

# D4.2.1 Overall reference architecture



## Document Control Sheet

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# 1. Introduction

## 1.1 Purpose of this document

The objective of this document is to give an overview about the high level of the central platform and its sub-satellite pilots to better understand the components at different level. This report may suggest how to design and realize similar projects in potential replicable cities/areas.

This report describes at high level, the architecture designed for the STEP-UP project and its pilots.

## 1.2 Target Audience

The target audience of this report is the STEP-UP partners and their technicians to allow performing of the STEP-UP platform.

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## 2. State of the art of STEP-UP pilots

PARTNER	Mobility data collection	Poi and Event data collection	Pilot SoA	Note
Marche Region	Ok	Ok	Done	STEP-UP Platform published STEP-UP App will be finalized within the EoP
Emilia-Romagna Region	Ok	Ok	Done	
Municipality of Lecce	Ok	Ok	Done	
County of Split-Dalmatia	Ok	WIP	Done	
City of Sibenik	Ok	WIP	WIP	
Zadar airport	Ok	WIP	WIP	The pilot will be performed within the EoP

### 3. High level of Architecture

The application architecture of the STEP-UP system is based on a Multi-Tier model, specifically **Three-Tier**, service-oriented (SOA):

- **Presentation Layer**
- Middleware - **Business Logic Layer**
- **Data Layer**

This architecture allows to reach different goals: **scalability**, **extensibility** and **testability** of the whole system. This selected architectural organization and implementation based on different layers and interfaces ensures the decoupling among various components of the system, offering the following advantages:

- 1- Modularity and ease of integration with other systems.
- 2- Decoupling between the interface with the logic application part in order to obtain the reusability of the logic components/parts in different contexts and for different interfaces (logic application services for multi channels).
- 3- Independence from basic infrastructures (database management system, application server, ecc...) in order to obtain the maximum portability and versatility of the system.

**The architecture includes SOA / ROA models.** The models are made through Web Services that publish services in a standard way. Especially, ROA is based on RESTful architecture and provides data exchange streams in JSON, JSONP, XML format.

OTP, Open Trip Planner (<http://www.opentripplanner.org/>), is a known and proven open source platform, recognized at worldwide level, suitable for calculating multimodal routes in multi-company contexts. OTP is based on de facto standard data such as:

- ✓ GTFS for public transport,
- ✓ OpenStreetMap (OSM), for road network.

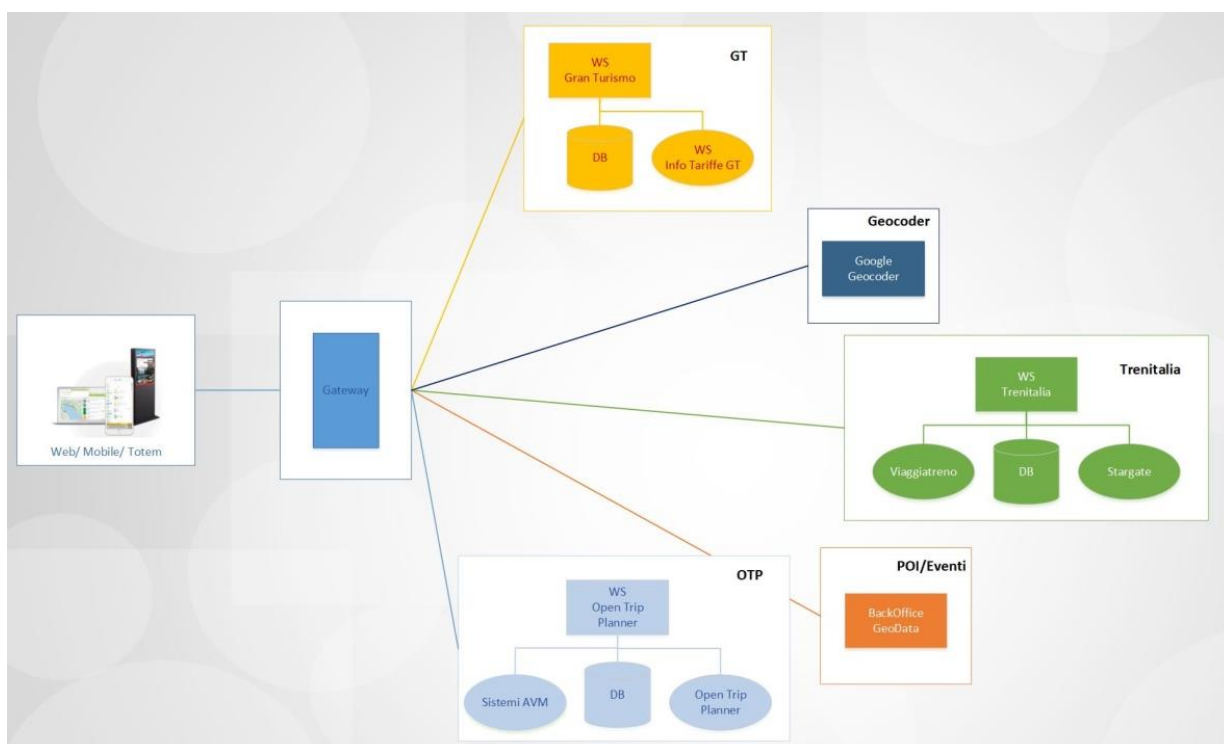
The main strengths of the system are the following ones:

- **Speed of the calculation:** thanks to the use of the AStar calculation algorithm, the system takes few milliseconds to calculate multimodal travel solutions regional level.

- **Evolution and maintenance:** thanks to the support of the design team and the developer community, the product is constantly evolving; in this way, with each new release, new functions and calculation methods are available.
- **Integration with real-time data** through the support of GTFS RealTime.

### 3.1 Logical Architecture of the whole STEP-UP system

The diagram below displays the type of service providers through which the platform provides information to clients.



**Figure 1: Logical scheme**

All requests pass through the Gateway (blue rectangle) in order to increase the security level of the services and at the same time to have a single-entry point towards the platform. Specifically, the services provided are:

- **GT:** Interface to the services of the Long-haul line provided by Pluservice that provide long-distance travel solutions with related price information.
- **Trenitalia:**
  - Interface to Trenitalia services that return travel solutions with related price information.

- Integration with real-time services of the ViaggiaTreno system (it is a system for displaying real-time data about delays of the rails at National level).
- **OTP:** Interface to the Open Trip Planner server.
  - Integration with the AVM services of the various transport operators to visualize advances/delays.
- **GEOCODER:** Interface to Google's prediction and geocoding services.
- **POI/Eventi:** Interface to the services that provide information on POIs and events.

Type of users who access into the services or information systems:

- **Back-office operators:** users authorized to manage content.
- **Third sources:** *Figure 2: Logical Scheme*
- **Final users:** citizens, tourists, commuters, travelers, vulnerable users who access into the platform for taking information about mobility or territory.

## 3.2 List of SW and HW components

Inside the data center 1, the following modules are available (as shown in Figure 2):

- E-Planner Web Application: web portal for end-user
- E-Planner Web Services: web services that provide information
- E-Planner Monitor Services: system monitoring services
- E-Planner Log Services: logging services
- OTP- Routing Engine: Open Trip Planner, engine for travel solutions
- GTFS Import: system power services (about mobility data)
- BI Pentaho (optional): Business Intelligence module / Modulo di Business Intelligence / production and consultation of reports

Inside the data center 2 into Marche cloud, the following modules are available:

- Backoffice POI/Events: CMS for the POI/events management
- Web Services POI/Events: services that provides information about POI/Events



- GTFS Repository: mobility data repository about different transport operators

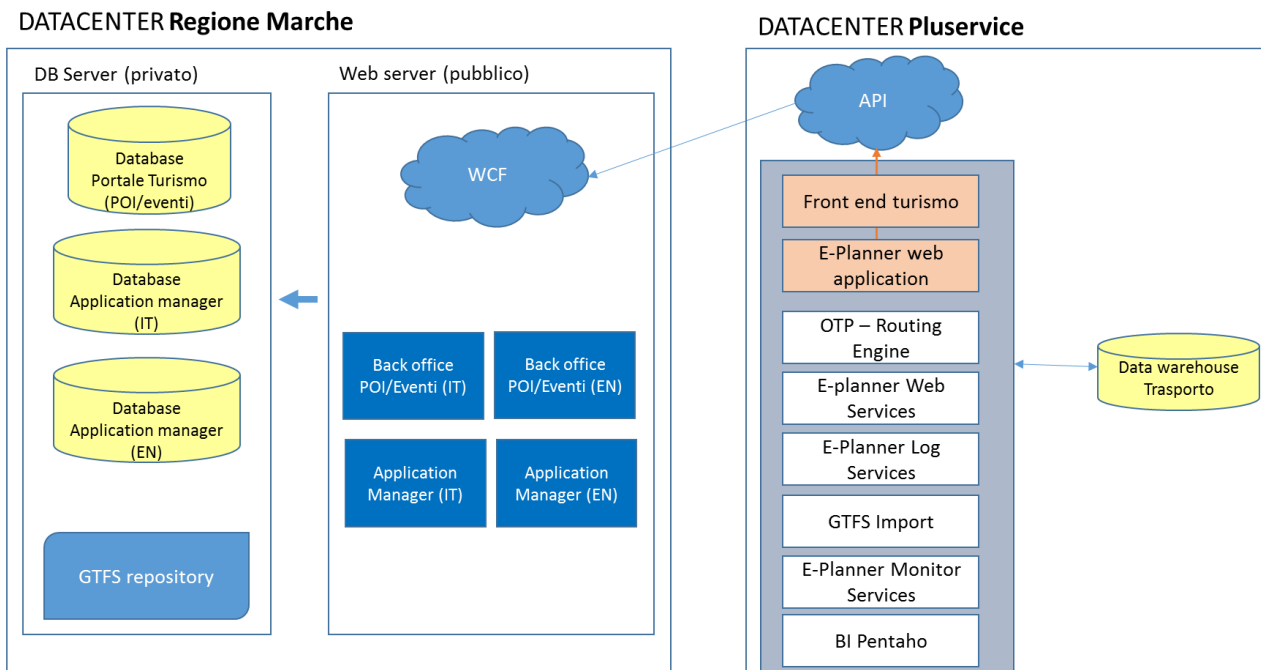


Figure 2: Macro components of the proposed system

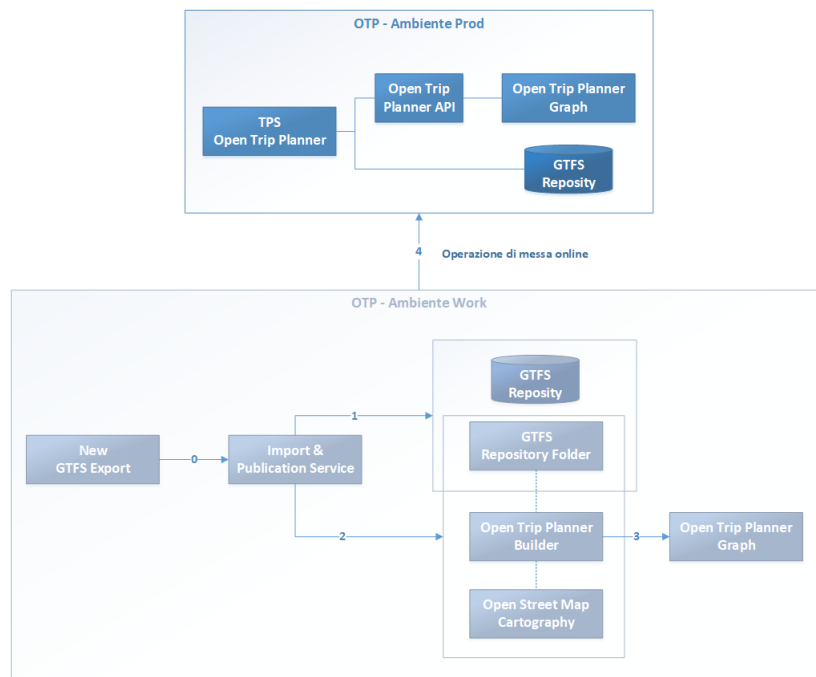
### 3.3 Physical Architecture

In the table below, the required virtual Data Warehouse POI / Event server features are defined:

Server Name	Type	Features
SRVSU-FE01	Virtuale	4 vCore vRAM 12 GB 1 vHDD 90GB on Tier 1 porte vLAN (Gigabit) Windows Server Standard 2016 Web Server IIS Dedicated personalize IP SQL Server 2017 Express Edition

## 3.4 Feeding the system

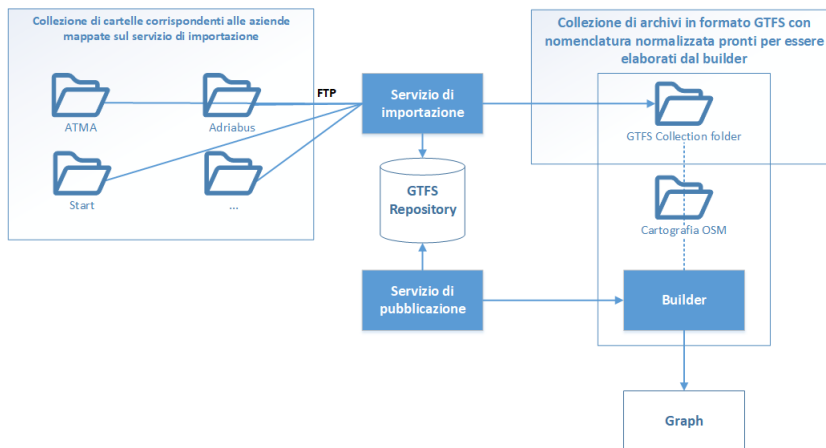
OTP – E-Planner feeding is done by mobility data flow coming from pilot partners.



**Figure 3: Feed process for the proposed system with mobility collected data**

The feeding process starts when the Import service **detects the presence of a new GTFS feed**. The data is processed and, if successful, the new transport network is published online ready for the planner system. The objects involved in the process, their interactions and the order in which they perform the different functions can be organised according to the following steps:

1. GTFS data, in the Marche Region infrastructure, is transferred to feed the system
2. It has been detected a new GTFS feed
3. The import service deals with:
  - a. Import the GTFS data into the database (stage environment)
  - b. Move the GTFS feed into the builder folder (stage environment)
  - c. The Publication service starts the builder and its process to build the network (graph)
  - d. The graph is moved into the real (operative) environment
4. The publication process ends when the new graph is uploaded, and the relative mobility data are moved into the real (operative) environment.



**Figure 4: Import data**

Synchronization between the import service and the publishing service is done through a state semaphore table in the data.

### Monitoring of the system

Each active component during data import and publication process is able to provide feedback on the progress of the activities' status also by email. In fact, it is possible to configure a mail box for this scope.

## 3.5 Integration with existing systems

In order to be able to satisfy as much as possible users' needs, the portal is also able to speak with Trenitalia's services for the provision of travel solutions and in real-time information about trains.

The system is also able, where available, to integrate real-time information system by a common standard called SIRI.

Moreover, the proposed system integrates the Google-keys necessary for the smart search of the addresses provided by Google.

## 3.6 Standards

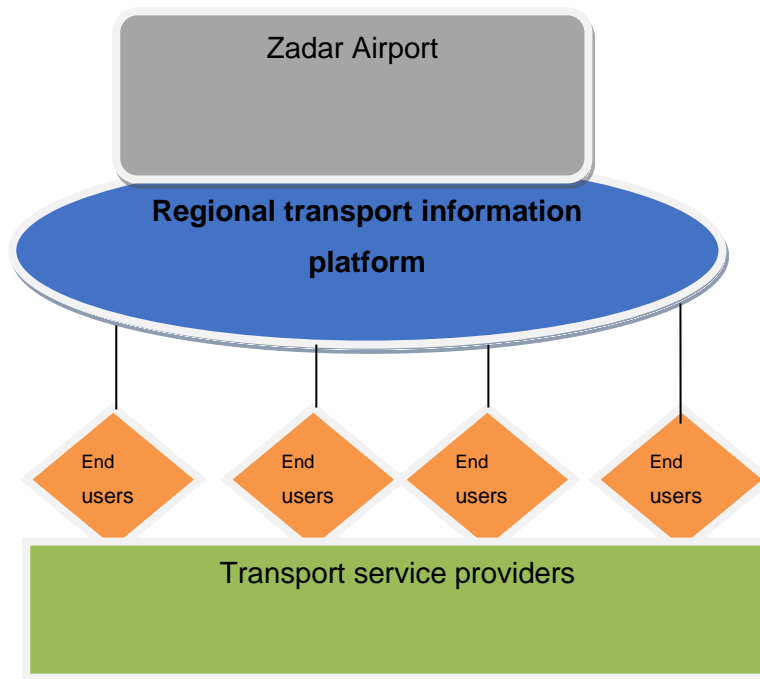
The main standards used within the platform are:

- GTFS – General Transit Feed Specification
- SOA – Service-Oriented Architecture
- SIRI – Service Interface for Real Time Information

## 3.7 Satellite pilots' architecture

### 3.7.1 Zadar pilot site

#### 3.7.1.1 Logical Architecture



#### 3.7.1.2 List of SW and HW components

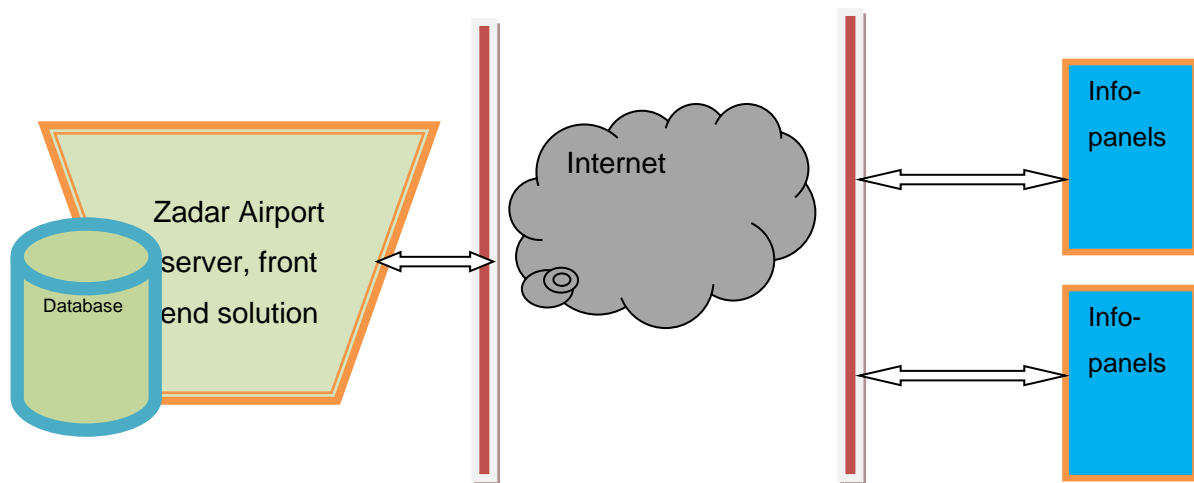
##### HW

1. Indoor info panel 42"
2. Outdoor info panel 42"
3. Processor: i5, min 4 GB RAM, 1GB LAN card, min 128 GB SSD.
4. Wi-Fi-802.11n

##### SW

1. Windows OS/Android/Linux

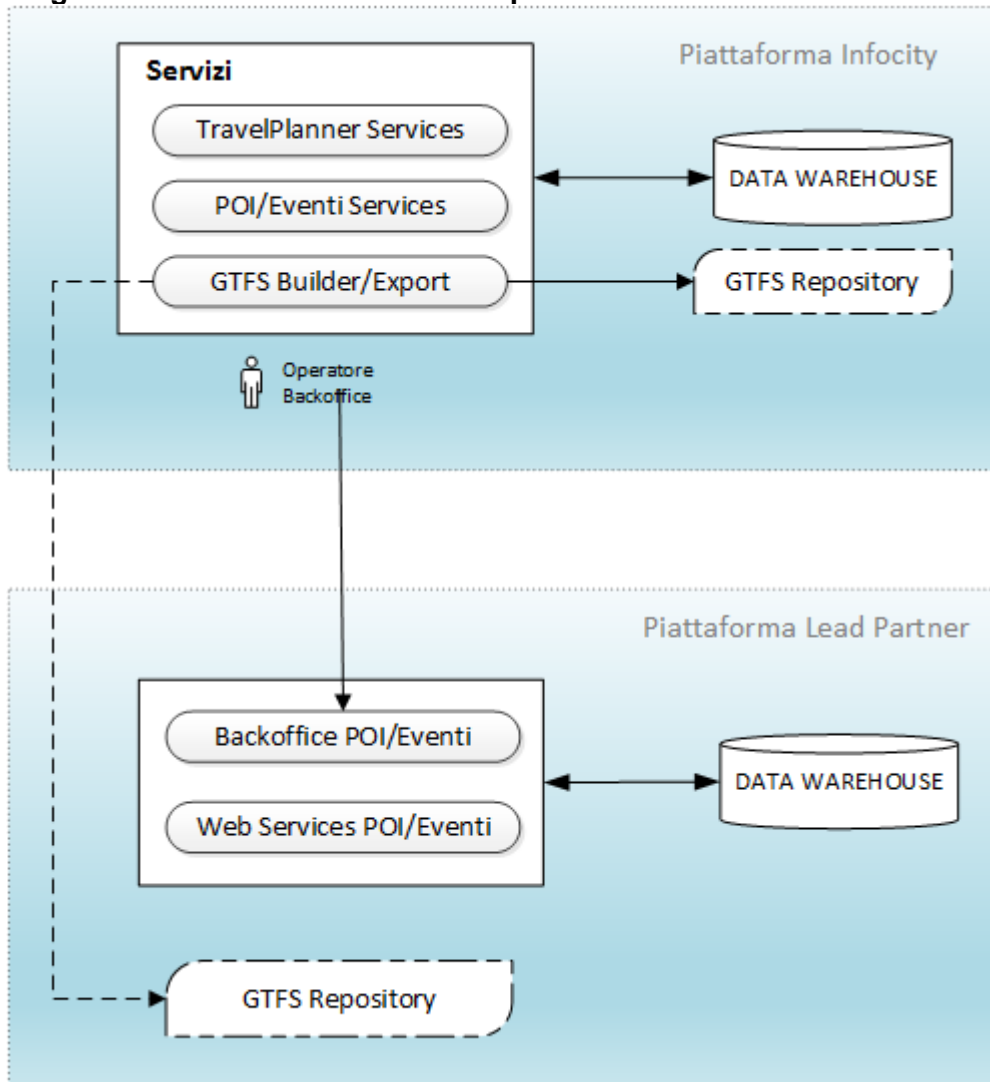
### 3.7.1.3 Physical Architecture



Info-panels will be connected to front end solution via internet connected by wire. Database and the front-end solution will be available on Zadar Airport server, firstly available only on the info-panels but through some modifications the front end solution might be available for further usage later on. Database and front-end solution hosted by Zadar Airport server will ensure quick response time and allow easier access to modifications and the updates. This will also have to be enhanced by the security protocols of relevant standard for Zadar Airport.

### 3.7.2 Lecce pilot site

#### 3.7.2.1 Logical Architecture with main components/modules described



List of the main SW and HW components:

In the local platform

- TravelPlanner Services: travel planner information services
- POI/Eventi services: points of interest and events information services
- GTFS Builder/Export: Module to build and export GTFS from local platform to STEP-UP platform.

Within Lead Partner platform:

- Backoffice POI/Eventi: back office for POIs and events management
- Web Services POI/Eventi: points of interest and events information services
- GTFS Repository: GTFS repository (transport data)

### 3.7.3 Emilia-Romagna Region pilot site

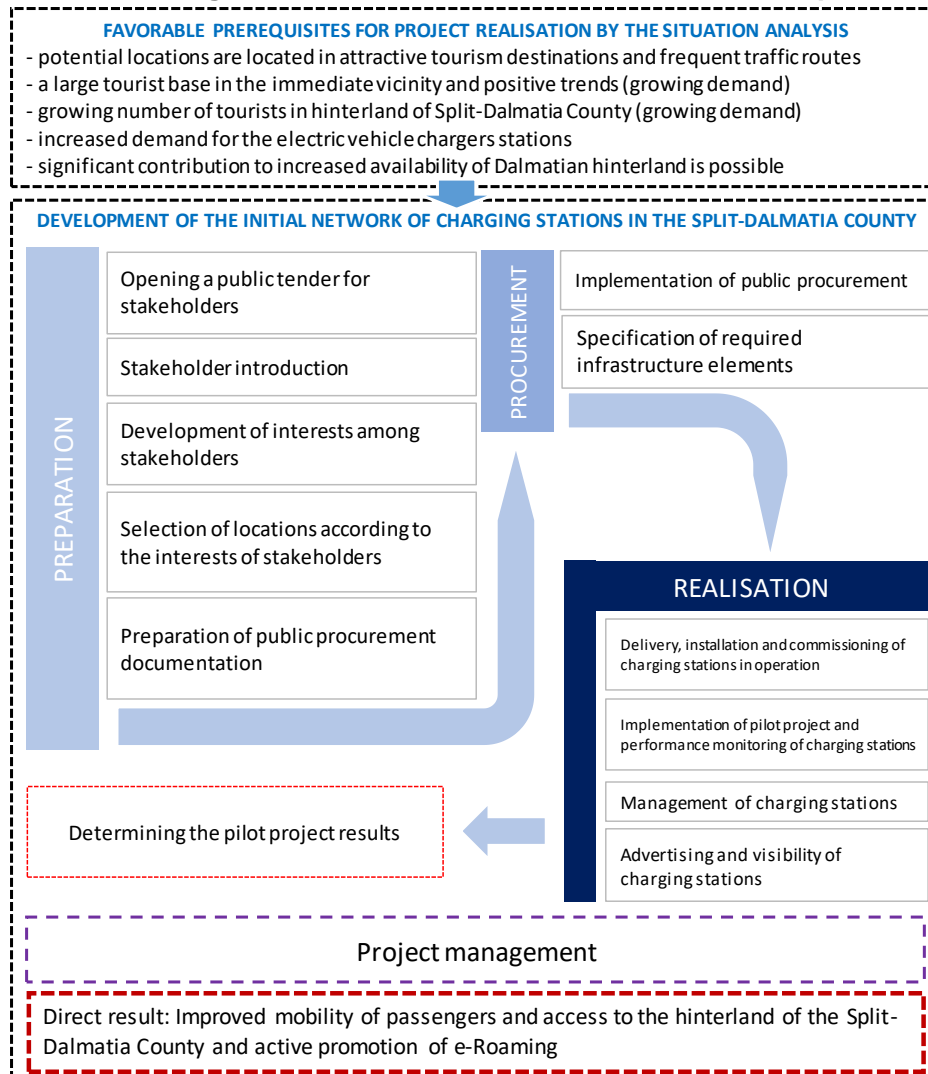
#### 3.7.3.1 Main components/modules

From an IT point of view, the project will be based on the following components:

- a table of racing timetables, created with a PDF by the transport manager (Autolinee Benedettini) and available on <http://www.benedettinisp.com>
- a series of web pages, on different sites, which will show the table:  
<https://www.aptservizi.com>)    <http://www.riminiturismo.it>    <http://www.turismo.ra.it/ita/info@sanleo2000.it>    <http://www.san-leo.it>    <http://www.comune.verucchio.rn.it>,  
<http://www.vallimarecchiaeconca.it>
- an email address (and a telephone number) of the company that will manage the reservations (San Leo 2000) [info@sanleo2000.it](mailto:info@sanleo2000.it)
- Back office: a mail connection between San Leo 2000 and Autolinee Benedettini, so that the transport company - knowing from time to time the number of reservations - can make available the bus of the suitable dimensions.

### 3.7.4 Split-Dalmatia County pilot site

#### 3.7.4.1 Architecture diagram with main hardware and software components/modules



The project needs standardised software components for normal functioning of electric vehicle charging stations, such as:

- software for user authorization on the vehicle charging device
- linking to a data collection portal from charging stations (maps with locations, reservations, etc.)
- software for customer integration and payment through: RFID card, PIN system, SMS, smartphone app or roaming platform.

Information and promotional activities via the internet will be carried out through existing web site stakeholders.

Hardware components make the focus of the pilot project and for its realisation are needed:



- **charging station, type A, model: G7 1x22kW with integrated router**

- Standard charging of 1 electric vehicle of any type (car, bike, motorcycle) within 90 minutes
- 1x high quality seven-pole outlet (type 2 Mennekes, 32A, maximum power of 22 kW on three-phase connection, or 7,4 kW on single-phase connection), in accordance with IEC 62196-2 and IEC 61851 standards,
- authorisation and billing mode: PIN, RFID, SMS and APP, optional (plug & charge),
- connectivity type: Ethernet, GSM (LTE), WiFi, PLC
- Color LCD display, 3,5 inch with multilingual options and geolocation advertising,
- aluminium frame with high degree of protection against vandalism (IK 08) and with extreme weather conditions (-20°C + 70°C), humidity 95 %, altitude 2000 m
- Dimensions: 45x27x13x5 [cm], weight 6,3 kg.
- Socket protection:
  - overcurrent socket protection,
  - differential socket protection ( $\Delta 30\text{mA}$ )
  - type B+
- wall bracket, screws and other equipment is included in the charging station
- Advanced demand side management and compatibility with the highest requirements of active manageability by the distribution system operator or third parties.
- Integrated artificial intelligence system, which adjusts the charging process depending on user habits.

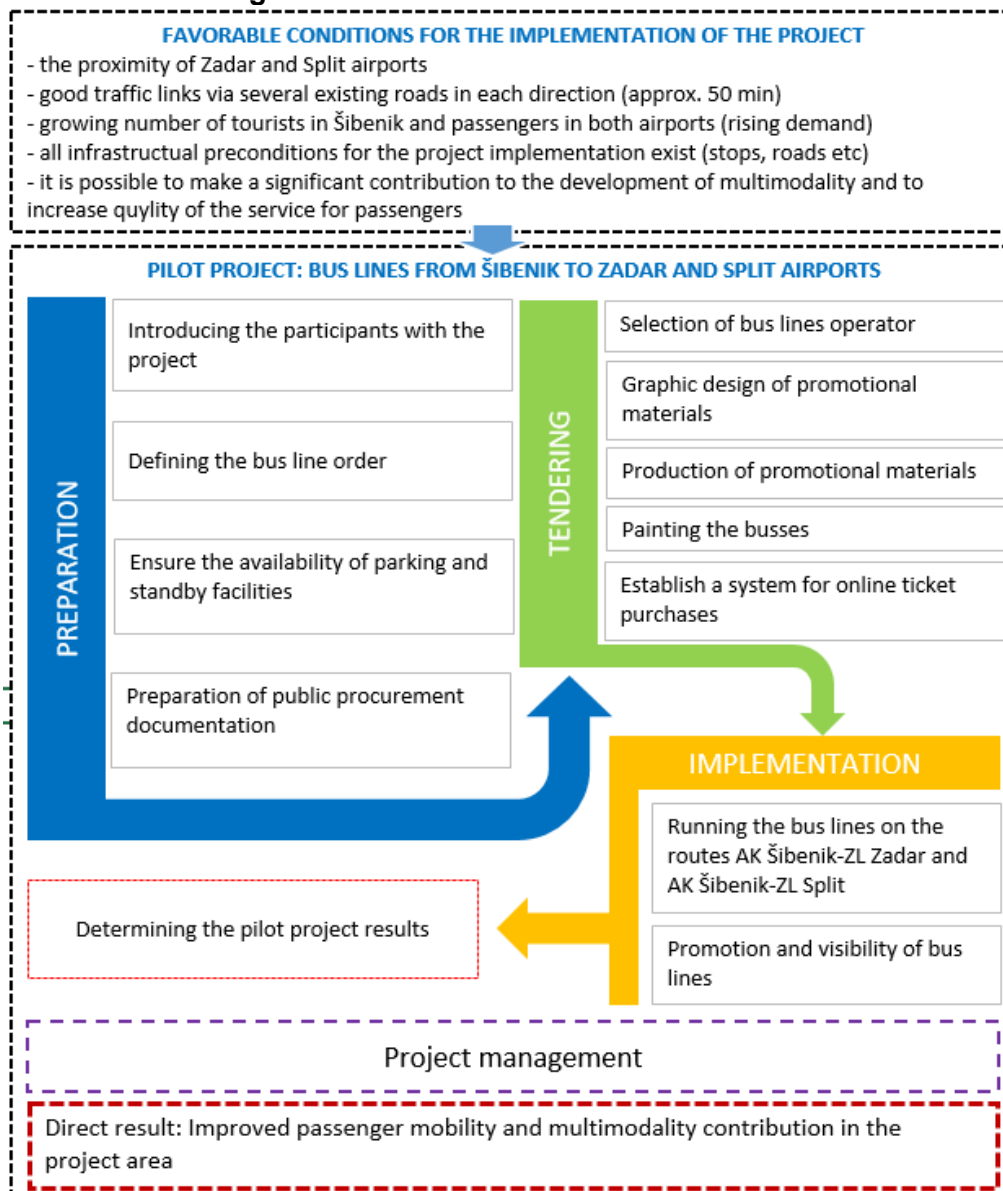
- **charging station, type B, model: G6 2x22 kW**

- simultaneously charging 2 electric vehicles of any kind (cars, motorcycles, scooters, bicycles) within 60 minutes,
- 2x high quality seven-pole socket (type 2 Mennekes, 32A, maximum power 22 kW), in accordance with IEC 62196 and IEC 61851 international standard (Most of the EV on the market support this standard. Standard defines the safety mechanisms and the method of data exchange between the vehicle and the charging stations)
- Use mode: Authorisation (RFID, SMS, APP),

- Connectivity type: Ethernet, GSM, Wireless
  - Socket protection:
    - overcurrent socket protection,
    - differential socket protection ( $\Delta 30\text{mA}$ )
  - The basic anchor is included in the bottle price.
- **RFID card set (x10 per station)**
  - **GPRS router**

### 3.7.5 Sibenik pilot site

#### 3.7.5.1 Architecture diagram



## 4. Role of Public Administrations

### 4.1 Definition of guidelines for adoption of services by Public Administrations

The Marche region uses two programming tools in the transport sector: the Regional Plan of local public transport and the Three-year Regional Services Program of Regional and Local Public Transport.

Both tools have measures designed for the diffusion and use for ITS systems. These systems are designed to support the main actors involved: regulators, companies engaged in the TPL service and end-users.

For the first two actors, the ITS systems are used to increase efficiency and reduce costs, while users have a system at their disposal to facilitate the access to the service, achieving the objective of encouraging the use of public transport instead of the private one.

The **Regional Plan on Local Public Transport** sets a programmatic framework on mobility services of Marche Region.

With the plan, the Region wants to identify all potential synergies between the railway system and the road one, improving the service offer like modal and fare integration, e-ticketing, infomobility.

The Marche Region is preparing to update the Plan in force; the new plan proposes potential evolutionary models based on the following principles:

- Redefining the traffic areas, choosing according to the possibility of integration under the technical-management and transport aspects;
- Company reorganization, whose implementation processes depend on single operators;
- Creation of new institutional governance, which is a direct consequence of choices made in the two previous points;
- Promote the introduction of information and communication technologies to facilitate access to the service by users and increase the efficiency of the transport sector governance and management of companies and public bodies' grantors.

In addition to the “Regional Plan for Local Public Transport”, the objectives of the transport programme in Marche Region are developed in the Three-yearly Regional Programme of Local Public Transport Services.

The **Three-Yearly Program** is the main operational tool of unitary policy of Marche Region and Local Authorities in the local public transport and urban mobility sectors which is the main programmatic document for the development of the public transport in Marche Region.

It is still in force by assessing the current situation of demand and offer of transport and considering future scenarios for development. The Regional plan takes into account several other regulations such as safety, air pollution, consumers' involvement.

The programme implements the forecast actions of the regional Local Public Transport Plan, in coherence with the minimum level of service, therefore it sets:

- Subdivision of urban and extra urban road transport among the different areas;
- Subdivision into main lines (in terms of connections, Km, journey and frequency) and secondary lines (in terms of connections and Km) that is approximately established by the regional Local Public Transport Plan;
- Railway services on regional and interregional lines to integrate with other transport services;
- Implementation status of interchange hubs;
- Allocation of resources to the operation and investments, divided by typology;
- Definition of fares, included those related to special rate tickets;
- Some criteria for the reduction of traffic congestion and environmental pollution.

On the technological innovation sector, the Marche region has identified as the main topic in the ITS scope, in relation to its needs and demands in the medium to long term, the automatic ticketing system at the regional level in order to implement, when at standard use, an integrated pricing of the local rail and road public transport services to allow travelers to take advantage of the various modes of transportation, using the same ticket.

In general, the Electronic Ticketing System (ETS) makes use of electronic equipment that handles electronic tickets, typically stored on media such as smart cards (Validation points and positioning systems on the vehicle – AVL or AVM – ground systems at the ticket offices and service centres to issuance/renewal of electronic tickets and for data management). The Region is in a very relevant phase, in fact it is ready to perform a new era about e-ticketing system by public procurement (tender) that should optimize and innovate the whole ticketing system with new feature overcoming the problems of the standard ticketing system. This new approach could foresee account-based ticketing, EMV payment, best fare calculation and more features.

An automated ticketing system is typically composed of the following subsystems:

- sales system (credit charging on smart cards);
- validation system (onboard, railway stations) and control;
- data download system;
- central management system and revenue sharing (clearing).

The ETS allows to:

- Purchase of new tickets, ensuring availability and wide spread on the territory, also using alternative payment methods (e.g.: Internet, ATM banking, Home Banking, Lottomatica, POS, Retailing, Tobacco shops network and so on...);
- Perform trips with the possibility to change between rail and road using undifferentiated tickets available in the TPL operator networks;
- Reduce time and costs of looking for information and the purchase of the tickets, making their use easier and more reliable;
- Create a flexible rate (as per time slot, travel distance...) implementing a “certified” distribution of income, fraud and tickets counterfeiting reduction;
- Create of a sales network and an organizational structure, the monitoring of the various paths and the control of the advancement of efficiency achieved;
- Know the precise number of users and their mobility habits;
- Compare and/or optimize the service quality, highlighting any gaps and/or overlaps in the intermodal transport network in a given area, through the simulation of routes for its integration and/or completion.

In addition to electronic ticketing, as part of broad policies for the promotion of an effective, efficient and sustainable mobility government, Marche Region began creating a centralized delivery system of multi-channel infomobility services for the local public transportation system in the entire region, composed by a network of onboard AVM devices (Automatic Vehicle Monitoring) and ground equipment at the stops (electronic display boards), all coordinated by 5 operational centers (CCB: central basin control), operating on each provincial basin, interconnected and interoperable to ensure that they behave as a single system at regional level, allowing for the provision of the following services:

- **Monitoring public transport fleets;**
- **Real time spread of information related to TPL services;**
- **Interfacing of different mobility agencies;**
- **Improving the availability and effectiveness of local public transport.**

The impacts of such system, in terms of expected benefits, touch both the users of TPL services and all the other actors involved (EE.LL. and TPL operators).

This system fits into a Regione Marche program, which aims to promote intelligent system applied to TPL, pursuing an “open system” in which the different telematics systems (existing and new) can “talk” through rules aimed to integrating the various telematic and computer applications, developed for the control and management of TPL systems. The aspects primarily addressed to define such rules of interoperability, in transposition of internal market directives from the Central Government, are:

- Functional, logical and physical relations between the systems;
- The information’s flow and the communication and data transfer protocols;
- The organizational relationship between the various parties (Government agencies and TPL Service Providers) involved in the development and management of IT systems;
- Standards related to the implementation issues of IT systems.

In addition, knowing that only through a quantum leap in the offer of services and in their perception among the potential customers, it will be possible to intercept new users and to introduce a new culture in the use of the public transport, in particular to decongest urban centers from the intrusiveness of the car, the Marche region, in the year 2006, has implemented a centralized search service of routes and timetables that can be accessed via the internet; and based on a data bank to collect all the information about routes, rides and timetables of all companies operating in the regional road T.P.L., and including regional and national trains schedules, transiting in the region and managed by Trenitalia s.p.a., as well as gran turismo services with the terminal inside the regional territory.

The service, operating since 2007, is accessible by users through this internet link:

<http://orari.trasporti.marche.it>.

Once connected to the website, the user can choose from different search modes and tools. With STEP-UP, Marche Region wants to aggregate all information and useful data for travelling offering a very new and efficient integrated services to the users (citizens or tourists). Definition of communication protocols among actors

The Marche region promotes the dialogue among actors, aimed to the knowledge and need sharing in ITS, organizing meetings, seminars and workshops between the various actors with the opportunities provided by European projects such as RITS-NET or TISAR.

In addition to the meetings, the region initiates appropriate co-financing programs for the ITS systems. For example, the region has already activated and is in the completion process of the program to equip with AVM devices all buses, as well as enabling electronic displays, in parallel on the territory at the most important stops, to give real-time information on the various routes.



Another tool to encourage the various actors involved in the use of ITS systems adopted by the Marche region, is to enter into agreements or locate appropriate conditions in service contracts with carriers for compliance with the standards set by the Region in the ITS scope.

Especially, the transport companies must notify the Region and the higher-level institutions, the services data in a unified and standardized format so that these data can be used on various platforms and applications, that is to create a since reference database for all needs.

It is also in the course of analyzing the possibility of implementing a software system that allows fully computerized management of service level agreements on the part of managers; such system operates on a shared web platform intended to the higher-level institutions and the managers themselves.

## 4.2 Impacts on territory

Marche Region is defined as a “polycentric” region, meaning a territory where urban functions (work, shop, entertainment etc.) generating mobility flows are scattered in a polycentric network of compact towns and villages. The current system generates road congestion (mostly during rush hours), CO2 emissions and accidents. Moreover, the end users miss confidence in public transport, reducing the interaction with collective transport.

Planning daily mobility in polycentric regions will require coordinating policies and services of many actors – transport and urban planners, local and regional policy makers, urban and interurban public transport providers – within and across different urban centres and administrative boundaries. Without any such planning, people are almost obliged to take the “do it yourself” solution of individual car use for any daily mobility purpose.

Over 700.000 inhabitants (48% of regional population) commute every day to work or school, 86% of which by privately owned motor vehicle, 13% by road public transport, 1% by rail services. 84% of the daily mobility is concentrated at the morning rush hour, between 7AM and 9AM. Of these trips around 75% stays within the region boundaries and 65% has origin-destination within the same municipality.

From the analysis of the “attractors” and “generators” of mobility it can be seen that there are many municipalities (183) that generate mobility and few (17) that act mainly as attractors of daily flow.

In the Marche Region, the role of road public transport is growing with a volume of around 50<sup>1</sup> million passengers in the Year 2014 (12-15% increase over the Year 2006). Conversely the regional rail service, with its 385 km of extension, appears to be under dimensioned with a ratio of 2,5 km every 10k inhabitants against an average of 3,3 km for the whole Italy. Furthermore, some portions of the rail network are of old technology with bad impact on the quality of the service.<sup>2</sup>

The promotion and encouragement of a new and innovative collective mobility should be integrated in the various forms of public intervention.

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<sup>1</sup> [http://www.regione.marche.it/Portals/0/Ambiente/Valutazioneautorizzazioni/VAS/022\\_Aggiornamento%20PTPL.pdf](http://www.regione.marche.it/Portals/0/Ambiente/Valutazioneautorizzazioni/VAS/022_Aggiornamento%20PTPL.pdf)

<sup>2</sup> <http://statistica.regione.marche.it/Statistiche-per-argomento/Pubblicazioni-Mobilit%C3%A0>



By reducing individual mobility using private cars there should be an increasing of the sustainable and collective mobility. A car-sharing system will perform within the year 2020.

ITS applications used to:

- Optimal using of the data coming from street, traffic and mobility
- Give some continuity of ITS services, mostly for “traffic management”
- ITS applications for transport and road safety
- Telematic connecting between vehicles and control centre

An integrated and multiservice management of the collective transport allows to generate a new mobility government at regional level. The smart and integrated system permits to gather feedback about several aspects:

- respecting of the timetables
- logbook useful to determine a new strategic public transport plan, according to the users' need (analysis of the OD matrix)
- knowledge of the incomes coming from the public transport (urban, extra-urban)
- transport and passengers' certification.

The Marche region has promoted over time initiatives to reduce the use of private cars, with the consequent reduction of CO<sub>2</sub> emissions and accidents.

In this sense, the region has initiated tariff concession policies to their employees and to certain people categories (students, seniors with disabilities, employees with income limits).

The Marche region promotes the adoption and introduction of Intelligent Transport Systems (ITS), also through the coordination of European-level projects like RITS-Net, born from the collaboration of the Marche region with other regions and other European partners.

RITS-Net aims to contribute to the integration of ITS into the urban mobility plans, aiming to develop the transport policies and ensure consistency between the application of local and national ITS plans, as required by EC directives (2010/40/EU) on the Intelligent Transport Systems in the field of road transport.

The exchange of good practices between project partners on ITS projects, promotes the exchange of experiences and data sharing for the efficient initiation of integrated systems (such as travel planning, automated fare collection and ticketing).