courier is approaching	BU1300, BU1330, BU1340, BU1360	Passenger, freight and travel management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
CSH_BOK	CAR_SHARING_BOOK	This functionality is used to book a car sharing service on the basis of a given travel solution.	BU490	Travel solution management
CTR_CRE	COLLECTIVE_TRAVEL_CREATE	This functionality creates a new collective travel request	BTIP100, BTIP90, BSP60, BSP70, BSP80, BSP90, BSP100, BSP110	Passenger, freight and travel management
CTR_UPD	COLLECTIVE_TRAVEL_UPDATE	This functionality allows the modification of any attribute of a collective travel request	BTIP100, BTIP90, BSP60, BSP70, BSP80, BSP90, BSP100, BSP110	Passenger, freight and travel management
CUS_TIC_PUR	CUSTOMISED_TICKET_PURCHASE	This functionality allows the user to select a travel solution based on her/his travel preferences (e.g. passenger category, best tariff, class choice, seat choice…)., visualize discounts/promotions/alternative options available for that travel solution and purchase a customized ticket (e.g. passenger category, best tariff, class choice, seat choice…).	BU640, BU650, BU660, BU670, BU680, BU690	Travel option purchase service
DEF_BIO	DEFINE_BONUS_IDENTIFICATION /OBLIGATION	This function is aimed at updating the user bonus based on its last choices (e.g. trip), given the BONVOYAGE bonus framework	BT30	Profile and account management
DEF_STP	DEFINE_STATIC_PARAMETERS	This function defines the static parameters needed for the implementation of the search algorithm in SRC_ENG.	BU440	Travel objective and target management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
DEL_DSC	DELETE_DISCOUNTS	This function allows any transport operator TROP_ID, given a REQUEST, to cancel any tariff profile discounts, offers and promotions in the current list of DISCOUNTS for each TARIFF_PROFILE.	BTIP60	Travel solution management
DEL_OBJ	DELETE_OBJECTIVE	This functionality is used to delete one objective	BU470	Travel objective and target management
DLV_INF	DELIVER_INFORMATION	This function delivers an information piece to a specified recipient.	BTIP180, BU110, BU120, BU130, BU140, BU1220, BU1230, BU1240, BU1260, BU1270, BU1280, BU1290, BSP60, BSP70, BSP80, BSP90, BSP100, BSP110, BSP140, BSP150, BSP160, BSP170, BSP180, BTIP150, BTIP160, BTIP170	Communication service
DSP_DRV	DISPLAY_DRIVER_INFORMATION	This function allows the user to see the complete profile of a driver who wants to subcontract	BU1090, BU1200	Travel solution information and visualization
DSP_FRG	DISPLAY_FREIGHT_SERVICE	This function allows the user to see a complete description of the available FREIGHT_SERVICE to be delivered	BU1070	Travel solution information and visualization
DSP_FRR	DISPLAY_FREIGHT_RESPONSIBLE	This function allows the user to see a complete description of the FREIGHT_SERVICE responsible	BU1110	Travel solution information and visualization

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
EXP_PIN	EXPOSE_PLATFORM_INFORMATION	This function exposes to external applications or Service providers selected, aggregated data which is available within the BONVOYAGE platform. It makes the platform behave as a data source for others. It allows the external Service provider to fetch a set of selected data from the BONVOYAGE platform by means of well-documented service platform in a standard format.	BSP130	Data interfacing service
EXS_REM	EXTRA_SERVICE_CANCELLATION	This functionality is used to remove extra services from a travel solution	BU850	Travel solution management
FAV_DRV	MARK_FAVOURITE_DRIVER	This function allows the user to mark a DRIVER as favourite	BU1190	Passenger, freight and travel management
FAV_FRG	MARK_FAVOURITE_FREIGHT	This function allows the user to mark a freight service as favourite	BU1150	Passenger, freight and travel management
FGT_OPT	FREIGHT_OPERATOR	This function keeps track of transports made by a single freight transport operator (both company and single driver) and of related results (e.g. volumes). Freight transport operator features (e.g. number of tracks, past experiences) and feedback are shown as results of the research a user has made on available freight services.	BU1390	Mobility information management
FIL_INF	SET_FILTER_INFORMATION	This function allows the user to set, from a planned route (collective or individual transport including freight drivers), a filtered notifications system (push) to be informed when is on the go, about transportation and state of the traffic.	BU200	Mobility information management
GET_AWA	GET_GIFTS	This function returns the list of Awards for a given user	BU1020	Membership management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
GET_CIS	GET_CIRCULATION_STATUS	This function allows the Service Provider to get information on the status of the circulation	BSP120	Mobility information management
GET_FBF	GET_FEEDBACK_ON_FREIGHT	This function returns the feedback about quality of service and freight transport operator provided by a user	BU1370	Mobility information management
GET_MYS	VIEW_MY_SCORE	This function returns the user points/scores for all the scores of a given user.	BU1010	Membership management
GET_OPR	GET_OPTIMIZED_ROUTE	This function allows the Service Provider to get an optimized route providing the STOPPING_POINTS information	BSP220	Travel solution information and visualization
GET_SCR	GET_SCORE	This function returns the user points/scores for a given score identifier.	BU1010	Membership management
GET_SRK	VIEW_SCORE_RANK	This function returns a ranked list of the best rated scores.	BU1010	Membership management
GET_STA	GET_STATISTICS	This function allows the Transport Information Providers to get the statistics about the use of their information in BONVOYAGE (e.g.: How many users have consulted your company information last month)	BTIP190	Passenger, freight and travel management
GET_TSS	GET_TIMESCHEDULE_SERVICE	This function allows the Service provider to get on-time time schedule for a specific service (e.g.: a specific flight)	BSP10, BSP20, BSP30, BSP40	Mobility information management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
GET_UFB	GET_TRAVEL_SOLUTION_USER_FEEDBACK	This functionality allows the end user to get feedback on a specific travel itinerary uploaded and shared by other users. Feedback can be provided by the user only if he has concretely experienced a travel solution.	BU961	Mobility information management
GET_USC	GET_USER_SCORE	This function provides the score associated to a given user	BU990	Membership management
GTR_CRE	GOODS_TRAVEL_CREATE	This functionality creates a new goods travel request	BTIP100, BSP220	Passenger, freight and travel management
GTR_UPD	GOODS_TRAVEL_UPDATE	This functionality allows the modification of any attribute of a goods travel request	BTIP100	Passenger, freight and travel management
INF_VIS	INFORMATION_VISUALIZATION	This function allows the user to display in a device/technology neutral information like weather, POIs, checkpoints…	BTIP140, BU190	Mobility information management
ITR_CRE	INDIVIDUAL_TRAVEL_CREATE	This functionality creates a new individual travel request	BT50, BU320, BU321, BU330, BSP100, BSP110	Passenger, freight and travel management
ITR_UPD	INDIVIDUAL_TRAVEL_UPDATE	This functionality allows the modification of any attribute of an individual travel request	BT50, BU320, BU321, BU330, BSP100, BSP110	Passenger, freight and travel management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
LEI_LOC_PUR	LEISURE_LOCAL_SERVICES_PURCHASE	This functionality allows the user the possibility to buy ancillary solutions which can include both local (municipal services) and leisure (recreational services) services.	BU770, BU780	Travel option purchase service
LPT_TIC	LPT_TICKET	This functionality enables the creation of LPT travel documents whose tariff can be paid through Smart Card, EMV credit card, NFC and bar code technology; travel documents can be also validated by the same tools.	BU890, BU900	Payment and reimbursement service
LPT_VAL	LPT_VALIDATION	This functionality enables the validation of a Local Public Transport ticket, stored in the user BONVOYAGE App, and whose tariff has already been paid by the user (BU870) or is going to be charged to the user only after the user has completed his journey on the local public transport (BU880).	BU870, BU880	Payment and reimbursement service
MAP_LAY	MAP_LAYER	This function allows viewing of tiles on a smartphone or web app. Suggested is to follow the OGC Web Map Tile Service (WMTS) standard version 1.0.0.	BU260, BU261, BU270, BU280, BU290	Maps management
MOB_SER_PUR	MOBILITY_SERVICES_PURCHASE	This functionality allows the user to purchase a set of additional mobility services which can be furthermore associated with the pre-identified travel solution and enter inquiry to book in a waiting list services not available.	BU730, BU740, BU750, BU760	Travel option purchase service
MOD_DSC	MODIFY_DISCOUNTS	This function allows any transport operator TROP_ID, given a REQUEST, to modify any tariff profile discounts, offers and promotions in the current list of DISCOUNTS for each TARIFF_PROFILE. Moreover, this function accurately tracks all the transport operators involved in the process and identified by the TROP_IDs: as a result, the OVERALL_BEHAVIOUR signal is provided as output.	BTIP70	Travel solution management
MOD_SAP	MODIFY_SEATASSIGN_PARAMS	This function modifies the vector of SEAT_ASSIGNMENT_PARAMS according to the STRATEGY_SUGGESTION signal, depending on the specific USER_PROFILE and the available TRAVEL_SOLUTIONs.	BT40	Travel solution management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
MON_DVR	MONITOR_DELIVERY_ROUTE	This function allows the Transport Operator (the freight company) monitor (in real time) the delivery route in the TRACEABILITY_SUPPORT_TOOL_SERVICE	BU1430	Mobility information management
NVG_OPR	NAVIGATION_OPTIMIZED_ROUTE	This function allows the user to start a navigation turn-by-turn (UC_01) from the calculated optimized route	BU1350	Passenger, freight and travel management
NVG_TZR	NAVIGATION_TRACEABILITY_TOOL	This functionality allows the driver to start a navigation turn-by-turn (UC_01) taking as reference the information of a TRACEABILITY_SUPPORT_TOOL_SERVICE (consignee's address)	BU1420, BU1430	Passenger, freight and travel management
ONT_VIS	ONTRIP_VISUALIZATION	This function is used by the user to visualize the route on the map followed by the transport mean (on-trip) and its current location.	BU390	Travel solution information and visualization
PAC_TRA	PARCEL_TRACKING	This functionality allows the freight transport information provider to notify / to provide to BONVOYAGE platform information on the status (location) of the parcel. Moreover this functionality lets the "addressee user" to track and monitor the parcel path until the delivery is finalised; it also allows "the sender user" to receive a notification about delivery finalisation.	BU1450, BU1460, BU1460, BTIP230	Mobility information management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
PAR_OFF	PARTNERS_OFFERS	This functionality enables the user to be informed on and to get available promotions and discounts offered from partners of BONVOYAGE platform transport operators. The functionality requires two types of input parameters: information related to the partner of BONVOYAGE platform transport operators, concerning especially the promotion and discounts offered for specific services/events; information on the BONVOYAGE user, that are essential to allow BONVOYAGE platform to distinguish and select discounts and promotions of possible interest for the user in order to send him notifications targeted to his profile and preferences.	BU30, BU690, BU1020	Partnership
PAR_SER	PARTNERS_SERVICES	This functionality allows the user to book services provided by partners of transport operators integrated into the BONVOYAGE Platform.	BU790	Travel option purchase service
PHT_DVN	PHOTO_DELIVERY_NOTE	This function allows the driver to take a photo of the physical delivery note and include it in the TRACEABILITY_SUPPORT_TOOL_SERVICE	BU1480	Mobility information management
PRF_CTE	PROFILE_CREATE	This function creates a user profile with account information	BU80, BU90	Profile and account management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
PRF_DTE	PROFILE_DELETE	This functionality deletes a profile registry, mainly for management purposes	BU80, BU90	Profile and account management
PRF_UTE	PROFILE_UPDATE	This functionality allows modifying existing profile information	BU80, BU90	Profile and account management
PRO_USE_PUR	PROFILED_USER_PURCHASES	This functionality allows the technology provider to display the list of purchases made by the profiled customer in the selected timeline. For each purchase, the following information is showed: Purchase date; Travel solution description; Travel solution ID code; Amount; Invoiced / not invoiced (with possibility to display invoice details).	BT60	Travel document management
PRV_VAS	PROVIDE_VIRTUAL_ASSISTANCE	This functionality allows the BONVOYAGE platform to get in contact, if possible, with the end user providing some vertical information to assist the user in case of problems. This function also allows the user to ask for road side assistance, in case of necessity, through the BONVOYAGE Platform. As a result of her/his request, the user will receive the help needed. The user sends the request for assistance by simply pushing a button on the BONVOYAGE App.	BU980, BU251	Mobility information management
PSS_CTE	PASSENGER_CREATE	This functionality creates a passenger entity linked with a profile for a new user	BU10, BU11, BU20, BU40, BU50, BU60, BU70, BU71, BU150, BU151	Profile and account management
PSS_UTE	PASSENGER_UPDATE	This functionality allows the system to edit an existing passenger	BU10, BU11, BU20, BU40, BU50, BU60, BU70, BU71, BU150, BU151	Profile and account management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
PUB_INF	PUBLISH_INFORMATION	This function publishes a piece of information. The information is associated with the identity of the publisher. The information is published under the specified name. The information can be encrypted so that only recipients possessing certain certified properties can decrypt it.	BTIP180, BU110, BU120, BU130, BU140, (incorporated here BU1220, BU1230, BU1240, BU1260, BU1270, BU1280, BU1290, BSP140, BSP150, BSP160, BSP170, BSP180, BTIP150, BTIP160, BTIP170 according to Tropea's email), BT80	Communication service
PUR_TIC	PURCHASE_TICKET	This functionality allows the user to: select his preferred payment modality when he decides to purchase a ticket/travel solution; choose among four different payment options (credit card, debit card, e-Wallet, PayPal); select the preferred type of reception of the ticket and the ID code of the travel solution on his smart phone or other mobile device whenever he finalizes the purchase (SMS, email, 2D code, QR code). The functionality also enables the user to get information on commercial conditions (e.g. refund, compensation) as defined by the relevant transport operator.	BU510, BU520, BU530, BU540, BU550, BU560	Ticket purchase service
PUT_BID	PUT_BID	This function allows the Service Provider to put a bid in one available FREIGHT_SERVICE in the BONVOYAGE platform according to some	BSP210	Passenger, freight and travel management
PUT_SCR	PUT_SCORE	This function stores the user's usage of the BONVOYAGE system to gather points/scores.	BU1000	Membership management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
PUT_UFB	PUT_TRAVEL_SOLUTION_USER_FEEDBACK	This functionality allows the end user to insert and share his feedback on the travel solution he obtained for a specific itinerary. Feedback can be provided by the user only if he has concretely experienced a travel solution. Hence the target travel solutions are stored in the user profile.	BU961, BU970	Mobility information management
REM_PSG	PASSENGER_REMOVE	This functionality is used to remove a passenger from a travel solution	BU830	Travel solution management
RMV_INF	REMOVE_INFORMATION	This function allows the Transport Operator to remove information (previously uploaded by the TO) from the BONVOYAGE platform	BTIP10, BTIP20, BTIP30, BTIP40, BTIP200	Public transport service
ROU_VIS	ROUTE_INFO_VISUALIZATION	This functionality will show all information related to a travel solution (pre-trip) like cost, codes of public transport, source-destination.	BU380, BU390, BU400	Travel solution information and visualization
RST_USC	RESET_USER_SCORE	This function reset the score associated to a given user. The new score will be the initial one	BU990	Membership management
SAL_TPP	SALES_2	This functionality allows the technology provider to display the sales report containing information on total sold amount, cancelled refunded amount (if any), passengers number with respect to a specific aggregation cluster: timeline (hour/day/month/year); transport mean/service type; channel/selling point; e-Wallet; Start date and end date of the search timeline.	BT50	Travel document management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
SAL_USR	SALES _1	This functionality allows the user to access to sales basic information to support audits, information provision to Public Security Authorities, complaints management.	BU620	Travel document management
SCORE	SCORE	This function allows the user to accumulate points from achieved targets that was created by the ADD_OBJECTIVE function	BU450	Travel objective and target management
SEL_TRS	SELECTED_TRAVEL_SOLUTION	This functionality is used to inform the BONVOYAGE platform about which travel solution has been chosen, on the base of a given set of search parameters and a given user profile. This information can be used to learn more about the user profile selection behaviour and related preferences, so that the user profile can be updated.	BU480	Travel solution management
SET_FBF	SET_FEEDBACK_ON_FREIGHT	This function enables the user to provide own feedback about quality of service and freight transport operator	BU1370	Mobility information management
SET_SPL	SET_SCORE_POLICY	This function sets the score assignment policy	BU1010	Membership management
SET_USC	SET_USER_SCORE	This function sets an initial score associated to a given user.	BU990	Membership management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
SGN_DVN	SIGN_DELIVERY_NOTE	This function allows the consignee to sign the electronic delivery note in the mobile handset screen	BU1470	Mobility information management
SHR_INF	SHARE_INFORMATION	This function allows the user to share with others (users or applications) all the information displayed in their devices resulting from previous searches (e.g.: route trip information); public transport information (status, lines...); Stored information (contacts, favourites POI), current location...	BU160, BU170, BU171, BU190, BU210, BU220 BU300, BU310	Mobility information management
SHW_PRG	SHOW_PROGRESS	This function shows progress towards the achieving of the objective and the pre-set time	BU460	Travel objective and target management
SND_DVN	SEND_DELIVERY_NOTE	This function allows the driver to send the delivery note included in the TRACEABILITY_SUPPORT_TOOL_SERVICE	BU1460, BU1480	Mobility information management
SRC_DRV	SEARCH_DRIVER	This function allows the user to search available drivers to be subcontracted (for a service or for a long term) and to filter and sort the results according to SEARCH_PARAMETERS	BU1080, BU1100, BU1120, BU1140, BU1160, BU1170, BU1180	Mobility information management
SRC_ENG	SEARCH_ENGINE	This function runs a travel solution search algorithm which is in charge of selecting/rejecting travel solutions according to the specific USER_PROFILE.	BU440	Travel objective and target management
SRC_FRG	SEARCH_FREIGHT	This function allows the user to search available freight services to be contracted and to filter and sort the results according to SEARCH_PARAMETERS	BU1050, BU1060, BU1120, BU1140, BSP190, BSP200	Mobility information management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
SRC_LOC	SEARCH_LOCATION	This function receives a request to find an address or a POI in order to search for routes or transport stops nearby etc..	BU230, BU240, BU241, BU250, BU291	Geolocation service
STP_INF	PT_STOP_INFORMATION_VISUALIZATION	This functionality is used to visualize the information of a specific public transport stop (scheduling, departing and arriving programmed, Interconnection with other modes of public transport…) and the arrival time.	BU410, BU420, BU430	Travel solution information and visualization
STP_VIS	PT_STOPS_LOCATION_VISUALIZATION	This function is used to visualize on the map the location of the public transport stops.	BU410, BU420, BU430, BU421	Travel solution information and visualization
SUB_INF	SUBSCRIBE_INFORMATION	This function subscribes to a piece of information. The subscription is created (or removed) for a specific information piece. A flag indicates creation or removal of the subscription.	BTIP180, BU110, BU120, BU130, BU140, BU1220, BU1230, BU1240, BU1260, BU1270, BU1280, BU1290, BSP140, BSP150, BSP160, BSP170, BSP180, BTIP150, BTIP160, BTIP170, BT80	Communication service
SVE_DRV	SAVE_DRIVER	This function allows the user to save a DRIVER in a CUSTOMIZED_LIST	BU1210	Profile and account management
SVE_FRG	SAVE_FREIGHT	This function allows the user to save a FREIGHT_SERVICE in a customized list	BU1150	Profile and account management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
SVE_OPR	SAVE_OPTIMIZED_ROUTE	This function allows the user to save the OPTIMIZED_ROUTE generated by BONVOYAGE	BU1310	Profile and account management
SVE_SRC	SAVE_SEARCH	This function allows the user to save the current search in a customized list	BU1130	Profile and account management
SWI_CUR	SWITCH_CURRENCY	This functionality allows the user to access a currency converter proposing the local (geo-referred) currency as first option whenever he has to purchase a ticket or a travel solution.	BU1040	Mobility information management
SWI_LAN	SWITCH_LANGUAGE	This functionality allows the user to access a language converter proposing the local (geo-referred) language as first option whenever he uses the BONVOYAGE platform.	BU1030	Mobility information management
SYN_INF	SYNC_INFORMATION	This function keeps two information pieces in sync. Whenever one of the information pieces changes, all changes are propagated to the other.	BU910, BU911, BU920, BU930, BU940, BU950, BU960, BU1220, BU1230, BU1240, BU1260, BU1270, BU1280, BU1290, BSP60, BSP70, BSP80, BSP90, BSP140, BSP150, BSP160, BSP170, BSP180, BTIP150, BTIP160, BTIP170, BT80	Communication service
TAR_TRA	TARIFF_TRANSFER	(While the user purchases an integrated ticket) this functionality allows the technology provider to transfer from BONVOYAGE platform to the single transport operator the amount related to the transport mode it operates and for which the user has purchased a ticket through BONVOYAGE platform.	BT70, BT70a, BT71	Travel document management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
TCH_UFB	PUT_TRAVEL_CHUNK_USER_FEEDBACK	This functionality allows the end user to insert his feedback on the travel chunk (that is a sub-part of the overall travel solution) he obtained for a specific itinerary; Feedback can be provided by the user only if he has concretely experienced a travel solution.	BU970	User feedback and profile management
TIC_COD_CHA	TICKET_CODE_CHANGES	This functionality enables to track and display original travel identification code and additional travel change booking code (changes incurred in case the user modifies the original purchased travel solution across time). This functionality allows the user also to visualise the timestamp related to year, date and hour of original purchase and changes occurred.	BU590	Travel document management
TIC_CRE	TICKET_CREATION	This functionality allows BONVOYAGE to create a travel document based on input parameters “deduced and assembled” by BONVOYAGE platform on the basis of: information provided by the user to search for a travel solution; data related to the travel solution selected and purchased by the user.	BU570, BU580	Travel document management
TIC_DET	TICKETS_DETAILS	This functionality allows the user to display all the details related to the purchased tickets/travel solutions accessing to an “Historical” section ; moreover this functionality allows the user to share the purchased tickets /travel solutions with the Wallet up available on his smartphone.	BU600, BU610	Ticket purchase service

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
TIC_MOD	TICKET_MODIFICATION	This functionality allows the user to modify / cancel a travel seat already booked or a service purchased and associated to a travel solution.	BU700, BU710, BU720	Travel option purchase service
TIC_REI	TICKET_REIMBURSEMENT	This functionality allows the user to receive a reimbursement of a purchased travel solution on his credit/debit card, PayPal account, e-Wallet.	BU860	Payment and reimbursement service
TRC_TOO	TRACEABILITY_SUPPORT_TOOL	This function allows to create a TRACEABILITY_SUPPORT_TOOL_SERVICE in order to improve the traceability of the shipment of goods for subcontracted drivers. The necessary inputs are: - SERVICE_INFORMATION: Sender, consignee, date, weight, observations, BONVOYAGE Driver id - DELIVERY_NOTE: An e-note created in the Transport Operator back office; An e-note created by BONVOYAGE based on the introduced data by the Transport Operator; or empty, waiting for the attachment of an image of the signed note (different formats: .pdf, .tiff…)	BU1440, BU1490	Mobility information management
TRS_EXT	TRAVEL_SOLUTION_EXTENSION	This functionality, is used to modify a travel solution with additional info regarding the whole travel	BU820	Travel solution management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
TRS_FIN	TRAVEL_SOLUTION_FINALIZATION	This functionality is used to confirm the purchase of a travel solution plus additional selected services	BU500, BU520, BU530, BU540, BU550	Travel solution management
TRS_MOD	TRAVEL_SOLUTION_MODIFICATION	This functionality is used to modify a purchased travel solution with additional selected services	BU800	Travel solution management
TRS_REM	TRAVEL_SOLUTION_CANCELLATION	This functionality is used to modify a travel solution removing parts of the travel solution	BU840	Travel solution management
TRV_MEM	TRAVEL_SETTING_MEMORANDUM	This function allows the user to set a memorandum of the travel in the calendar and the possibility to receive notifications under MEMORANDUM_PREFERENCES (e.g. 1h before departure, in station with list of booking codes).	BU630	Travel solution information and visualization
UPD_INF	UPDATE_INFORMATION	This function allows the Transport Operator to update the route initially uploaded, and the option of maintaining previous versions on BONVOYAGE platform.	BTIP10, BTIP20, BTIP30, BTIP40, BTIP200	Public transport service
UPD_OPR	UPDATE_OPTIMIZED_ROUTE	This function allows the user to modify a created optimized route by changing some parameters and recalculating it	BU1320	Travel objective and target management
UPD_USC	UPDATE_USER_SCORE	This function updates the score associated to a given user by adding a given value to the previous score	BU990	Membership management

ID	NAME	DESCRIPTION	ADDRESSED REQUIREMENTS	MODULE
UPL_DSC	UPLOAD_DISCOUNTS	This function allows any transport operator TROP_ID, given a REQUEST, to upload a list of DISCOUNTS including tariff profile discounts, offers and promotions for each TARIFF_PROFILE.	BTIP50	Travel solution management
UPL_INF	UPLOAD_INFORMATION	This function allows the Transport Operator to upload information to the BONVOYAGE platform like time schedules, list of services, list of existing ticket prices and offers, etc.	BTIP10, BTIP30, BTIP40, BTIP200	Public transport service
UPL_TPR	UPLOAD_TRAVEL_PROFILE	Update of the user profile based on its last choices (source and destination of the trip)	BT20, BU440, BTIP80	User feedback and profile management
USE_SHR	USE_SHARED_INFORMATION	This function allows the user to use information shared by others, giving him a list of possible actions.	BU160	Mobility information management
VAL_PRC	VALIDATE_PRICES	This function validates the PRICES chosen by BLD_PRC, thus providing the FINAL_PRICES, which are ready for the subsequent operation phase.	BTIP80	Travel solution management
DIS_INF	DISCOVER_INFORMATION	This function is used to discover what kind of data sources (for instance published schedules or real-time feeds) are available in a certain region or matching a set of search criteria	BU20, BU100	Communication service
VER_INF	VERIFY_INFORMATION	This function verifies that an information piece has been published by the claimed publisher, that it has not been tampered with, and that it can be decrypted by the recipient based on recipient's attributes.	BU20, BU100	Security management

F. USE CASES

i. UC_00 table

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_00_01	*Passenger registering and creating an account on BONVOYAGE platform, choosing to perform only the basic registration or completing an existing account*	*This Use Cases illustrates how a user can: register and create his account on BONVOYAGE platform ("basic profile"); deepen his existing profile providing additional data; authorise BONVOYAGE platform to share his data.*
UC_00_02	*Passenger updating his account on BONVOYAGE platform*	*This Use Case shows how a user can update his account on BONVOYAGE platform through: creation of a list of favourite addresses / places /events; display of gained fidelity scores; association of a status / emoticon to his profile.*
UC_00_03	*Passenger associating a status to his profile and sharing it through Social network*	*This Use Case describes how a user can link a status / emoticon to his BONVOYAGE profile and share it on social networks.*
UC_00_04	*Passenger inviting friends to join BONVOYAGE platform*	*This Use Case shows how a user can invite friends to join BONVOYAGE platform.*
UC_00_05	*Passenger making "friendships" on BONVOYAGE platform*	*This Use Case shows how a user can establish friendships on BONVOYAGE platform.*

ii. UC_01 table

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_01_01	*Private or professional car driver*	*The Use Case describes how a user (pre- and on-trip) can utilise the BONVOYAGE platform to check travel planning options and get fresh information about traffic, incidents and rerouting options when necessary.*
UC_01_02	*City bike renting student*	*The Use Case describes how a user (pre- and on-trip) can utilise the BONVOYAGE platform for route planning for bikes and the availability of bikes racks and bike. In the Use Case the platform can also be used for combining cycling with PT-travel.*
UC_01_03	*Private or professional driver requiring road assistance through BONVOYAGE platform*	*The Use Case describes how a user can send a request for road assistance through the BONVOYAGE platform*

iii. UC_02 table

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_02_01	*Passenger planning an intermodal journey with public transports*	*This Use Case describes how a user can: plan and a journey / travel itinerary from point A to B using public transports and according to his travel preferences; display and select his preferred travel solution.*
UC_02_02	*Passenger displaying scores gained using the systems available on BONVOYAGE platform*	*This Use Case shows how a user can display scores him has gained through BONVOYAGE platform.*
UC_02_03	*Passenger needing to re-plan his journey path due to unforeseen events*	*This Use Case describes how a user, who is already on-trip, can use BONVOYAGE platform to: check updates on public transport circulation on*

UC ID	USE CASE NAME	SHORT DESCRIPTION
		BONVOYAGE platform; re-plan his journey real-time; display alternative travel solutions.
UC_02_04	*Passenger wanting to be informed on events he may be interested in, also in relation to a trip he has already planned*	*This Use Case applies to both a pre-trip and on-trip situation and describes how a passenger can use BONVOYAGE platform to: look for events taking place in his destination city he may be interested in; purchase a ticket for selected events.* *The Use Case also describes how BONVOYAGE platform notifies the user on possible trips (and related travel solutions) associated to a specific event.*
UC_02_05	*Passenger searching for an intermodal travel solution through filter selection*	*This Use Case illustrates how a user can search for a customised travel solution through BONVOYAGE platform.*
UC_02_06	*Passenger planning a travel solution considering other users' feedback*	*This Use Case describes how a user can display feedback on a specific travel itinerary uploaded and shared by other users in order to make an informed decision on the travel solution to select.*
UC_02_07	*Passenger planning a travel solution asking other users tips by chatting*	*This Use Case outlines how a user can interact with other BONVOYAGE users in order to ask them suggestions and / or feedback on a travel solution they have already experienced.*
UC_02_08	*Passenger purchasing an intermodal travel itinerary according to his preferences*	*This Use Case shows how a user can perform a multitude of tasks related to a travel solution booking and purchase, namely: display of available discounts / promotions; seat selection; ticket purchase and reception; finalised purchase notification reception.*
UC_02_09	*Passenger setting a travel memorandum*	*This Use Case illustrates how the user can set up a travel memorandum on BONVOYAGE platform.*

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_02_10	*Passenger displaying the nearest collective/public transport stations to his point of departure and arrival*	*This Use Case describes how a user can use BONVOYAGE platform to: display on a map the nearest public transport stations to his current location; for each station, departing and arrival public transport schedule.*
UC_02_11	*Passenger applying filters to receive "push" information related to a specific route.*	*This use-case describes how the user can apply a set of filters to regulate the type and the timing of information received by BONVOYAGE platform, in order to receive alerts and information related to the route he is going or he wants to go through.*
UC_02_12	*Passenger searching for information shared by other users with respect to a specific route in order to get updates on his journey/itinerary*	*This Use Case describes how a user can display information shared by other users regarding his daily route.*
UC_02_13	*Accessing to restricted areas through alternative travel solutions purchase*	*This Use Case shows how a user can purchase an alternative mobility services, namely the access to urban limited traffic zones.*
UC_02_14	*Passenger sharing information before a journey*	*This Use Case outlines how a user can: share on BONVOYAGE platform his travel itinerary and several information related to his journey; check information circulation for his travel itinerary.*
UC_02_15	*Passenger searching stops and routes of public transports, providing BONVOYAGE his localisation*	*This Use Case describes how a user can perform the following tasks enabled by BONVOYAGE platform: display of an urban public transport stops, considering his geographical position; display the travel schedule (arrival time, stops) of each public transport line; display the time required to reach his destination considering the route selected.*

UC ID	Use Case Name	Short Description
UC_02_16	*Passenger modifying a purchased travel solution*	*This Use Case shows how a user can modify a travel solution purchased through BONVOYAGE platform.*
UC_02_17	*Passenger synchronizing events stored on his calendar or on social networks*	*This Use Case shows how a user can synchronize an event already inserted on his smart phone calendar and / or social network on BONVOYAGE platform; set a reminder linked to the event (reminder will be sent through BONVOYAGE platform).*
UC_02_18	*Passenger selecting different options during the ticket purchase*	*This Use Case outlines how a user can perform a multitude of tasks while purchasing a public transport ticket, namely: selecting the type and the number of passengers; selecting the best rate using a fidelity card; selecting his preferred class; selecting the best price.*
UC_02_19	*Collecting scores and receiving awards.*	*This use-case illustrates in which cases BONVOYAGE attributes points/scores to the user; how the user can check his score and the score of others users; how the user can collects scores in order to receive an award.*
UC_02_20	*Passenger adding further requests to a pre-identified itinerary*	*This case shows how a user can update a travel solution he has already purchased by: adding passengers; adding a new travel solution.*
UC_02_21	*Deleting pre-identified travel requests*	*This Use Case describes how a user can: delete passengers to a pre-identified travel solution; delete a travel solution from a pre-identified travel; delete additional services from travel solution*
UC_02_22	*Passenger purchasing ancillary services*	*This Use Case illustrates how a user can purchase ancillary services linked to a travel solution he has previously purchased. Ancillary services include: leisure services; local services (municipal services); other additional services.*

UC ID	Use Case Name	Short Description
UC_02_23	*Passenger defining and cancelling user objectives*	*This Use Case describes how a user can: define objectives to be achieved in relation to a specific or a plurality of travel solutions purchased and experienced through BONVOYAGE platform; monitor progress towards achieving the objectives; delete pre-set objectives.*
UC_02_24	*Passenger receiving notifications/proposal to purchase travel solutions related to his profile*	*This Use Case outlines how BONVOYAGE platform sends the user notifications to propose him to purchase to additional services related to his travel solution (e.g. destination city LPT ticket, museum tickets).*
UC_02_25	*Passenger receiving BONVOYAGE periodic newsletter*	*This Use Case shows how BONVOYAGE platform notifies the user on its news through periodic newsletter. This contains information on new transport operators / service providers that have joined BONVOYAGE platform and new services offered through the platform.*
UC_02_26	*Passenger applying setting to define the kind of information to be received through notifications*	*This Use Case describes how a user can apply settings to define the type of information to be received by BONVOYAGE platform*
UC_02_27	*Passenger using the "Add me on travel" functionality*	*This Use Case shows how a user can perform several tasks related to travel solution information sharing with his friends through BONVOYAGE platform. Information includes: route information (e.g.: travel time, estimated time of arrival) and location; address associated with contact phone / smart phone (which then becomes the starting address / travel destination); place reserved on the means of transport with his friends; favourite places with other applications that require location information; his location.*
UC_02_28	*Passenger changing the default preferred*	*This Use Case shows how a user modify the default preferred language he has*

UC ID	Use Case Name	Short Description
	language	*chosen during the registration to BONVOYAGE platform.*
UC_02_29	*Passenger looking for commercial conditions related to a travel solution he has purchased*	*This Use Case describes how a user can search and display commercial conditions associated to his travel solution through BONVOYAGE platform.*
UC_02_30	*Passenger sharing the ticket purchased through BONVOYAGE with another Wallet up he has downloaded on his smartphone*	*This use outlines how a user can share the purchased ticket with a Wallet App on his smart phone.*
UC_02_31	*Passenger purchasing a LPT ticket that can be e validated through Smart Card/EMV credit card/NFC /bar code technology*	*This Use Case describes how BONVOYAGE platform can create a travel document containing a LPT ticket that can be validated through Smart Card, EMV credit card, NFC and bar code technology.*
UC_02_32	*Passenger purchasing a LPT ticket whose tariff can be paid through Smart Card, EMV credit card, NFC and bar code technology*	*This Use Case shows how BONVOYAGE platform can create a travel document containing a LPT ticket whose tariff can be paid through Smart Card, EMV credit card, NFC and bar code technology.*
UC_02_33	*Passenger wanting to modify a purchased travel solution*	*This Use Case describes how a user can modify the purchased travel solution by: modifying/deleting the assigned/reserved seat; modifying/deleting services associated to the travel solution.*
UC_02_34	*Passenger wanting to book services managed by partners of BONVOYAGE transport operators*	*This Use Case describes how a user can purchase a service provided by partners of BONVOYAGE platform transport operators.*
UC_02_35	*Passenger wanting to get a travel solution refund*	*This Use Case outlines how a user can ask for and get refund for a purchased travel solution.*

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_02_36	*Passenger validating a Local Public Transport Ticket he has purchased through BONVOYAGE platform*	*This Use Case shows how a user can validate a Local Public Transport ticket, that is stored in his BONVOYAGE System and whose tariff is charged when he starts his journey on the local public transport.*
UC_02_37	*Passenger validating a Local Public Transport Ticket he has purchased through BONVOYAGE platform*	*This Use Case illustrates how a user can validate a Local Public Transport ticket, that is stored in BONVOYAGE System and whose tariff is going to be charged to the user only after the user has completed his journey on the local public transport.*
UC_02_38	*Passenger sending a general feedback on BONVOYAGE App functioning*	*This Use Case describes how a user can provide a "general" feedback on BONVOYAGE App in order to: notify possible problems the App (e.g.: problems with maps, places missing; feedback if misplaced); provide suggestions for improvement; evaluate his experience with the App.*
UC_02_39	*Passenger sending a feedback on how the journey is going on, while travelling from his point of origin to his point of destination*	*This use-case describes how a user can provide an on-trip feedback to BONVOYAGE App in order to notify how the journey is going and if he is satisfied with the travel solution BONVOYAGE has provided him with.*
UC_02_40	*Passenger receiving promotions and discounts from partners of BONVOYAGE platform transport operators*	*This use-case shows how a user can receive notification containing promotions and discounts from partners of BONVOYAGE platform transport operators.*
UC_02_41	*Passenger searching travel information for others*	*This Use Case describes how a profiled user can make a travel solution search on behalf of someone else.*

UC ID	Use Case Name	Short Description
UC_02_42	*Passenger planning a trip by car sharing*	*This Use Case shows how a user can look for an available car sharing service for his travel.*
UC_02_43	*User looking for travel document changes*	*This Use Case outlines how a user can display different changes related to a travel document.*
UC_02_44	*User consulting BONVOYAGE system to check sales data*	*This Use Case shows how a user can display different information related to BONVOYAGE sales.*
UC_02_45	*Passenger purchasing an intermodal travel solution*	*This Use Case describes how a user can purchase a ticket for an intermodal travel solution.*
UC_02_46	*Service provider questioning BONVOYAGE platform to receive information about time schedule of BONVOYAGE transport operators*	*This use-case shows how BONVOYAGE platform interacts with the App of external service providers to provide information on time schedule of transport operators that have joined BONVOYAGE.*
UC_02_47	*Service provider questioning BONVOYAGE platform to receive information about the updated time schedule of BONVOYAGE transport operators*	*This Use Case describes how BONVOYAGE platform interacts with the App of external service providers to provide updated information on time schedule of transport operators that have joined BONVOYAGE.*
UC_02_48	*Service provider questioning BONVOYAGE platform to receive information about a modified list of services of BONVOYAGE transport operators*	*This Use Case outlines how BONVOYAGE platform interacts with the App of external service providers to provide information on the updated list of services of transport operators that have joined BONVOYAGE.*
UC_02_49	*Service provider questioning BONVOYAGE platform to receive information about the*	*This Use Case illustrates how BONVOYAGE platform interacts with the App of external service providers to provide information on the geographic*

UC ID	USE CASE NAME	SHORT DESCRIPTION
	effective geographic coordinates of transport means operated by BONVOYAGE transport operators	*coordinates of transport means run by transport operators that have joined BONVOYAGE.*
UC_02_50	*Service provider questioning BONVOYAGE platform to receive information on the profile of customers that have registered to BONVOYAGE platform*	*This Use Case shows how BONVOYAGE platform interacts with the App of external service providers to provide information about the profile of its users.*
UC_02_51	*Service provider questioning BONVOYAGE platform to receive information on the list of passengers that have reserved a seat for a specific transport operated by a BONVOYAGE transport operator*	*This Use Case illustrates how BONVOYAGE platform interacts with the App of external service providers to provide information about the passengers list.*
UC_02_52	*Service provider questioning BONVOYAGE platform to receive information on the list of passengers that have reserved a seat for a specific transport operated by a BONVOYAGE transport operator*	*This Use Case shows how BONVOYAGE platform interacts with the App of external service providers to provide information about the passengers list.*
UC_02_53	*Service provider questioning BONVOYAGE platform to receive information on the list of passengers of specific transport operated by a BONVOYAGE transport operator that need to be "re-protected"*	*This Use Case describes how BONVOYAGE platform interacts with the App of external service providers to provide information about the passengers to be "re-protected".*

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_02_54	*Service provider questioning BONVOYAGE platform to receive information on the list of passengers of specific transport operated by a BONVOYAGE transport operator that have been "re-protected"*	*This Use Case describes how BONVOYAGE platform interacts with the App of external service providers to provide information about the passengers that have been "re-protected".*
UC_02_55	*Service provider questioning BONVOYAGE platform to receive information on the list of disabled passengers of specific transport means operated by a BONVOYAGE transport operator*	*This Use Case shows how BONVOYAGE platform interacts with the App of external service providers to provide information about the disabled passengers list.*
UC_02_56	*Service provider questioning BONVOYAGE platform to receive information on the list of passengers entitled to special services of specific transport means operated by a BONVOYAGE transport operator*	*This Use Case shows how BONVOYAGE platform interacts with the App of external service providers to provide information about the passengers entitled to special services.*
UC_02_57	*Technology provider managing authorisations for different profiles of system users operating on different channels*	*This Use Case describes how account and authorisations for different profiles of system users operating on different channels can be created and managed on BONVOYAGE platform.*
UC_02_58	*Creation of a new user profile*	*This Use Case illustrates: how a new user travel profile can be created on BONVOYAGE platform; how a new user profile can be used as basis for travel solution research and travel document purchase.*

UC ID	Use Case Name	Short Description
UC_02_59	*Technology provider defining parameters and rules for bonus assignment*	*This Use Case illustrates how a technology provider can define rules to grant bonus through the combination of a pre-defined set of parameters.*
UC_02_60	*Technology provider defining parameters to define seat assignment*	*This Use Case outlines how a technology provider can modify parameters used to assign seats to passengers that make a reservation or purchase a travel solution for a specific transport mean.*
UC_02_61	*Technology provider wanting to display report on services/tickets sold through BONVOYAGE platform*	*This Use Case describes how BONVOYAGE platform provides information on services/tickets sold for services provided by a defined transport operator.*
UC_02_62	*Technology provider wanting to display report on services/tickets purchased by a specific profiled customer*	*This Use Case shows how BONVOYAGE platform provides information on services/tickets purchased by a profiled customer.*
UC_02_63	*Technology provider guiding the user in the purchase of an intermodal travel solution.*	*This use-case illustrates how BONVOYAGE platform manages the purchase of a multi-modal travel ticket, driving the user in the purchase process.*
UC_02_64	*Technology provider uploading on BONVOYAGE platform information on the presence of public transport that cannot be reserved*	*This Use Case outlines how BONVOYAGE platform can restore public reservation services.*
UC_02_65	*Transport operator providing public transport information on time schedule, geographic coordinates and available commercial offers to BONVOYAGE platform.*	*This use-case describes how BONVOYAGE platform receives and upload: a transport operator time schedule; the effective geographic coordinates to exactly identify the departure, arrival, intermediate location of a public transport; the transport operator tariffs, offers and promotions targeting*

UC ID	Use Case Name	Short Description
		different users.
UC_02_66	*Transport operator providing BONVOYAGE platform with information on planned delays on its transport means*	*This use-case shows how BONVOYAGE platform receives and uploads information (provided by transport operators) on delays planned on the medium-long term in order to: provide adequate information to the user; offer effective travel solutions (new travel solutions following rescheduled timetables) in order to provide the user with a new updated travel solution.*
UC_02_67	*Transport operator providing BONVOYAGE platform a modified list of services*	*This Use Case describes how BONVOYAGE platform receives and uploads a modified list of services offered by transport operators.*
UC_02_68	*Transport operator checking tariff profile offers and promotions*	*This Use Case shows how BONVOYAGE platform receives from transport operators' information on tariffs profile, offers and promotions to be deleted.*
UC_02_69	*Transport operator modifying tariff profile offers and promotions*	*This Use Case illustrates how BONVOYAGE platform receives from transport operators' information on tariffs profile, offers and promotions to be modified.*
UC_02_70	*Transport operator providing BONVOYAGE platform with rules to be followed for pricing building*	*This Use Case shows how BONVOYAGE platform receives from transport operators' rules to be followed for price building, based on necessary elements for tariffs, offers and promotions definition.*
UC_02_71	*Transport operator providing BONVOYAGE platform with the list of disabled passengers for a specific transport mean*	*This Use Case outlines how BONVOYAGE platform receives and integrates the list of disabled public transport passengers provided by a transport operator.*
UC_02_72	*Transport operator providing BONVOYAGE platform with the list of passengers entitled to special services*	*This Use Case shows how BONVOYAGE platform receives and integrates the list of passengers entitled to special services provided by a transport operator.*

iv. UC_03 table

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_03_01	*Intermodal journey planner for passengers with special needs/requirements*	*This Use Case describes travellers who want to use the BONVOYAGE application to plan their origin-destination route based (mandatorily) on their inherent special needs or requirements*

v. UC_04 table

UC ID	USE CASE NAME	SHORT DESCRIPTION
UC_04_01	*Anna's gift*	*The Use Case describes how the BONVOYAGE platform can advise on how to send parcels according to user specific preferences and how a client can track parcels until they have reached their destination*
UC_04_02	*Transport Operator sending goods through an external transport provider*	*This Use Case describes how a Transport Operator can use the BONVOYAGE application in order send good through an external transport provider*
UC_04_03	*Transport Provider looking for available freight services*	*This Use Case describes how a transport provider can search (according its preferences) through the BONVOYAGE application available freights services to and how he can place a bid for a specific one.*
UC_04_04	*Traceability support tool for a Transport Operator*	*This Use Case describes how, from the Traceability support tool service information, the driver can:* - *Use BONVOYAGE as turn-by-turn navigator (UC_01) to reach the*

		place of delivery of the goods (helping also the Transport Operator to monitor the delivery route) *To collect the sign of the consignee writing it by touching the mobile screen or by photo (automatically it will be sent to the TO)*
UC_04_05	*Managing a bid*	*This Use Case describes how the Transport Provider can modify/delete a previously performed bid*
UC_04_06	*Feedback the transport service*	*This Use Case describes how the user can feedback the transport service*
UC_04_07	*Transport Provider wants to feedback the Transport Operator*	*This Use Case describes how the Transport Provider can leave a feedback of the Transport Operator*
UC_04_08	*Setting an alert to be notified with new information*	*This Use Case describes how a user can fix an alert in the BONVOYAGE application in order to be notified when there is new available information (as soon as arrives or from time to time).*
UC_04_09	*Setting an alert based on a performed search*	*This Use Case describes how a user can fix an alert from a previously performed search.*
UC_04_10	*Managing an alert*	*This Use Case describes how a user can manage an alert by editing it or deleting it*
UC_04_11	*Route optimization for freight*	*This Use Case describes how a transport provider can organize the daily route covering different pickup/delivery points, using the BONVOYAGE application, in the most efficient way*

UC_04_11B	*Multimodal route optimization for freight*	*This Use Case describes how a transport provider can plan a route in the most efficient way based on freight characteristics, internal and external constrains as well as other needs including the consideration of multimodal alternatives.*
UC_04_12	*Pony express start-up*	*The Use Case describes how entrepreneurs can use the BONVOYAGE platform to look for available parcels to be delivered and how certain delivery criteria can be preferred based on the sender's specific preferences*
UC_04_13	*Marina the driver / freelance driver – parcel delivery*	*The Use Case describes how freelance drivers can use the BONVOYAGE platform for optimizing transport and as an online service for available goods*