ICT cloud-based platform and mobility services available, universal and safe for all users

D2.1 Current infrastructures, mobility requirements and information sources

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Abstract:

- Executive review of the SotA in smart mobility and the most relevant EU policies.
- For the 3 piloting cities:
  - detailed information on the current mobility and ITS infrastructures deployed
  - definition of services to be implemented
  - detailed requirements on infrastructures, public transport management and final users'
  - detailed information on datasets available for the development of MoveUs services

History

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List of Abbreviations

ACK	Acknowledgement
ADIMOT	Adaptive Multialgorithmic Optimisation Technique
AID	Automatic Incident Detection
APP	Application
ATOS	ATOS SPAIN
B2B	Business To Business
B2C	Business to Consumer
CaaS	Communication as a Service
CBS	Content-Based Security
CCM	CSA Cloud Control Matrix
CCTV	Close Circuit TV
CDG	Municipality of Genoa
CDMI	Cloud Data Management Interface
CEB	Council of Europe Development Bank
CICB	Context Independent Constant Behavior Operators
CIP	Competitiveness and Innovation framework Programme
C-ITS	Cooperative Intelligent Transport Systems
CIVB	Context Independent Variable Behavior Operators
CSA	Cloud Security Alliance
D	Deliverable
DATEX	Data Exchange
DCaaS	Data Compute as a Service
DDBB	DataBases
DDG	Traffic Data Provider

DSaaS	Data Storage as a Service
DTA	Dynamic Traffic Assignment Models
EC DG	European Commission Directorate General
EE	Energy Efficiency
EFII	European Future Internet Initiative
EFP	European Foresight Platform
EIB	European Investment Bank
EMT	Empresa Municipal de Transportes de Madrid
ENoLL	European Network of Living Labs
ERTICO	European Road Transport Telematics Implementation Coordination
ESS	Exploitation Support System
ETC	Electronic Toll Collection
EU	European Union
EV	Electric Vehicle
FCD	Floating Car Data
FEMP	Federación Española de Municipios y Provincias
FI PPP	Future Internet Public Private Partnership
GDF	Geographic Data File
GHG	Green House Gas
GIS	Geographic Information System
GML	Geography Markup Language
GMP	General Mobility Plan
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HTML	HyperText Markup Language
IaaS	Infrastructure as a Service
IAM	Identity & Access Management

ICT	Information and Communication Technology
ID	Identification
IEC	International Electrotechnical Commission
IPSUD	Integrated Plans for Sustainable Urban Development
ISO	International Organization for Standardization
IT	Information Technologies
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response
JDL/DFIG	Joint Directors of Laboratories/ Data Fusion Information Group
JSON	JavaScript Object Notation
KI	Key Innovations
LOS	Level Of Service
LPT	Local Public Transport
LTC	Local Traffic Controller
LTZ	Limited Traffic Zone
LWR	Lighthill Whitham Richards
MAC	Machine Access Control
MAD	Ayuntamiento de Madrid
MJP	Multimodal Journey Planner
M2M	Machine to Machine
MTM	Mobile Trusted Modules
NA	Not Available
NaaS	Network as a Service
NACK	Negative Acknowledgement
NAM	Not Available to MoveUs partners
NApp	Not Applicable

NAPTAN NTPG	National Public Transport Access Node Database - National Public Transport Gazetteer
NI	Not to be Implemented
NIST	National Institute of Standards and Technology of U.S.
NOx	Nitrous Oxides
NR	Not Relevant
OBU	On-Board Unit
OCR	Optical Character Recognition
O/D	Origin/Destination (matrices)
ODE	Ordinary Differential Equation
OGC	Open Geospatial Consortium
OS	Operating System
OTAP	Open Travel Data Access Protocol
OVAL	Open Vulnerability and Assessment Language
PaaS	Platform as a Service
PM	Measurement Point
POI	Point Of Interest
PSP	Policy Support Programme
PT	Public Transport
QoS	Quality of Service
QRY	Quaeryon
RDS/TMC	Radio Data System/Traffic Message Channel
REST	Representational State Transfer
RFID	Radio Frequency Identification
RTTI	Real Travel Time Information
RWIS	Road Weather Information System
SaaS	Software as a Service
SCA	Surveillance and Control Application

SET	Strategic Energy Technology
SICE	Sociedad Ibérica de Construcciones Eléctricas SA
SIEM	Security Information and Event Management
SIRI	Service Interface for Real-time Information
SME	Small Medium Enterprise
SMS	Short Message Service
SOA	Service Oriented Architecture
SOF	Softeco Sismat Srl
Sox	Sulfur Oxides
SP	Solution Proposal
SQL	Structured Query Language
SSO	Single Sign-On
STTP	Strategic Transport Technology Plan
SUMP	Sustainable Urban Mobility Plans
SW	Software
T	Task
TCC	Traffic Control Centre
TECNALIA	Tecnalia Research and Innovation
TIC	Traffic Information Center
TISP	Traffic Information Service Provider
TPEG-PKI	Transport Protocol Experts Group- ParKing Information
TPEG-PTI	Transport Protocol Experts Group-Public Transport Information
TPM	Trusted Platform Modules
TRE	Tampereen Kaupunki
TTDP	Tourist Trip Design Problem
TUT	Tampere University of Technology
UDF	Urban Development Funds

URL	Uniform Resource Locator
USDL	Unified Service Description Language
UTC	Urban Traffic Control
VMS	Variable Message Sign
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WP	Work Package
XML	Extensible Markup Language

Executive Summary

The **legal framework for Smart Mobility** is well established according to the analyses done by MoveUs partners and reported in this document: policies, directives and actuation plans both at European and national levels are numerous and include not only public but also private initiatives for example from Ibm, Cisco, General Electric and Siemens.

In general the three countries represented in MoveUs (Finland, Spain and Italy) and in particular the cities of **Tampere, Madrid and Genoa have adopted plans and measures to deal with the urban mobility in strategic terms** also taking advantage of the technological developments of ITS.

The **reference organizations, associations and forum** are numerous and are counted in this report as well as the **smart mobility initiatives** where the three cities can be considered pioneers and leaders in Europe.

The **technologies related to smart mobility** considered in this deliverable are:

- Mobility data acquisition: inductive-loops sensors detection, video-based traffic surveillance, video-based detection, Bluetooth, Optical Character Recognition (OCR), Floating Car Data (FCD), crowdsourcing applications
- Data integration and analysis: data fusion, analysis and prediction, routing
- Cloud computing: Infrastructure as a Service (IaaS) and Data Storage as a Service (DSaaS), Data Compute as a Service (DCaaS), Platform as a Service (PaaS)
- Mobility service provision: content, personalization and provision of the services: Pre-trip road traffic information, On-trip real-time road information, Pre-trip public transport information, Real-time passenger information, Multi-modal trip planning and dynamic route guidance, Parking monitoring information
- Data privacy and security related to cloud applications: Identity & Access Management, Privacy and Sensitive Data handling, Data Mining – Bulk Data, Context-based Security Compliance, Security Monitoring, End User terminals, Secure Internet Applications

For each of them definitions, states of the art, main challenges still unsolved and reference projects are given.

The Consortium has identified and assessed **current systems, sub-systems, components and technologies available in the piloting cities** that can be used to design and implement the MoveUs architecture; they are:

- Overall Architectures, Traffic management, Emergency Notification and Response, Public Transport management, Traveler Journey Assistance, Electronic Fee collection, In-vehicle systems, Law Enforcement, Communications, Demography & Economics, Tourism, Business, Crowd Sourced data.

For each of them information on current status, physical and/or virtual location, owners, technical conditions, users, economic conditions (i.e. costs) and constraints are given.

The Consortium has also identified and agreed the **services to be implemented in the piloting cities based on the MoveUs cloud platforms**; they are listed in the following table:

Services in Madrid	Objectives
Smart prioritization of vehicles	This service is expected to give priority to specific vehicles in crossings controlled by traffic lights from the Urban Traffic Control System operating in Madrid, so as to optimize the time of travel and the travel efficiency of those modes of transport. In principle, priority will be assigned only to public buses and upon request in the case the bus is delayed in its route. This service might be extended to other specific vehicles like car sharing vehicles, electric vehicles, etc. in a post-project phase.
Smart routing for pedestrian	This service aims to provide pedestrians with the smartest route between their actual position and a selected destination following the mobility preferences recorded at the registration phase. Among the smartest options -and the respective incentives related to them- offered by this service, the users can choose the way they want to move: public transport, car-sharing, on foot, etc. and the application will guide the user to achieve the target point. Upon request by the user, this service also offers links to websites with local information of the user interest, like leisure events, cultural visits, gastronomy, etc.
Smart crossing for pedestrian	This service aims to provide the smartest crossing options to the pedestrians, whether using special crossing points – known as SafeCross – or by applying a reaffirmation of a demand. Users subscribed to this service will receive the smartest way (the smartest the crossing the smartest the way) for a predefined route. This service will support the user in its route in order to cross safely in those crossings which use a camera to detect pedestrian crossing and that extends the green time until it has crossed safely or until a maximum pre-

	programmed time is exceeded. Whenever a user enters in the Bluetooth area of a crossing, a protocol is initiated in his/her personal device so as to send to the MoveUs platform the intention of crossing through the detector located in the Local Traffic Controller. Then the system implemented will reaffirm the pedestrian crossing demand in those points with a Bluetooth technology locally implemented.
Eco-efficient Route Planning and Traffic Prediction	This service is aimed at providing travelers with privileged mobility information like on-trip advanced traffic information, automatic incident warnings and on-trip eco-routing. This service may be considered as a premium service; it will be offered to travelers that use shared transport modes and/or green mobility modes like electric cars, bike-hiring, etc. This service may be offered also as an incentive to reward and/or foster eco-friendly mobility patterns.
Services in Genoa	**Objectives**
Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities (*)	The service is a web application expected to allow users to fulfill all personal mobility needs in an urban environment; most functions will be also available on mobile devices like smartphone or tablet. "Personal mobility needs" are to be understood in a broad sense, and include not only aspects related to the travels themselves but also to personal needs such as point of interests, shops, hobbies, etc. The service will provide results in terms of criteria chosen such as time of travel, cost, energy consumption, carbon footprint, incentives, personal needs, etc.
Integration of crowd sourced data into the Genoa traffic supervisor	Crowd Sourcing is a new form of computing that is facing with several research challenges, from the social incentives to share info and data, to the technical issues of collecting and analyzing a huge amount of real-time and historical data, still the most important issue in security and privacy for end users. The service is built over the integration of crowd sourced (sensor data) provided by users through mobile devices (smartphone, phablet, tablet) with Traffic Supervisor
Services in Tampere	**Objectives**

Multimodal journey planner	This service aims to offer the user the possibility to see all available mobility (i.e. bus/car/bike/pedestrian) and routing (streets and pathways) options between its current location and a declared intended destination.
Energy efficiency / CO2 assessment of journey options	This service aims to assess the energy efficiency and / or CO2 cost of input journey (i.e. mobility & routing) options between a source and a destination point, per user.
User tailored incentive-based visualization	This service aims to give an incentive oriented view of input transportation options information, per user. It acts as an adaptor for user-friendly meaningful display of backend computed information. In MoveUs, for the Tampere pilot, this service targets the mapping of EE/CO2 labels to incentive points (and subsequently relevant incentives) for the user considered, based on a Set of Incentive Rules stored in a dedicated DB.

Table 1 Services to be implemented in the piloting cities

(*) it is a bundle of sub-services: multi-modal journey planner, car and bike sharing management, carbon footprint and energy consumption calculator, carpooling, incentives and coupons/vouchers/deals management, electronic wallet registry, social network management.

For each service were also identified related datasets and information sources, systems involved, applications and components and information flow, users and stakeholders, functional and non-functional requirements.

Finally the Consortium has mapped **datasets which are generated and made available by the systems and technologies in the piloting cities** and that will be needed to build the above mentioned services; for each of them information on name, content, physical and virtual location, owner, provider, user, standard and format of data, geographic coverage, update cycle, communication channel, device of output, pricing model, and possible usage restrictions are given.

1. Introduction

This Deliverable D2.1 is one of the three deliverables expected for **WP2 – User requirements and current infrastructures.**

The **objectives** of WP2 are:

- To identify the currently deployed mobile technologies, devices, networking infrastructures and platforms with a special emphasis in the piloting cities
- To identify stakeholders and end-users' needs and requirements in order to define the necessary features and functions of the MoveUs platform and its associated services
- To create and analyze an initial set of potential MoveUs services usage scenarios, and identify those with highest priority that could serve as reference implementations in the living labs and city pilots.
- To provide more detailed specifications for the city pilots, clearly identifying the similarities and differences between them.
- To define energy-efficiency mobility rules and packages of incentives related to them
- To identify the information sources and sinks in cities, focusing especially in the pilot test cities, and assess the quality of the data available in terms of accuracy, usefulness, reliability, latency, etc.

To achieve these objectives, **WP2 is divided in five tasks**:

- **T2.1**: Analysis of mobile technologies, devices, networking infrastructures and platforms, and description of current interaction modes with the user
- **T2.2**: Mobility requirements: Including infrastructure requirements, public transport management requirements and final users' requirements
- **T2.3**: Identification of mobility and users' information sources and sinks for each piloting city
- **T2.4**: Incentives-based model concept
- **T2.5**: Use cases and common specifications for the pilots

This Deliverable describes the final results of the Tasks 2.1 and 2.3 and an intermediate result of Task 2.2, as follows:

Task and Key Objectives	Reference
Task 2.1: To share and acquire a common view on the current status of smart mobility initiatives, the most relevant EU and national policies and the main technologies involved.	• Chapter 2 • Details in Annex 1
Task 2.1: To gather information on the currently deployed mobile technologies, devices, networking and ITS infrastructures and platforms in the piloting cities (Madrid, Genoa, Tampere).	• Chapter 3 • Details in Annex 2

Task 2.2: • To describe the structure and history line of the usage services to be considered in the piloting cities (Madrid, Genoa, Tampere), based on which the mobility requirements will be identified and defined. • To identify and define mobility requirements from the user point of view based on the usage services to be considered in the piloting cities.	• Chapter 4 • Details in Annex 4
Task 2.3: To gather information on datasets available in Madrid, Genoa and Tampere useful for the development of MoveUs.	• Chapter 5 • Details in Annex 3

Table 2 Reference Chapters

For ease of reading, the detailed information has been grouped in the following annexes:

- Annex 1: Detailed technology status
- Annex 2: Detailed inventory of the existing Mobility & ITS Infrastructures in the pilot cities
- Annex 3: Detailed inventory of the existing Datasets in the pilot cities
- Annex 4: Information sources and datasets, users and stakeholders involved in the services at each pilot site

2. Executive review of the SotA in smart mobility and the most relevant EU policies

2.1 Legal Framework for Smart Mobility

2.1.1 Policies, directives and actuation plans

2.1.1.1 EU level

2.1.1.1.1 *EU policy framework*

The EU policy framework relevant for MoveUs embraces a broad set of policies (Environmental, Energy, Climate Change, Transport, Health, ICT), different EU directives [1][2][3] and many strategic initiatives and actions plans.

Particular mention deserves the following strategic initiatives and action plans:

- Smart Cities & Communities Initiatives
- Sustainable Urban Mobility Plans (SUMPs)
- European Future Internet Initiative (EFII)
- Strategic Transport Technology Plan (STTP-2011)
- EC White Paper on Transport 2050 (2011)
- *ITS Action Plan* (2009) and *ITS Directive* (2011)
- Europe 2020 Strategy (2010)
- Action Plan on urban mobility (2009)
- Green Paper on Urban Mobility & Action Plan (2008)
- JESSICA – Joint European Support for Sustainable Investment in City Areas

The *Smart Cities & Communities Initiative* aims to make Europe's cities more efficient and more sustainable in the area of energy, transport, and information and communication technologies. To this end, the Initiative aims to accelerate the large scale deployment of innovative low carbon technologies as identified in the EC Communication "Energy 2020 – A strategy for competitive, sustainable and secure energy" (action 3)[4]. The Initiative is part of the Strategic Energy Technology (SET)-Plan and supports ambitious demonstration projects in cities that undertake transformations of, for instance, their transport systems, building stock, and energy networks [5]. Thus ICT for Mobility in Smart Cities sits within a broader European political and strategic context that embraces a range of responses across transport, environment, ICT, energy, and health.

Programs, strategies, initiatives, and action plans from various EC DGs (among them being DG MOVE, DG INFSO, DG R&I, DG CLIMA, etc.) are articulated in the EU "*Research and Innovation Strategy*" and include:

- EU Transport Policy, such as the Strategic Transport Technology Plan (STTP-2011), the ITS Action Plan (2009) and the ITS Directive (2011), the Transport White Paper 2010-2020, and the Green Paper on Urban Mobility & Action Plan (2008);
- EU Research Policy in ICT in turn uses a variety of instruments to strengthen ICT research in the different transport and mobility sectors, including: The Seventh Framework Programme (7FP), The ICT Policy Support Programme (ICT-PSP), and The Competitive and Innovation Programme (CIP);
- Other policies and initiatives, including: The Europe 2020 Flagship Initiatives, The Digital Agenda, The European Future Internet Initiative (EFII), The European Economic Recovery Plan, The EU Environmental Policy, plus other major initiatives in climate change (EU-ETS), energy efficiency, health, and ageing areas.

The *Transport 2050 Roadmap to a Single Transport Area* [6] outlines a strategy for implementing measures to transform the transport sector. The main EC policy strategic responses are [7]:

- Reducing greenhouse gas emissions by at least 60% by 2050 (compared to 1990)
- Increasing the efficiency and capacity of the transport system (use less energy and cleaner energy)
- Closing to zero accidents and higher customer satisfaction
- Driving conventional cars out of the cities and optimizing urban logistics

The subsequent *EU Strategic Transport Technology Plan* (STTP-2011) aims to refocus transport research and development efforts in Europe. In terms of relevance for MoveUs, the STTP gives priority on how IT and traffic management tools can manage and integrate complex transport systems. In the short term, there will be a push to move ahead with the necessary EU measures to facilitate multi-modal integrated travel planning as well as necessary legislative measures to ensure service providers have access to real time travel and traffic information.

The *ITS Action Plan* [8] aims to help transport and travel become cleaner, more efficient, safer and more secure by accelerating the deployment of Intelligent Transport Systems (ITS) in road transport. The plan outlines six priority areas for action, with target date where in particular the following four offer a clear overview of how ITS can improve Intelligent Mobility.

The *Green Paper on Urban Mobility & Action Plan* (2008) provides the basis for the development of a European urban mobility strategy. The Green paper identifies a number of challenges, where the following are most relevant to the MoveUs context:

- Smarter urban transport –ITS can allow the routing and scheduling of journeys to be optimized to reduce carbon use, cost, and pollution. ITS also supports more efficient use of existing infrastructure and services, such as route choice, especially when combined with economic incentives.

- Accessible urban transport – urban transport infrastructures and services must be accessible to people with a diverse range of capacities and needs.

The *Europe 2020 Strategy* builds on the Green Paper. It sets out a vision to achieve high levels of employment and a low carbon economy (Smart Growth and Sustainable Growth), productivity and social cohesion (inclusive Growth and Economic Governance), to be implemented through concrete programs, actions and initiatives at EU and national levels. Europe 2020 emphasizes how ICT can contribute to resolving the following two mobility issues:

- Decarbonisation, including potential measures to support the roll-out of infrastructure to support electric vehicles, intelligent traffic management, better logistics, and the launch of European "Green Car Initiative"; and
- Infrastructure development, including the development of smart, interconnected transport and energy infrastructure.

The *ELTIS* and *ELTISplus* represent two projects (2010-2013) initiated by the EC to support the implementation of the Action Plan on Urban Mobility defining guidelines for developing and implementing sustainable urban mobility plans (SUMPs) by competent authorities in Europe [9].

The *European Future Internet Initiative* (EFII) [10] has identified several "Application Sectors" defined as "vertical usage areas" by the FI PPP programme, from which Transport and Mobility is probably the major one. ICT innovations shall bring opportunities to successfully manage relevant issues as well as traffic monitoring, reduction in energy consumption and pollution. In order to reach this target, several services can be envisaged:

- for local authorities and transportation operators (traffic monitoring, infrastructure management system, public transportation monitoring, toll collection system;
- for citizens (car sharing services, enhanced navigation solution such as eco driving assistance, in-building navigation, real-time traffic updates, multimodality transportation network, on demand public transportation services; for companies (goods multimodality transportation solutions).

JESSICA – Joint European Support for Sustainable Investment in City Areas, is a policy initiative of the EC developed jointly with the European Investment Bank (EIB) and in collaboration with the Council of Europe Development Bank (CEB). JESSICA aims to support sustainable urban development and regeneration through financial instruments, which combine European Structural Fund resources (ERDF) with other public and private sources of finance to create revolving investment funds such as Urban Development Funds (UDFs) to invest PPPs and other projects included in Integrated Plans for Sustainable Urban Development (IPSUD).

Malmö, Barcelona, Manchester and Amsterdam have been chosen as successful case studies within this initiative, since they all are pioneers of smart and sustainable cities as well as centers of innovation and creativity which support their sustainable development.

2.1.1.1.2 *Private initiatives*

Diverse technology companies have developed smart city initiatives of their own.

The *IBM Smarter Planet* [11] initiative emphasizes the importance of capturing, analyzing and utilizing data as part of what they call the Decade of Smart. Their conception of the smarter planet focuses on all 'things' being instrumented (by means of sensor or micro-computer), connected and communicating (via the internet) with other things in intelligent ways. A successful use case was the implementation of a new 'smart' road tolling scheme in the city of Stockholm, powered by an IBM system which allowed a network of cameras all over the city to take photos of vehicles and map their precise journey. This traffic system helped the city cut gridlock by 20%, reduce emissions by 12% and increase the use of public transportation dramatically.

The *Cisco Smart+Connected Communities* [12] initiative provides the ICT infrastructure and service delivery platforms to support smarter working, in new and existing cities. Cisco provide the supporting ICT infrastructure for Smart Grids, the data centres to hold, manage and processes the masses of data generated in the Smart City and provide local technical solutions to Smart Buildings and Smart Workplaces.

Ecomagination [13] is GE's business strategy to create new value for customers, investors and society by helping to solve energy, efficiency and water challenges. Simple Energy is an example of how gamification might contribute to global energy savings. It starts with someone inviting someone to join an energy consumption challenge through Facebook or email. The platform establishes a baseline to compare energy consumption according to the size of the living space, location and climate. Households are ranked on their energy consumption (or more specifically, ranked on their energy savings) against others in their group. Real prizes drive and in particular the competitive behaviour of children, drive significant energy savings.

Siemens Infrastructure and Cities [14] division looks at supporting sustainable solutions for the Smart City and also maintains the Green City Index, which looks at the performance of cities against a number of sustainability and wellbeing indicators.

2.1.1.2 National plans

2.1.1.2.1 *Finland*

Finland's Strategy for Intelligent Transport 2009 [15] was the world's first national ITS strategy covering all modes of transport. It attracted international attention and received the European Commission's eSafety Forum's Policy Award in Brussels in autumn 2010. A revised version of this strategy was elaborated in 2013 [16].

The Transport Policy Report (approved in April 2012), promotes the creation of a transport system centered on the level of service. In this system, a public sector

client defines the level of service required, and service providers are given greater freedom to meet these requirements through the technological means of their choosing. In the future, all levels of the transport administration will reflect this change in thinking. The report is based on the Government Programme, and will be promoted by the New Transport Policy Forum, which took over the duties of the Intelligent Transport Advisory Board when its term ended at the end of 2012. Intelligent transport will be integrated into the new transport policy and become a natural part of transport system development.

2.1.1.2.2 *Italy*

In 2001 a **General Plan** [16] for transport and logistics was launched by the Ministry of Transport and Infrastructure and became a reference text for technological innovation and improvement of the economic, environmental and safety aspects of transport systems. The text addressed effective and essential measures for the practices based on new technologies like intelligent transport systems and telematics applied to the transport infrastructure and technologies for the data acquisition and transmission inside the car. The need for a reference, unified architecture for the development of such systems was also stressed and was later considered within the national project ARTIST.

The objectives of the plan included also the development of innovative technologies aimed at improving the efficiency, safety and sustainability of the transport and traffic infrastructures and an improved use of infrastructure, services and resources, the development of low-emission vehicles and the promotion of alternative mobility solutions like shared vehicles. In order to address the problem of mobility in urban areas , the need for introducing an integrated planning process which could take into account the urban territory and the transport system was raised and intermodal transport interconnections to be achieved with investments and new organizational/management schemes were seen as primary objectives in that sense.

Another reference step for a comprehensive regulatory framework in the smart mobility organization was the Guidelines for **General Mobility Plan** [16] set by the Ministry of Transport in 2007. Considering the strong link between the local situation and the measures to be introduced, the plan encourages the cooperation between the local bodies and institutions for the realization of integrated transport solutions. One key aspect of the integration is the development of multimodal transport offerings with the objective of discouraging the use of motor vehicles for the individual or private transport with a preference for alternative methods of transport. Among these interventions, particularly significant is for example the activation of Park & Ride with interchange parking, usually built in sub-urban areas, where the car can be left and another mode can be used. Other action is the introduction of special pricing systems which could make the use of alternative modes of transport more appealing and attracting.

Thanks to the deep knowledge of the territory, in terms of needs and morphology, strategic areas of intervention have been addressed by the plan in the domain of

Mobility of persons (Public Transport and improved interconnections) and the Mobility of goods (logistics and distribution of goods). In this context, regulatory framework and common standards for IT and telematics have been studied and developed for the development of tools able to support integrated, sustainable and safe mobility. The guidelines of the GMP provides lines of action regarding information services, services and systems for the control and management of traffic and transport, dynamic navigation, Vehicle Control Systems.

In May 2007, the **Agreement on Infomobility** [16] was formalized at the national level, through the Joint Conference State-Regions-Local Authorities which led to activation of Regional Plans for Infomobility. This resulted in facilitating the promotion of initiatives for the development of new services by the individual regions.

Finally, the **Urban Mobility Plans** (PUM) [16] are planning tools for detailed mobility management at local level which consider a number of aspects forming all together a detailed and complete picture of the traffic and road traffic situation. This includes network infrastructure, local public transport, demand analysis, mobility and accessibility to the area, freight transport.

2.1.1.2.3 *Spain*

Sustainable Mobility Strategic and Legislative Framework were defined by the Spanish Federation of Municipalities and Provinces (FEMP) as a section of the Spanish Network of Cities for Climate, in collaboration with the Spanish Ministry of Environment.

There are two specific laws at regional level that regulate Smart Mobility in cities, which are:

- Ley 9/2013, de 13 de junio, de la movilidad de Cataluña [21].
- Ley 2/2006, de 30 de junio, de suelo y urbanismo de la Comunidad Autónoma del País Vasco [21]

2.1.2 European standardization initiatives

Intelligent Transport Systems for Urban Areas

Intelligent Transport Systems (ITS) support urban policy goals in areas such as travel information, traffic and demand management, smart ticketing or urban logistics. An integrated approach is even more required in urban areas, including various transport modes and combining both technical and policy issues. The citizen should be in the centre of attention.

Good local initiatives exist but sometimes with limited scope. Cities welcome support from the European level if they can retain independence to decide on ITS deployment. Technical solutions exist and the main barriers to more integrated deployment are more organisational or financial.

Both Action Plans on ITS and on Urban Mobility include complementary activity on ITS for urban areas.

- The ITS Action Plan[23] wants to set-up an ITS collaboration platform to promote ITS initiatives in the area of urban mobility.
- The Action Plan on Urban Mobility [24] offers assistance on ITS applications for urban mobility, possibly in the form of a guidance document.

In 2010 the European Commission has therefore set up an Expert Group on ITS [25] for urban areas with local authorities and their main partners to promote the deployment of ITS. The 24-month long mandate of the Expert Group ended in December 2012. During its mandate, **the Expert Group developed guidance on deployment of three key applications of urban ITS** (travel information, traffic management (incl. urban logistics) and smart ticketing) [26], **collected a number of related best practices and reflected upon the need for further standardisation in the domain of Urban ITS** [27]. The abovementioned documents are freely available in the 'Related documents' section. The European Commission strongly encourages local decision-makers to consult and use the Guidelines for deployment, in order to strengthen interoperability and continuity of ITS deployment across European cities.

2.1.3 Reference organizations, associations and other fora

2.1.3.1 EU level

There are a wide number of organizations and networks that aggregate, fund and stimulate various stakeholders (research, industry, local authorities) which facilitate the implementation of the EU policy framework for Smart Mobility and Smart Cities. The most relevant to MoveUs are:

- Smart Cities Stakeholder Platform
- European Foresight Platform (EFP)
- ENOLL
- Eurocities

The *Smart Cities Stakeholder Platform* promotes innovation and is part of the *Smart Cities and Communities European Innovation Partnership of the EU*. It aims to accelerate the development and market deployment of energy efficiency and low-carbon technology applications in the urban environment. The Platform brings together different stakeholders, including technology providers, financiers and specialists in implementing smart city strategies at local level. For each area (e.g. Smart Mobility and Transport, Smart Energy, Smart Environments, Smart Government, etc.) a technical Working Group (WG) is engaged in selecting from a spectrum of Solution Proposals (SPs) submitted by stakeholders the most promising and fundamental solutions, to accelerate the development of smart solutions in smart cities [28].

The *European Foresight Platform (EFP)* is a network building program supported by the EC FP7. It aims at building a global network of networks bringing together different communities and individual professionals to share their knowledge about foresight, forecasting and other future studies methods. Strategic activities in the area of smart mobility were stimulated at the EFP European Policy Workshop – Smart Mobility 2050 on June 2012

The *European Network of Living Labs* (ENoLL) is the international federation of benchmarked Living Labs in Europe and worldwide. Founded in November 2006 under the auspices of the Finnish European Presidency, the network has grown in 'waves' up to this day. To this date, 7 Waves have been launched resulting in over 340 accepted Living Labs. The ENoLL international non-profit association, as the legal representative entity of the network, is headquartered in Brussels, at the heart of Europe.

EUROCITIES is the network of major European cities. Its members are the elected local and municipal governments of major European cities. Founded in 1986 by the mayors of six large cities: Barcelona, Birmingham, Frankfurt, Lyon, Milan and Rotterdam, today this network brings together the local governments of over 130 of Europe's largest cities and 40 partner cities, which govern 130 million citizens across 35 countries. EUROCITIES lays on a powerful position to influence and work with the EU institutions to respond to common issues that affect the day-to-day lives of Europeans.

2.1.3.2 National level

2.1.3.2.1 *Finland*

The **Ministry of Transport and Communications** is in charge of implementing the strategy and is responsible for allocating sufficient resources to it within the transport administration sector. The Ministry is responsible for establishing intelligent transport as a central transport policy tool, and for creating a good operating environment for intelligent transport solutions through appropriate legislation and communication.

The national **Intelligent Transport Advisory Board (2010–2012)** assisted the Ministry of Transport and Communications in steering the implementation of the strategy and in preparing national guidelines e.g. for the European Union. When the board's term ended in late 2012, its transport policy management duties were taken over by the New Transport Policy Forum. The board's project-related duties, such as the monitoring and coordination of the development of the key projects, became the responsibility of the newly-established Intelligent Transport Strategy Coordination Group. The advisory board's communication policy-related duties were taken over by ITS Finland.

The **New Transport Policy Forum (2012–2015)** aims to ensure that transport policy is purposefully drafted in a way that promotes new types of customer-oriented operations and a culture of collaboration. It also aims to find new ways to

improve the productivity and impact of transport policy and to promote the efficient use of innovations and new technology.

The **Intelligent Transport Strategy Coordination Group (2013–)** assists the Ministry of Transport and Communications in steering the implementation of the strategy and in preparing national guidelines e.g. for the European Union. When it was founded in spring 2013, the coordination group took over the national Intelligent Transport Advisory Board's operative tasks, such as the monitoring, coordination and impact assessments of the key projects. Under the guidance of the Ministry of Transport and Communications, the Finnish Transport Agency is responsible for implementing the intelligent transport strategy in its sector and for guiding Centres for Economic Development, Transport and the Environment (ELY Centres) in implementing the strategy. The Agency is also in charge of ensuring the availability of services in major urban areas and continuity across administrative boundaries, and is responsible for the overall intelligent transport architecture.

Under the guidance of the Ministry of Transport and Communications, the **Finnish Transport Safety Agency TraFi** is responsible for implementing the intelligent transport strategy in its sector. TraFi places particular emphasis on ITS-related register and information services and on using ITS tools to create safety and environmental impacts.

ITS Finland acts as an advisory community of experts, which represents its members in implementing the strategy and– in cooperation with other stakeholders –monitors international developments and keeps its sector well-informed on these developments. ITS Finland promotes the globalization efforts of its members – and particularly of small and medium-sized companies – through the ITS Europe 2014 Congress and export network activities.

2.1.3.2.2 *Italy*

The **Ministry of Infrastructure and Transport** is the department of the Italian Government that has jurisdiction over transport infrastructure networks (road, highway, railway, port, airport), and regulates the plan for the transport sector, including urban mobility plans, logistics etc. The Ministry has a structured organization at central and peripheral level and supervise several bodies including: Port Authorities; Aero Club of Italy; the National Authority for Civil Aviation; the National Institute for studies and experiences of naval architecture; The National Board on the streets - ANAS SpA; CETENA S.p.a. - Center for the Study of Marine engineering; ENAV Spa-National Company for Air Navigation Services; Ferrovie dello Stato S.p.A.

The **Ministry for the Environment, Land and Sea**, (MATTM - Ministero dell'Ambiente e della Tutela del Territorio e del Mare), is the institutional body in charge of the implementation of environmental policy. Its functions address the environment, ecosystem, protection of marine resources, pollution, as well as the environmental impact assessment, Strategic Environmental Assessment and the integrated environmental authorization. In order to achieve the objectives and

execute its functions, the Ministry also promotes research initiatives in various fields including infomobility and Smart Mobility.

TTS Italia [29] is Italy's National Association for Telematics for Transport and Safety. It was established with the purpose of improving the efficiency and safety of the Italian transport system, through the analysis of problems and opportunities, formulation of proposals and dissemination of information and knowledge in the field of Intelligent Transport Systems. TTS Italia support and promotes the development of user-oriented and effective telematics applications at local and National level by providing support of various types. TTS Italia foster collaboration on technical, institutional and organizational solutions; promotes discussion about topics which could be of strategic interest and is engaged in spreading the experience and knowledge on ITS applications and best practices at national level. Following ERTICO's model, TTS Italia brings together both public and private organizations active in the development and implementation of Intelligent Systems for Transport and Safety.

Automobile Club of Italy – ACI [30] is a public organization, active in the regulatory control and steering of the automotive industry. ACI is engaged in the promotion and realization of infomobility systems with several initiatives and offerings in this sector.

CCISS [31] is a public service operating in Italy for the coordination of all traffic and road safety information at national level and the management of the national Traffic Information Center.

AutostradeTech [32] is a spin-off of the Atlantia Group, the financial holding of the group of companies active in the management of motorways under concession. AutostradeTech has an expertise in the area of research and development and integration of hardware and software systems. The technological know-how is applied to management, knowledge and development of solutions in the domain of Intelligent Transport System (ITS) particularly for toll collection systems, security and road network management.

Genoa Smart City Association [33] has been created by the Municipality of Genoa with Enel Distribution and the University of Genoa to consolidate and facilitate the process of transformation of the City of Genoa into a smart city and to engage key partners (research bodies, enterprises, institutions, and public finance institution and organizations) to undertake actions towards this objective. Smart mobility initiatives constitute a key segment where the association operates to reach these objectives.

The **Research Centre for Transport** (Centro di Ricerca Trasporti – CIRT) [34] is a qualified partner of private and public companies , government agencies for the execution of feasibility studies for the establishment and the development of partnerships at national and European projects in the field of multimodal transport (road, rail and maritime). CIRT participates in numerous European projects in the field of technology and planning of railway transport, the execution of studies in the field of logistics applied to land transport, maritime and intermodal and

comparative analysis on systems and vehicles for local public transport. In the field of land transport road, particular attention has been paid to public transport systems and the management of goods in urban areas especially with regard to safety and better use by citizens.

ENEA [35] is the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA). ENEA has set up a structure, the Technical Unit for Energy Efficiency (UTEE) [36]. Among the other activities, this body studies the evolutionary trend and the environmental and energy impact related to the mobility of people and goods in various modes of transport. UTEE operates along various lines of action including planning, evaluation of policies and actions for energy consumption/ environmental improvement as well as the development of instruments, technologies and methods for efficient management of the mobility of transport and goods. UTEE promotes research, development and application of innovative solutions for sustainable transport, in collaboration with industrial partners and central and local government bodies.

MobilityTech [37] is the International Forum on technological innovation for the development of mobility and transport, which aims to create opportunities for dialogue on technological innovation and the development of public transport systems and mobility in Italy and in Europe.

Federmobilità [38] is a non-profit association active in the promotion and support of sustainable mobility with several initiatives. Federmobilità brings together the administrations in charge of mobility management at different level: Regional, Provincial and local/Municipal.

Euromobility [39] is an association for the promotion and dissemination of information, knowledge, culture and education suitable to promote and encourage the introduction of new forms of mobility and transport, both individual and collective which could be more and more eco-friendly, for a better quality of citizens' life and preservation of the environment.

Metrogenova.com is a forum on metro and public transport in Genoa.

2.1.3.2.3 *Spain*

Transport Research Centre (TRANSyT) [40] is an organisation launched in 2004 by the "Universidad Politécnica de Madrid" (UPM) with the aim of:

- Generate management capacity and participation in programs and projects within the transport area.
- Promote the relationship with centres of similar characteristics.
- Transfer technology to other countries.
- Transfer knowledge to the scientific community and the society as a whole within the transport sector.
- Serve as a link between universities and different transport stakeholders.

Metropolitan Mobility Observatory (MMO)[41] is an initiative of analysis and reflection, comprised of the Public Transport Authorities (PTA), of the main Spanish metropolitan areas, the Ministry of Agriculture, Food and Environment and the Ministry of Public Works in order to reflect the contribution of public transport to improve the quality of life and sustainable development in cities.

The MMO publishes an annual report analyzing the mobility of participating metropolitan areas. Another important activity is the MMO Technical Conferences, which presents the annual reports.

Centre for Innovation in Transport (CENIT) [42] is a research centre created in 2001 as a consortium between the Generalitat de Catalunya (Autonomous Government of Catalonia) & the Technical University of Catalonia (UPC). Its aim is to generate knowledge about all transport fields and make it available throughout society.

The activities currently developed by CENIT can be included in the following main areas:

a. Advanced technologies applied to transport exploitation and logistics.
b. Road & railway infrastructures
c. Air & maritime infrastructures.
d. Economic, social and environmental impact of transport.
e. Country planning and transport laws.

Associació per a la Promoció del Transport Públic (PTP) - in English, Association for the Promotion of Public Transport - (PTP) [43] is an NGO born in 1993 who works continuously for safe and sustainable mobility based on the improvement of collective public transport, in every aspect, and reduce the current reliance of private vehicles for transportation of passengers and goods. The goal of PTP is to improve environmental quality and social equity from the defense of a more inclusive and sustainable mobility that meets the needs of mainstream mobility.

2.2 Smart Mobility Initiatives

2.2.1 EU level

2.2.1.1 Smart cities stakeholder platform Key Innovation on Smart Mobility

The "*10 Years Rolling Agenda*", prepared by the Smart Cities Stakeholder Platform, highlights identified actions at European level required to promote the adoption of Key Innovations (KI), the removal of regulatory barriers or recommendations on the focus of the Horizon 2020. The objective of the Agenda is to present stakeholders' ideas forming a 'practical vision' of the Smart Cities Stakeholder Platform on how to move forward in accelerating the deployment and integration of

technologies that are required to transform European cities and communities into 'smarter' cities and communities.

In the area of Smart Mobility and Transport the following four main KIs have been collected and refined by the Platform:

- Multimodal personal mobility: the aim is to combine public transport with other motorised and non-motorised modes as well as with new concepts of vehicle ownership.
- E-Mobility and Power Matching: the aim is to match transport demand and supply on the one hand (by promoting electric vehicles or bicycles) and electricity demand for e-mobility and power supply capacity (by promoting smart charging stations and connections with smart grids) at the right place and time on the other hand.
- Cooperative Intelligent Transport Systems and Services (C-ITS): all cooperative parties (ITS stations, i.e. vehicles, road side units) exchange information between each other, enabling self-organisation at a local level, i.e. up-to-date traffic information, improved road safety and traffic efficiency
- Smart Organisation of Traffic Flows and Logistics: it involves multi-agency interaction, linking individual mobility with public transport services. Beyond the technical requirements of data exchange it also requires new governance structures to reach changes in mobility behavior.

For the "Multimodal personal mobility" KI, which is the most relevant KI to MoveUs, the toolkit includes seven SPs, all selected with the aim of integrating technologies in order to encourage the multi-modality for public transport users, motorists, cyclists and pedestrians as well as logistic companies. These SPs are identified in the following pilot projects and best practices:

- (SP#1) SMILE - Simply Mobile Integrated Mobility Platform with Personal Mobility Assistant. Pilot Project (Oct. 2012) to be carried out in Vienna and other Austrian cities, driven by transport operators, it provides an integrated mobility platform with a personal mobility assistant which allow end-users to get real-time information for their multimodal travel chain, to book all transport modes needed and to receive the necessary tickets and access codes.
- (SP#2) BUSDIRECT - Selective Priorisation for Buses in urban context. Best Practice (Sept. 2012) accompanying action to improve multimodality and favour public transport and soft modes compared to the car. Already implemented in Valladolid, Vitoria and other cities, it provides interaction between bus fleet management systems and traffic-light center, considering the main goal of making the bus/tram network more attractive for city mobility, improving quality of services (interval regulations).
- (SP#3) FACTUM - Facility Assigning Credits for Urban Mobility. Pilot Project (Oct. 2012), it applies a system of credits to influence personal mobility in cities (or city districts) with high congestion and space problems. Credits could be earned by people when using specific modes of public transport, an extra-urban parking facility or as an award for avoiding a congested route.

Those credits could be spent as discounts on transport facilities or to purchase the right to enter a restricted traffic area.

- (SP#4) OPTIMOD'Lyon - Optimised urban mobility for passenger and freight. Pilot Project (Oct. 2012) which sets up a multi-modal information platform integrating multi-source data for different modes and services, such as carpooling, carsharing, bikesharing, and time scale (historical, real time and predictive data). This aims at reducing traffic congestion and improving mobility information services in urban areas for people and freight operators. Three services will be plugged on this platform: a predictive tool, a multimodal GPS with real time and predictive information and a freight navigator.
- (SP#5) SIMBA - Intermodal mobility chains for people with special needs. Pilot Project (Oct. 2012), providing mobility options for elderly people/ people with special needs, considering their capability to understand paper-based information material instead of electronic resources.
- (SP#6) Low Lijn Amsterdam. Pilot Project (Jan. 2013) focuses on the creation of a specific bicycle parking garage involving specific amenities.
- (SP#7) eMORAIL – Integrated eMobility Service for Public Transport. Pilot project (Jan. 2013), commuters use electric cars - which are used during the day by companies for their business - to reach the nearest station, where they switch to the train to town and there use public transport or e-bikes for the last mile.

For the E-Mobility and Power Matching KI, which also has some relevance to MoveUs services, the following SPs deserve particular attention:

- (SP#2) Integration of electric vehicles and energy infrastructure. Project idea (Sept. 2012) whose innovation in the energy management is not only in terms of capacity but also a smart usage of electricity. The project provides up to the minute info by sensors and congestion alarm.
- (SP#3) KATE: Personal Mobility Assistant. Pilot Project (Sept. 2012), is intended as framework providing generic functionalities that can be used to create innovative mobility services. The Personal Mobility Assistant application called "Congestion Alarm" is the first application developed on top of the KATE platform. The KATE platform comprises a number of modules to predict travel times and travel patterns, an agenda (including appointment retrieval functionality), a database containing travel profiles, surveys, serious games and more. The platform provides a mechanism to disclose open mobility data within the smart city and is intended for the development many different smart city services.
- (SP#5) ICT solution to enable efficient car-sharing services (including EVs). Best Practice (Dec. 2012) which aims at providing in Madrid a smart organisation of the procedure of car sharing services including the specific needs of EV.

2.2.1.2 EC projects and initiatives on Smart Mobility

Innovation in the Smart mobility area through EC projects involves different programs (mainly FP7 and CIP), different funding instruments (e.g. Collaborative projects, coordinated and support actions, demonstration pilots) and different specific themes (e.g. Open Innovation for internet enabled services, ICT for a low carbon economy and smart mobility).

2.2.1.2.1 *Smart Cities Pilots Portfolio (CIP ICT-PSP)*

The 'Smart Cities Portfolio Working Group' brings together different cities (e.g. Issy-les-Moulineaux, Brussels, Cologne, Bologna, Oulu Bremen, Malmo, etc.) which also act as 'Living Lab' test-beds for new Future Internet services that will benefit citizens and businesses alike.

In the Open innovation for internet enabled services theme, smart mobility and transport have been addressed in different ways by the following projects:

Demonstration Pilots:

PEOPLE – Pilot Smart Urban Ecosystems Leveraging Open Innovation for Promoting and Enabling E-services – One of the two scenarios focuses on smart mobility and urban information services to citizens in relation to public safety but also to city living aspects (commerce, leisure and tourism);

PHERIPHERIA – Networked Smart Peripheral Cities for Sustainable Lifestyles – One of the urban settings focuses "Smart Street, meant as corridors supporting multi-modal mobility", as a livable public/social space where new transportation behaviours and new kind of interactions develop;

SMARTiP – Smart Metropolitan Areas Realised Through Innovation & People – this open platform focuses the co-production of citizen-centric internet- enabled services also in smart mobility, for citizen' personal travel routes using public and private transport, cycling and walking, with the aggregation of real time data and analysis of data.

Platforms:

CitySDK – Service Development Kit for Cities – this project create a Smart City Application Ecosystem through large-scale demand-driven City Pilots that package and align key smart city application areas to an open source service developer toolkit in the domains of Mobility, Tourism and Participation.

In the "ICT for a low carbon economy and smart mobility" theme, the demonstration project **IN-TIME** – Delivering intelligent and efficient travel management for European cities – focuses on multimodal Real Time Traffic and Travel Information (RTTI) services with the goal of 1) reducing drastically energy consumption in urban areas across the different modes of transport and 2) changing the mobility behaviour (modal shift) of the single traveler. With pilots in

Brno, Bucharest, Florence, Munich, Oslo and Vienna, it offers via a harmonized, standardized and open interface, B2B services which encourage access to the single city's traffic and travel data and services to Europe-wide Traffic Information Service Providers (TISPs).

COSMO: Cooperative Systems for Sustainable Mobility and Energy Efficiency – The projects looking at addressing energy aspects is in the traffic environment through different angles: vehicle fuel consumption, engine technology, environment sensitive traffic control strategy; eco-driving style, LED technology energy, etc.

Co-Cities – This is an ICT PSP pilot project which aims to introduce and validate cooperative mobility services in cities and urban areas. It will develop a dynamic 'feedback loop' from mobile users and travelers to the cities' traffic management centres, and add elements of cooperative mobility to traffic information services.

MOBI.Europe – It promotes the full integration and interoperability of a cloud of ICT applications associated with electro-mobility among European citizens. The project aims to develop mobility services in benefit of the EV user. MOBI.Europe will enable also the assessment of energy sources and the tracking of each user carbon footprint, opening the door to the integration of a new credit model based on CO2 emissions, thus setting a benchmark for rewarding consumers.

SYNCRO – This CIP – Competitiveness Innovation Programme (CIP) project aims at developing a smart road system, from road/car sensors to smart data collection.

Concerning FP7:

OUTSMART – It aims to contribute to the Future Internet (FI) through the development of five innovation ecosystems. These ecosystems facilitate the creation of a large variety of pilot services and technologies that contribute to optimised supply and access to services and resources in urban areas.

iCARGO – This FP7 projects aims at designing and implementing a decentralized ICT infrastructure allowing new logistic and planning services that: i) synchronize vehicle movements and logistics operations across various modes and actors to lower CO2 emissions; ii) adapt to changing conditions through dynamic planning methods involving intelligent cargo, vehicle and infrastructure systems and iii) combine services, resources and information from different stakeholders, taking part in an open freight management ecosystem.

INTRASME (Innovative Transport SME Support Action) – This FP7 project aims at improving the capacity of European SMEs to develop and implement innovative solutions in the Low Carbon and Smart Mobility sectors focusing on the changing role that SMEs have on innovation mechanisms for the transport sector.

T-TRANS – Enhancing the transfer of Intelligent – Transportation System innovations to the market. Studies innovation mechanisms for the Intelligent Transport Systems (ITS) and identifies best practices for upbringing innovative ITS products and services to the market. Facilitates innovation mechanisms in the ITS domain thought four use cases.

2.2.2 National level (pilot cities)

2.2.2.1 Tampere

The strategy's implementation programme includes the following key projects:

1. Intelligent transport system reference architecture
2. Real-time situation picture of transport system status and operation
3. Integrated public transport system
4. Intelligent traffic control
5. Reactive and proactive safety systems
6. Multi-service model for transport
7. Intelligent logistics
8. Smarter and more eco-friendly mobility
9. Innovation and piloting programmes for intelligent transport

Project Coordinator and Participants	Project Description
MinTC, FTA, TraFI, ITS Factory 2013-2015	Organise and allocate resources for influencing and participating in ITS sector standardisation.
FTA, MinTC, TraFI, ITS Finland, municipal sector, corporate sector 2013-2015	Draw up an upper-level intelligent transport reference architecture
FTA, TraFI, ITS Finland, LVM 2014-2015	Update the transport information architecture and the national KALKATI.net interface library ti fit current and future ITS needs. Establish a host organisation for the updated intelligent transport information architecture to be in charge of updating, implementing and maintaining the architecture.
FTA, MinTC, TraFI, ITS Finland, R&D sector, ITS Factory 2014-2015	Assess the need for and steps of any and all certification procedures for intelligent transport systems and services.

Table 3 Involvement of Tampere in smart mobility projects and initiatives

More information, for each of the key strategic projects can be found in the document elaborating 'Finland's Second Generation Intelligent Strategy for Transport' [44].

2.2.2.2 Genoa

Project Acronym and Link	Project Description
CIVITAS CARAVEL (Program CIVITAS II). (http://www.civitas-caravel.org/)	The initiative CiViTAS aims to promote the development of new strategies for sustainable urban transport, based on actions, new technologies and innovations applied to infrastructure. The municipality of Genoa coordinated the **CIVITAS CARAVEL** project and developed a number of initiatives and new solutions in the domains of Integrated access control, Car sharing, Mobility Plan, Central monitoring of accidents, Integrated model traffic environment.
MERCURIO (http://www.bluareagenova.it/repository/public/crediti_mobilita/depliant_mercurio.pdf)	**MERCURIO** is a project, commissioned by the City of Genoa aimed to rationalize and optimize the transport of goods within the Old Town, in order to facilitate the preservation of the environment, public health and urban quality of our historic downtown.
DEMOCRITOS (http://democritos.ipacv.ro/)	**DEMOCRITOS** (2009-2011) is an EU project which introduces the concept of "Mobility Credits" as incentive for the promotion and achievement new and sustainable schemes of transport and travel behavior in the Urban Context. The concepts and results developed during the project have been simulated in Lisboa, Craiova, Stuttgart and Genoa.
iCity (2012-2014) (http://www.icityproject.com/)	**iCity** is a running Pilot B project under the CIP ICT Policy Support Program, aiming to facilitate the co-creation of services of public interest by third parties interested in playing the role of service providers in Smart Cities' urban spaces. Open innovation ecosystems such as Living Labs are seen as pivotal in bringing the users together in the whole co-creation process. Particularly, iCity looks at different types of stakeholders and their synergies in the process: private and third sector as new services developers, and citizens and companies as beneficiaries and final users of the new services. The project responds

	to the growing demand from social stakeholders to provide services of public interest based upon the exploitation of available public information, digital assets and infrastructure. Open Data and Open Infrastructures are in the focus of iCity, where the available municipal ICT networks already deployed in urban spaces will be made available and accessible to open innovation ecosystems (especially SMEs) with the objective of maximizing the number of deployed services of public interest. Together with the Greater London Authority, the Municipality of Barcelona and the Municipality of Bologna, the Municipality of Genoa is one of the Local Administrations piloting several open data based applications in domains of a public interest, including transport and mobility.
eMOTION (2006-2008) (http://www.emotion-project.eu/)	**eMOTION** is an initiative co-funded by the European Commission under the thematic area Sustainable Development, Global Change and Ecosystems of the 6th Framework Programme for Research and Development. The objective of the project is to investigate, define, specify recommendations about Pan-European solutions for the provision of multi-modal, pre-trip and on-trip Traffic and Travel Information Services based on well-known and emerging standards. The Municipality of Genoa participated in the project and a Proof of the Concept was developed in the City.
3iPLUS (http://plus.3i-it-fr.eu/)	3iPLUS is an EU project co-financed with the European Regional Development Fund whose aim is the realization of a data processing structure able to gather information on transportation and real-time traffic and to make it and accessible in a uniformed way to users through common networked devices. The city of Genoa is partner of Subproject B "Design and implementation of a multi-device travel planning", and Sub-project D for the provision of services for real-time information on mobility.
S.I.MO.NE (http://www.programmaelisa.it/BP-SIMONE-1.pdf)	**S.I.MO.NE** (Innovative System for Management of Mobility in Metropolitan Areas) is National project coordinated by the City of Turin and 5T with the collaboration of a number of local authorities including the Municipality of Genoa aiming at developing and establishing innovative systems for management of mobility in Metropolitan Areas. The new Traffic Supervision System of the Municipality has been developed within this initiative.

New mobility services for the City of Genoa (MATTM initiative)	New mobility services for the City of Genoa (MATTM initiative) is a national project for the development of new and innovative infomobility services in the city of Genoa. The initiative operates especially in relation to the developments obtained with the S.I.MO.NE project (the traffic supervisor) and the information systems available for public transport (mainly the metro).
IO guido 1. (http://www.genovacarsharing.it/privati/circuito_ioguido.aspx)	IO guido is an initiative of Genova Car Sharing which make available the Car sharing service for individual use in Genoa.
"Bus a chiamata" (https://www.amt.genova.it/rete_e_orari/drinbus.asp)	"Bus a chiamata" (On-Demand Bus - Ministry of Environment and Protection of Territory) is a project where a system of flexible public transport suitable for urban areas or situations with low demand of public transport has been designed, built and put into service.
SIDDHARTA (European Union) (http://ec.europa.eu/environment/life/project/Projects/files/laymanReport/LIFE03_ENV_IT_000319_LAYMAN.pdf)	SIDDHARTA is an initiative about Bus on demand.
Collective taxi (Taxi collettivo - Ministry of Environment and Protection of Territory) (http://www.amt.genova.it/news_e_promozioni/multitaxi.asp)	Collective taxi is a project aiming at activating a collective taxi service for the management of emergency situations.
eMobility	eMobility (European Union) is a EU project where innovative parking management solutions have been developed.
Wi-Move (http://www.wimove.it/)	**Wi -move** (ELISA Program - Local Authorities program - Innovation System) is an initiative where several Infomobility projects and solutions have been carried out.

Table 4 Involvement of Genoa in smart mobility projects and initiatives

Other initiatives and involvements in EU projects by the Municipality of Genoa includes: ASIA, INVISIP, PELLUCID, ROTRANOMO, EDGE, SILENCE, SEA / TRAMO.

2.2.2.3 Madrid

Project Acronym and Link	Project Description
Secur-ed (www.secur-ed.eu)	The main objective of the SECUR-ED project is to give transport operators of large and medium cities of Europe the means to enhance urban transport security. The second main objective is to enlarge the mass transport security market for the European industry.
Enhanced WISETRIP (www.wisetrip.travel)	The proposed Enhanced WISETRIP project aims at building on the knowledge developed in the last FP7 project to bring the current system to new possibilities to create an open platform for planning, booking and travelling multimodal journeys adapted to all user needs.
Gambas (https://sites.google.com/site/gambasict/)	The GAMBAS project develops an innovative and adaptive middleware to enable the privacy-preserving and automated utilization of behavior-driven services that adapt autonomously to the context of users.
COSMOS	In a world of multi-stakeholder information and assets provision on top of millions of real-time interacting and communicating things, COSMOS aims at enhancing the sustainability of smart city applications by allowing IoT-based systems to reach their full potential.
IPPOCRATE	Instruments for the preparedness and protection of critical assets from terrorist risks.
FREVUE	Pilot project of the Seventh Framework Programme to demonstrate the feasibility of electric vehicles in urban freight distribution.
e-MAD (acronym to be confirmed)	Interoperability demonstration pilot project for implementation of commercial experience charging management of electric vehicle (would become the MOVELE continued, as it has avoided launching a public tender).
MADEV (http://www.eib.org/products/technical_assistance/elena/index.htm)	Project of ELENA program from the European Investment Bank to support investment in both the public and private charging infrastructure and electric vehicles.
STARS (www.starseurope.org)	The project aims to design a program of action to promote cyclist mobility in schools and get a change in shift mode schoolchildren to and from school. The goal is

	to get at least 5% of trips made, move from car to bicycle. There are two lines of action: design a model of accreditation for schools and develop a loyalty program involvement and young people between 11 and 19 years to involve themselves in the development of awareness campaigns.
POLIS Partners: Madrid City and EMT (http://www.polis-online.org/)	Dissemination and promotion of sustainable mobility initiatives, Madrid City Council abroad fostering synergies, projects and external funding sources.
deAaB Pilot Programme (http://www.deaab.com)	Pilot program for the promotion of carpooling in companies.
Sustainable Urban Mobility Plans in Madrid City	Definition of Sustainable Urban Mobility Plans (PMUS) driven by DG of Sustainability of the Madrid City Council.
MOVELE Plan (www.movilidadelectricamadrid.es)	Plan for the implementation of electric vehicles charging points in the City of Madrid.
EVUE (www.urbact.eu/evue)	Development of Electric Mobility Strategy of the participating cities and knowledge sharing through networking and maintaining regular meetings in the participating cities and seminars by experts in other cities that hold the active promotion of the electric mobility.
GREEN eMOTION (http://www.greenemotion-project.eu/)	Develop and demonstrate a commonly accepted framework and easy to use consisting of interoperable and scalable technical solutions in relation to a sustainable business platform: smart networks development, innovative ICT solutions, different types of electric vehicles, different concepts of urban mobility, etc.
CONNECTED URBAN DEVELOPMENT (CUD) Programme (http://www.smart2020.org/case-studies/connected-urban-development/)	The CUD programme is a five-year initiative aimed at reducing global carbon emissions while simultaneously promoting economic development by fundamentally changing the way cities operate and use natural resources. CUD is a Public-private partnership between Cisco and cities around the world (incl. Madrid) that demonstrates how information and communication technology (ICT) and network connectivity can increase efficiencies and reduce carbon emissions in urban environments.

Table 5 Involvement of Madrid in smart mobility projects and initiatives

2.3 Current technology status

2.3.1 Mobility data acquisition

Different technologies for the acquisition of mobility data will be used in MoveUs project, which can be obtained either by systems deployed in the infrastructure, in-vehicle systems and by the use of personal devices and mobility applications.

This sub-section will briefly describe the status of the data acquisition technologies considered in each of the three aforementioned categories and will identify the main challenges still unsolved.

Further technical details are provided in Annex A1.1 to this Deliverable D2.1.

2.3.1.1 Data acquisition technology from the mobility infrastructure systems

Traffic data collection refers to equipment capable of acquiring -and processing- basic traffic data, either from highway or from urban roads. Traffic data collected is used to supply information about conditions in the field to other system components, and provide information needed to perform functions like traffic conditions measuring, control decision taking and road performance monitoring.

Inductive -loops sensors- detection technology

Induction loops are able to detect, count and classify vehicles, by forming a pair of rectangular loops per detection site, specifically before an intersection itself, in order to know urban intensity (vehicles flow) and occupation (stationary vehicles).

Challenges to be solved

Inductive loops-based detectors are normally used due to their high robustness and reliability, their low sensitivity to adverse meteorological conditions and their low cost. Therefore, the probability of erroneous vehicle sensing is very low, although they can also suffer from shifts in their reference frequency, mainly due to big thermal changes in the pavement, and from possible breaks or wire short-circuits.

Video-Based traffic surveillance technology

The video surveillance system allows real-time visual coverage in special places where incidents are likely to happen in order to take the appropriate measures against incidents that may happen on the urban roads, highways and on entrance ramps and exits.

This system constitutes a basic visual aid to ITS operators located in the Traffic Control Centre (TCC). The traffic data that can be obtained with this system are intensity (flow), average speed, and traffic composition (light and heavy vehicles).

Challenges to be solved

CCTV cameras are located in specific points of the road and can provide with information only at the local level.

Video-based detection technology

Video detection technology provides real-time data and image information for optimal traffic control and fast accurate incident detection.

Video streaming systems are also used for the visualization and verification of the pedestrian detection in pedestrian ways or at specific road points like crossing zones at road intersections.

Challenges to be solved

The traffic operator is still in charge of evaluating and confirming that the occurring incident detected by the AID system is an incident or not (i.e. in sandstorms, at the sunrise and sunset periods…). Only when the operator confirms that is a real incident the automatic process may begin.

Pedestrian with different visual patterns than configured in the detection software (person pushing a pram, person in a wheelchair, children, etc.) may need a specific detection software in order to be correctly detected by the system.

Bluetooth technology

Bluetooth is a wireless standard used to communicate between electronic devices like mobile/smart phones, headsets, navigation systems, computers etc. It provides an accurate and inexpensive way to measure travel time and make origin/destination analysis, by means of Bluetooth road sensors able to detect Bluetooth devices passing nearby.

Challenges to be solved

The penetration rate of the technology in the society and the need to have activated the Bluetooth communication in the personal devices may not be sufficient, in some cases, so as to collect representative mass of traffic and mobility data.

Optical Character Recognition (OCR) technology

This technology lies in the recognition of a printed text in an image, and its digitizing into an electronically readable text, so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as key data extraction and text mining. This concept is directly applied to Automatic Number Plate recognition, what is of use for systems such as Traffic Enforcement Cameras and vehicle identification and tracking systems in parking facilities, restricted zones, etc.

Challenges to be solved

The images obtained in the operation environment are not perfect, thus the character recognition process may face several problems:

- The location of the cameras and the different height of the vehicles in urban roads may cause visual occlusion effects in the camera thus avoiding an accurate detection of the number plate;
- The device that captures the image might introduce levels of grey color at the bottom that do not belong to the original image;
- The resolution of those devices might introduce noise in the image, affecting the pixels to be processed;
- The distance between the characters to be detected is not always the same, what might cause errors in the detection;
- The connection of two or more characters per common pixels might cause errors too.

2.3.1.2 Data acquisition technology from in-vehicle systems

"Floating car" or "probe" data collection (FCD) is a set of relatively low-cost methods for obtaining travel time and speed data for vehicles traveling along streets, highways, freeways, and other transportation routes.

FCD technology provides advantages over other methods of traffic measurement:

- Less expensive than sensors or cameras
- More coverage (potentially including all locations and streets)
- Faster to set up and less maintenance
- Works in all weather conditions, including heavy rain

Broadly speaking, three methods have been used to obtain the raw data:

- **Triangulation Method**. The phone(s) contained in each vehicle periodically transmit their presence information to the mobile phone network, even when no voice connection is established.
- **Vehicle Re-Identification**. Vehicle re-identification methods require sets of detectors mounted along the road. In this technique, a unique serial number for a device in the vehicle is detected at one location and then detected again (re-identified) further down the road. Travel times and speed are calculated by comparing consecutive detections.
- **GPS Based Methods**. Position readings from in-vehicle GPS navigators these vehicles are used to compute vehicle speeds.

Challenges to be solved

FCD provide valuable information to operate in the local level, however lacks a more global view of the traffic situation in the whole road network.

The conceptual idea of using cars as sensors to measure, acquire data and share related road environment and traffic situation, have been explored [116][117], being now technically feasible many advanced functionalities. As reported in a paper of 2008 [118], a modern car can be equipped with more than one-hundred different sensors. For sure, the usefulness of the sensor is determined by the desired use; nevertheless, relevant information is commonly available: state of the street (accelerometers, gyroscopic angular and linear position), state of the traffic (speed), weather and environmental information (temperature, pressure, rain), radar/video capture systems and others signals (e.g. complex systems as ABS (Antilock Breaking System)), that can be used as "implicit" sensors when active. Concerning the communications on the in-vehicle network, the Smart Car Sensor Network (SCSN) concept implies collection of acquired measurements and making them available inside an in-vehicle network by using a standardized buses at the desired data rate, enriched with position information from GPS system.

At this stage, the gathered information could be used in isolation by the vehicle; however, the great potential is to share among the different actors, enriching and improving the information to support reliable decision making, following different approaches (e.g. centralized, distributed). **V2X technologies supports the so called Cooperative Systems, being considered as one of most promising solutions to address current and future needs for increased safety and road efficiency.**

During the last decade a strong effort has been made in this field through different initiatives and R&D projects, aiming at last term to align and harmonize existing results in order to achieve the required critical mass on Cooperative Systems. In addition, the European Commission promoted an intense activity on standardization, looking also outside to establish a fruitful cooperation with the U.S. and Japan. Some relevant standardization work is being conducted under major standardization bodies, such as ISO (ISO TC204 WG16 CALM, WG18 jointly developing standards with CEN TC278 WG16 on cooperative systems), IEEE (IEEE 802.11 [i.1] /p and 1609 WAVE) and ETSI (TC ITS) that have resulted in specifications regarding an ITSC system architecture, functionality and protocols.

The framework for the support of research in European Cooperative ITS was set by the Intelligent Car Initiative [119], one of which pillars was the iMobility Forum [120], whose Communications Working Group advised the European Commission on the deployment of a harmonized EU wide communication system for V2V/V2I.

On the industry side, key initiatives can be also mentioned such as the Car2Car Communication Consortium (C2C-CC) [121], promoting an open European industry standard for V2V wireless communications.

Concerning research and development activity, funded by the local, national and European Commission under the 6th and 7th Framework Programmes, putting the focus perspectives on different aspects: from the global view, the ISO CALM architecture [119], the development of a safety bubble ensuring the driver awareness to anticipate potentially dangerous situations [122], defining V2I communications for safety-relevant data exchange [123], specifying risk warning

and intervention functionalities [128], addressing a common functional architecture [124] or dealing with security and privacy aspects [125]. More recently, GEONET [126] produced reference specifications covering geo networking and IPv6, adopted for standardization and PRE-DRIVE C2X [127] prototyped a common European V2X communication system and designed the necessary tools for operating Field Operational Tests.

Beyond always promising R&D projects, Pilots and Field Operational Tests are intended to bridge the gap from demonstrations to roll-out, providing real performance, user acceptance and cost-benefit ratio of these systems. Some representative examples at national and regional level are: SIM-TD in Germany, SCORE@F in France, SPITS in the Netherlands, Easy Rider in Italy and SISCOGA in Spain, among others. In the chapter of pilots relevant to MoveUs, the most representative is COMPASS4D [129], aimed to deploy three Cooperative ITS services (Intersection management) in seven different European cities.

Challenges to be solved

The main challenges are the efficient calibration of a the heterogeneous sensors deployed, the ability to scale to support real operational scenarios, in terms of communication bandwidth, storage and processing capabilities upstream and whole system performance.

2.3.1.3 Data acquisition from Crowdsourcing

The word "crowdsourcing" was invented in 2006 to describe the participation of a crowd in a process of co-creation based on ICT (information and communication technology); this concept can be applied to a wide range of activities, including the acquisition, collection and use of mobility data reported by on-line communities that may include pedestrian, commuters and/or drivers.

Solid examples of this new technology for mobility data acquisition are WAZE app and iCOYOTE app.

- WAZE app is the world's largest community-based traffic and navigation app, which can be considered as a social-GPS multiplatform navigator. Waze connects drivers to one another, in order to create local driving communities that work together to improve the quality of everyone's daily driving by sharing real-time traffic and road info on their daily commute (including information about fuel prices in the different fuel stations, etc.). Waze also allows sharing information about alerts like police management actions, accidents, road hazards and/or traffic jams in real-time. Waze app is compatible with iOS, Symbian, BlackBerry, Windows Mobile and Android operating systems.
- iCOYOTE app users create an on-line community to which they contribute with warnings about the presence of mobile, fixed and average speed road radars in the real time; afterwards this information is sent to the rest of iCOYOTE users riding by the zone where the radar has been detected and

reported for the following three hours. The information about the location and the type of radar is daily updated. iCOYOTE also informs users about 'risk zones' where radars have been often detected for the last three months.

Challenges to be solved

The accuracy of the information obtained and its representativeness may depend on the active contribution of the people as information suppliers. In some cases, a critical mass of information suppliers may be needed in order to fully rely on the crowd-sourced information.

The human factor (accuracy in the reporting and trust in the information reported by other people) is also a key issue in the use of this technology.

2.3.2 Data integration and analysis

Different types of algorithms will be developed-and implemented in MoveUs for mobility data handling and analysis, which can broadly be classified in the following categories: Data fusion, Analysis & Prediction and Routing.

2.3.2.1 Data fusion

At present day, there are a variety of sensing technologies able to capture information about the current state of the road. In fact, they are constantly improving and developing new technologies for vehicle detection and monitoring, which may support the measure of speed, vehicle count, presence detectors, vehicle classification, etc. Each detection device, however, has its pros and cons, making it suitable for some purposes, but not for others, none is appropriate to cover all the needs, therefore the need for a merger of appropriate data. The problem of merging data from multiple sensors in order to define the so-called Dynamic Traffic Assignment Models (DTA) has been widely addressed in traffic engineering literature.

In general, fusion operators can be classified according the information managed. Soriguera [45] proposes the following taxonomy: Context Independent Constant Behavior Operators (CICB), where only measures are taken into account (e.g. Bayesian and Dempster-shafer methods), Context Independent Variable Behavior Operators (CIVB), where the behavior is function of the variables to fuse (e.g. expert systems) and Context Dependent Operators (CD, where the operation depends also of the global knowledge (e.g. linguistic-based fuzzy-logic). Independently of the specific methods and sources, data fusion techniques allow fusing different inputs, obtaining more reliable estimations than originals.

Reference work [46] defines a data fusion environment based on models (model-based data fusion) where different sources of traffic data can be merged in a systematic manner, by using simulation-based models and minimizing iteratively

inconsistencies between the model estimates and field samples. It uses a variant of the pattern search algorithm Hooke-Jeeves [47] and as inputs: loops, video cameras, toll counters and specific DTA systems. Quin Ou [48] presents a comprehensive overview of fusion techniques of heterogeneous traffic data and proposes a new approach under the concept of "data-data consistency", aligned with the different levels of the classic JDL/DFIG model[1], particularized in the traffic context.

Challenges to be solved

From the perspective of MoveUs, traffic information can be obtained from different sources as aggregated variables: intensity, occupancy, speed or on-board technologies (off-roadway), collecting specific information as position and instantaneous speed for further treatment. These sources must be integrated to provide richer and better information, for which MoveUs platform should facilitate a flexible configuration, according the desired behavior by involved actors.

2.3.2.2 Analysis & Prediction

Depending on the traffic mode to be managed, specific functionalities or factors are relevant: for road traffic, detection of congestion tails, traffic measures or detection of heavy goods vehicles; for public transport, vehicle tracking, travel time deviations detection and re-planning support are needed for operation. Any kind of analysis or prediction activity is directly supported by a traffic model or specific field measures, being both complementary in many aspects to achieve reliable results.

The modelling of traffic has been an open research issue during the last decades, addressing questions as the data measurement, the analysis of traffic behavior and its optimization by means of proper operational procedures, engineering design and control algorithms and methods.

As result, different models focused on different aspects of traffic management have emerged, ranging from time-space behavioral of individual drivers to collective patterns. Although with diffuse frontiers, Ni [49] proposes a modeling of traffic flow performed at a spectrum of four scales, namely picoscopic, microscopic, mesoscopic, and macroscopic; defining each one, specific model attributes as: the variable state (location, speed individual or mean, density), space domain (continuous, discrete, semi-discrete), the concept (different coordinate axis: X-Y plane, lane, time, probabilistic, etc.), underlying principle for analysis (e.g. control theory, dynamical systems, field theory, statistical mechanics, fluid dynamics), modelling approach and coupling capabilities to allow global consistency.

Some relevant theories and underlying models are: Newell-Daganzo merge model [50][51], Newell's Car Following Model [52], the three-phase traffic theory [53], optimal velocity model [54], Korteweg-deVries equation and extensions [55] based on a 2nd order ODE for free flow and jam modelling [56] developed the modified

[1] JDL/DFIG model. Revisions to the JDL Data Fusion Model. *www.dtic.mil/dtic*

Korteweg-deVries equation. Deeper analysis can be found on FLEXSYS Project Report [57].

The analysis algorithms involve heuristic algorithms in order to cluster and to identify patterns and trends from the historic data. In general, the input data to be considered will be statistical data obtained from sensors aimed to measure traffic density flow and speeds in particular places of the road network. These data will be augmented with individual vehicle data which provide complete trajectories from GPS or other devices onboard. The consolidation by means of data fusion of the statistical and the individual data provides important improvements for the calculation of OD matrices, a key element to describe the traffic dynamics. Many times the output of these algorithms serves as input for the algorithms in the other two categories (Prediction and Routing).

The prediction algorithms aim to obtain the state of traffic in the short-medium term. This is of crucial importance in order to foresee possible problematic situations beforehand and on time to take the most convenient measures. Examples of these algorithms are: Regression algorithms, cellular automaton systems, or methods based on physical models. Among the regression algorithms that allow estimating the OD matrices, the following must be mentioned as key examples: information minimization, probability maximization or Bayesian inference. The Nagel-Schreckenber [58] model and its variants can be viewed as the basics for many of the most sophisticated microscopic traffic simulator systems. This cellular automaton system incorporates micro-rules which dictate the dynamics of the individual elements with high accuracy. As an alternative to cellular automata, there are predictor systems which are based on physical models similar to Navier-Stoker. The LWR approximation is one of such approximations where the flux of vehicles is a function of its density.

Challenges to be solved

Commonly, currently available traffic control systems lacks of these capabilities to predict, analyze and even identify incidents, although traffic data, field measures and historic registers are available. The feedback of traffic analysis and in last term the prediction of traffic evolution to the traffic control system, will allow operators to optimize the performance of the transportation networks.

2.3.2.3 Routing

Computing best possible routes in road networks from a given source to a given target location is an everyday problem. Many people frequently deal with this question when planning trips with their cars. There are also many applications like logistic planning or traffic simulation that need to solve a huge number of such route queries. Given these increasing exigencies, route planning techniques have evolved quickly in terms of efficiency and accuracy during last years.

Two of the first routing algorithms proposed consider the distance (Dijkstra, Bellman-Ford, using a predefined metric) between one node to every other one in a graph. The Classic Algorithm A* extends these calculations with supplementary

information and a greedy strategy to improve its results. Meta-heuristic methods have been also used successfully in the computation of the shortest path. Nevertheless, these solutions yields very slow query times when we deal with realistic road networks, this fact disable its use in real-time or interactive applications. On the other hand, applying aggressive heuristics not always achieve accurate results.

Road networks present structural properties (e.g. networks are sparse, layered, almost planar and present hierarchical structures) that support different speed-up techniques. These techniques are based on a preprocessing step, where auxiliary information about the network is obtained and annotated, that are used to accelerate all subsequent queries. Speed-up techniques can be classified on:

- *Goal-Directed Search techniques*, with origin on AI scientific field, explore the solution domain when this is not completely known in the beginning. Here, different algorithms can be found: geometric A∗ search, considering sense of direction to the search and lower bounds of the distances, heuristic A∗ search based on distance estimations, landmark-based A∗ search, signposts, geometric containers or edge Flags, managing different graph annotation schemes and exploration.
- *Hierarchical Approaches*, that takes advantage of the topological properties of the network and partite the graph recursively into several pieces and classifying nodes and edges fully automatically in a preprocessing step. Several algorithms have been developed as the separator-based multi-level method or the popular contraction hierarchies.

More recently these kinds of problems tend to be computed in dynamic, parallel, multi-target environments where have proven to be more convenient. An interesting alternative to these methods is where the routing problem is tackled by means of dynamic optimization.

A deep description of the available methods can be found on [59] and [60]. Depending on the graph topology and the kind of queries to realize, different combinations have been analyzed.

On the other hand, the structure of public transportation networks on the other hand is fundamentally different. The key property that determines the difference with road networks is the inclusion of time-dependency aspect, each public transport service is subject to a timetable.

The eCOMPASS project [61] presents an updated deep analysis of current problems, algorithms and underlying approaches. Basically, there are two different approaches to cover timetable requirements: time-expended and time-dependent, each one, priorizing flexibility under changing constraints or memory needs and response time [62]. Adaptations of successful speed-up techniques from road routing are complex and without a clear extrapolation of results. In multi-modal routing planning, multi-criteria methods are a suitable approach, trying –to balance different constraints according the user preferences (e.g. earliest arrival time, total travel-time, number of transfer, spent time on transfer, price, preference for

specific transport modes, ability to walking, riding or driving, displacement emissions, enjoyable/cultural trips, forced passing points or any combination).

Additionally, various uncertainties must be considered when dealing with public transportation as unexpected interruption or cancelation of the service or delays, caused all of them to different reasons: weather, breakdowns, mass events, demand increase, strikes, among others. The delay propagation can be catastrophic and reason of mistrust by the users so delay propagation robustness and real-time travel re-planning capabilities is a must. At design time, this is being partially addressed by stochastic sensibility analysis; but the model adjustments, when available, must be done by hand by experts.

Finally, in reference to the Tourist Trip Design Problem (TTDP), proposing user touristic routes according its preferences, several mobile applications just provide route recommendations (e.g. Google City) and specific algorithms have been developed to satisfy different variant of the problem.

Challenges to be solved

In general, existing solutions resolve properly the multi-criteria routing subject to time constraints and most popular transport modes (train, busses, rail, tram, drive, walking), but they lack of alternative mobility options as ride or vehicle sharing in an integrated way. Current applications are neither able to handle delays and operational incidents in real-time.

2.3.2.4 Flow control (Non-individual Routing)

Urban traffic congestion is an important problem, with significant costs for drivers through wasted time and fuel, deep impact on the environment due to increased vehicle emissions and associated investment needs [131]. At operational level, traffic signals timing is the main actuation way, being key its ability to respond to current traffic patterns. A detailed state of the art, can be found in Smith and Barlow [130].

Different operational supporting tools are existing, based most of them on scenario simulations, classified into the following categories according the underlying model: macroscopic, microscopic and mesoscopic simulation. Their goals are diverse, including predicting queues, the impact of changes in signaling in urban traffic, studies at roundabouts and intersections priorities or impact of specific vehicle types on the traffic. Nowadays sophisticated, flow control systems are also integrating available control measures to improve the total road performance. In [132], several look-ahead traffic-adaptive control algorithms, such as PRODYN [133], OPAC [134], UTOPIA-SPOT [135] and RHODES [136], are assessed, based on computational speed and on the quality of the results (in terms of vehicle delay). All these algorithms use a stage-based approach to traffic control. As opposed, more flexible movement-based approach employed by in vehicle-actuated control or block/movement-based approach can be found on [137][138].

Some remarkable projects/initiatives around traffic simulation technology are the European projects IN-SAFETY [139], PRE-DRIVE C2X [127], iTETRIS [140], that propose new simulation models (micro and macro), along with a risk analysis tool for estimating the expected benefits in terms of safety, efficiency and environmental impact.

In electro mobility domain, different projects supported by V2X interfacing have been exploring the optimized traffic flow control. Ecogem vehicles [141] are able to learn over time the energy profile and the traffic behavior of the various segments in the road network, and thus to predict and avoid congested or inefficient routes, based on experience they gather autonomously and through exchanges via V2V/V2I interactions. Emerald project [142] extends this approach, addressing the seamless integration into the energy grid, providing enhanced power demand prediction and power flow management support.

Challenges to be solved

In general, there is no market supporting tool that address all factors affecting the traffic. There are many points that are still undeveloped as the heterogeneous sensor and source fusion and the capability to deal with multi-criteria traffic optimization and new challenges as electric vehicle deployment. In the MoveUs context of energy efficient driving and urban freight management, new actuation and mediation technologies for energy efficient with both stand-alone and cooperative systems are open research issues.

2.3.3 Cloud computing

2.3.3.1 Cloud computing definition

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [63]. This cloud model promotes availability and presents five essential characteristics: On-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.

This definition provided by the NIST (National Institute of Standards and Technology of U.S. Department of Commerce) also specifies three service models for cloud computing:

1. *Software as a Service* (SaaS). The capability provided by the service provider to the consumer is to use its applications which are being executed on a cloud infrastructure[2]. The consumer does not manage or control the

[2] *Cloud infrastructure* term is different from *Infrastructure as a Service* term (IaaS). A *cloud infrastructure* is the collection of hardware and software that enables the five essential characteristics of cloud computing. The cloud infrastructure can be viewed as containing both a physical layer and an abstraction layer. The physical layer consists of the hardware resources that are necessary to support the cloud services being provided, and typically includes server, storage and network components. The

underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings [64]. The service provider is the responsible to manage the cloud infrastructure in order to being able to offer software applications as services.

2. *Platform as a Service* (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment [64].
3. *Infrastructure as a Service* (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and limited control of select networking components [64].

The ISO (International Organization for Standardization) and the IEC (International Electrotechnical Commission) are currently working on the definition of Cloud Computing Overview (ISO/IEC DIS 17788) [65] and Vocabulary, and Cloud Computing Reference Architecture (ISO/IEC DIS 17789) [66]. In order to accomplish this standardization process, the ISO and the IEC established a new working group WG3 inside the ISO/IEC JTC 1/SC 38 Distributed application platforms and services (DAPS) [67].

According to the NIST there are only three service models in cloud computing. However the ISO/IEC initiative [68] attempts to include other models such us *Network as a Service* (NaaS) and *Communication as a Service* (CaaS) cloud computing service categories specified by the ITU-T, or *Data Storage as a Service* (DSaaS) defined in ISO/IEC 17826:2012 [69], *Cloud Data Management Interface* [70] (CDMI).

- *Network as a Service* (NaaS). A category of cloud services where the capability provided to the cloud service user is to use transport connectivity services and/or inter-cloud network connectivity services [71].
- *Communication as a Service* (CaaS). A category of cloud services where the capability provided to the cloud service user is to use real-time communication and collaboration services. In this context, communication and collaboration services include voice over IP, instant messaging, and video conferencing, for different user devices [71].
- *Data Storage as a Service* (DsaaS): The delivery of virtualized storage and data services on demand over a network, based on a request for a given

abstraction layer consists of the software deployed across the physical layer, which manifests the essential cloud characteristics. Conceptually the abstraction layer sits above the physical layer [64].

service level that hides limits to scalability, is either self-provisioned or provision less, and is billed based on consumption [72].

ITU-T defined the abovementioned two new cloud service categories (ITU-T specifies service categories instead of service models), extending the existing three service models specified by the NIST, due to the increasing importance of the role that telecommunication providers are playing in the emerging cloud ecosystem.

2.3.3.2 Cloud computing in the Smart Mobility field

In the Smart Mobility field, and specifically in MoveUs, Cloud computing usage will help manage a huge amount of distributed and heterogeneous data, from multiple sources in a smart city environment. These data will be drawn from asynchronous user-generated information (e.g. mobility patterns, preferences), synchronous user-generated data (e.g. position in real time), historic databases (e.g. weather reports and trends, public transportation schedules) and data from mobility companies and vehicles in real-time. After collecting the data, a smart mobility platform needs to process these data to infer valuable information of the traffic status and users' mobility patterns.

Based on the essential characteristics of the Cloud computing, an overall solution of a smart mobility platform based on Cloud computing will have to at least include capabilities for managing high volume of data, real-time information processing and handling application load fluctuations. This cloud-based mobility platform will also have to offer high availability, one of the major advantages from the usage of Cloud computing.

Besides these core cloud computing capabilities, the cloud-based mobility platform can also offer other PaaS functionalities such us deployment of web services for publishing the information to the final users of the platform, or deployment of services for incentives in the smart mobility ecosystem.

2.3.3.3 Current cloud computing technologies

This section outlines the cloud technologies and the cloud providers that can provide the required capabilities for a cloud-based smart mobility platform. Based on the computational and data management (storage, processing, etc.) requirements mentioned before, the cloud service models to evaluate to be included in the platform are:

- DSaaS, in order to storage the high volume of distributed and heterogeneous data.
- Data Compute as a Service[3]: This service model covers Big Data[4] and real-time processing services, in order to execute data-mining techniques and advanced algorithms in smart mobility environment.

[3] We have defined a new cloud service model that includes all capabilities for managing big data and real-time processing, which are key in a smart mobility environment.

- PaaS, in order to deploy the mobility services which are based on the valuable information inferred from the data analysis and processing.
- IaaS, in order to provide support to the other three cloud service models.

Technical details on the most relevant Cloud computing technologies and providers are given in Annex A1.2 to this Deliverable D2.1.

The following table summarizes the main cloud products and cloud providers, classified by the cloud service technology they provide.

Cloud service models	Cloud products	Cloud providers
IaaS & DsaaS	OpenStack OpenNebula Red Hat CloudForms Eucalyptus	FI-WARE Windows Azure Amazon Web Services
PaaS	CloudFoundry Red Hat OpenShift AppScale	FI-WARE Windows Azure
DcaaS	NoSQL databases MapReduce technology platforms like Apache Hadoop	FI-WARE Windows Azure Amazon Web Services

Table 6 Cloud products & technology providers

2.3.4 Mobility service provision

The ICT Services for Smart Mobility applications are developed and deployed for several market segments and target users including the transport and traffic operators as well as the travellers.

The technology status and trends in this domain, especially for mass market solutions, typically follows the changes and evolutions occurring with the advent of what many operators and specialists of the ICT market calls "post-PC era" with a dramatic growth of mobile devices sold compared to those of PCs. Such evolution makes internet-connected smartphone and tablets the ideal devices for today's personal mobility especially where a fast, "on the road" access to the information is required.

[4] "Big Data" is a term encompassing the use of techniques to capture, process, analyze and visualize potentially large datasets in a reasonable timeframe not accessible to standard IT technologies. By extension, the platform, tools and software used for this purpose are collectively called "Big Data technologies" [73].

For these reasons mobility services are focusing more and more on mobile technologies and on the other hand, the technologies themselves are evolving to offer increased opportunities to the developers of mobile solutions. For example, besides the realization of mobile apps running on mobile OS (like Android and iOS) a process of de-jure and de-facto standardization is occurring with the massive introduction of HTML5-based solutions. The HTML5 specification, which is expected to become a standard in the next years, enables key technologies like positioning access, speech recognition and others that are of great importance for mobility solutions.

The provision of services to the end users, however, is only the final stage of the complete chain of content/service provision. The analysis of the technological status of the mobility services should ideally look at each different aspect of this process where the following main aspects can be identified:

- **Content provision**
  The operations of data access and retrieval needs to establish connections based on available communication protocols. At the bottom level local systems are connected either directly to the service provider or to another node that operates as "content integrator". At this level, custom or dedicated connections are established typically with the latest available communication channels, technologies and protocols. The "content integrator" may process the data or provide a more standardized and uniformed access if necessary. This can be a Regional Organizations or another actor operating between the local systems and the service/technology provider. SOAs or other well-known infrastructural solutions can be introduced to support the service provision[5].

  Key technological aspects to be considered at this stage include:

  - Information categories/features
  - Standards and communication protocols for data/service exchange

- **Service provision**
  The service provision can be seen as a group of actions, operations, processes, controls which offer an added value to existing data for the travelers or the stakeholders.

  The range of applications may vary from traffic lights control operated by Traffic Control Centers to public transport service information provided by operators by means of mobile solutions, to advanced in-car navigation systems offered by private operators.

  The service generation is then interested by several technological aspects which includes for example communication technologies (e.g. broadband mobile communication channels available today from several operators) or

[5] This approach has been followed and deeply investigated in several European Projects including eMOTION, In-Time and Co-Cities

technological support for personal mobility (Smartphone, Tablets, Navigation systems)

Key technological aspects to be considered at this stage include:

- Functionalities
- Types of visualisation
- Map interface
- End user device/media
- Technologies/protocols used for service provision to the end user

- **Personalization of services**
  The personalization of the final services is based on a number of technical features including:
  - Possibility to store data internally to the mobile device (like personal preferences)
  - Geo-positioning facilities: GPS, Wi-Fi or cell-based system
  - Management tools for the end users: Any facilities which can be used to set, store, control the personalization details and preferences. This can be a function embedded in a mobile app or a centralized web portal with restricted-access web tools.
  - Management tools for the operators: tools for controlling, enabling, changing the status of the personalized features.

A detailed analysis on the different aspects of service provision is given in Annex A1.3 to this Deliverable D2.1 for two main categories: multi-modal trip planning and route guidance, and real-time traveler information.

Details and technological status

The details and technological status for single features/aspects of the service provision defined in Annex 1.3 are summarized in the following table:

	Pre-trip road traffic information service	On-trip real-time road information service	Pre-trip public transport information service	Real-time passenger information	Multi-modal trip planning service and dynamic route guidance	Parking monitoring information
Information categories/features	Congestion level/LoS data, Incident Road works Travel times Access restriction/road closure Events Road weather Camera pictures/stream	Congestion level/LoS data, Incident Road works Travel times Access restriction/road closure Events Road weather Camera pictures/stream	Timetables Lines Modes of transport Infrastructure (e.g. stations) Public Transport Services Interchange	Delays Next stop Interchange information Side where to get off	Journey information including modes of transport, journey alternatives, travel times, interchange information, turn-by turn navigation/instructions	Availability Facilities Opening Times Tarifs Type of parking Infrastructure
Standards for data exchange (local systems/service provider)	RDS/TMC Alert-C Datex and Datex2 OTAP	RDS/TMC Alert-C Datex and Datex2 OTAP	SIRI TransXchange Transmodel-based standards National standards like NAPTAN NPTG TPEG-PTI Journeyweb Delphi	SIRI National standards like NAPTAN NPTG TPEG-PTI	Journeyweb Delphi EU-Spirit	TPEG-PKI
Functionalities of the end user service	Traffic alert information Traffic flow information	Traffic alert information Traffic flow information	Static and dynamic public transport information including timetables, bus stop, line and service information Public Transport Journey Planning	Real time dynamic public transport information including delays, next stop, messages for traveler assistance	Multimodal journey planning information Navigation service	Static and dynamic parking information including availability, tariffs, opening times Infrastructure information (type of parking, parking entrances etc.)
Types of visualisation	Interactive Maps with symbolization Text Video streams or still pictures	Interactive Maps with symbolization Text Video streams or still pictures	Interactive Maps with symbolization Text/tables SMS Email IVR	Text On-board displays Audio messages	Interactive Maps with symbolization (like journey legs, interchange points) 3D maps with navigation instructions Text Voice	Interactive Maps with symbolization Text/tables On-street panels

	Pre-trip road traffic information service	On-trip real-time road information service	Pre-trip public transport information service	Real-time passenger information	Multi-modal trip planning service and dynamic route guidance	Parking monitoring information
Map interface	Interactive, multi-layer maps with icon-based and polyline-based graphical representation of information. Detailed information available on user click.	Interactive, multi-layer maps with icon-based and polyline-based graphical representation of information. Detailed information available on user click.	Interactive, multi-layer maps with icon-based and polyline-based graphical representation of information. Detailed information available on user click.	-	Interactive, multi-layer maps with icon-based and polyline-based graphical representation of information. Detailed information available on user click. 3D maps with navigation instructions and trip data (including track, speed, time to arrival)	Interactive, multi-layer maps with icon-based and polyline-based graphical representation of information. Detailed information available on user click.
Personalization features	User Location-based information PUSH services with identification/selection of preferred geographical area and/or preferred time/calendar	User Location-based information PUSH services with identification/selection of preferred geographical area and/or preferred time/calendar	User Location-based information PUSH services with identification/selection of preferred geographical area and/or preferred time/calendar	-	User Location-based information	User Location-based information PUSH services with identification/selection of preferred geographical area and/or preferred time/calendar
End user device/media	PC with internet connection Mobile device (smartphone, tablet with internet connection) Mobile phone (SMS, MMS, email, voice) Interactive Voice Recognizer Info point with public PCs/Kiosk Television/Teletext Radio / RDS-TMC receiver	PC with internet connection Mobile device (smartphone, tablet with internet connection) Mobile phone (SMS, MMS, email, voice) Interactive Voice Recognizer Info point with public PCs/Kiosk Television/Teletext Radio / RDS-TMC receiver	PC with internet connection Mobile device (smartphone, tablet with internet connection) Mobile phone (SMS, MMS, email, voice) Interactive Voice Recognizer Info point with public PCs/Kiosk Television/Teletext Radio / RDS-TMC receiver	On-board panels and devices	PC with internet connection Mobile device (smartphone, tablet with internet connection) In-car navigation systems	PC with internet connection Mobile device (smartphone, tablet with internet connection) Mobile phone (SMS, MMS, email, voice) On-street panels

	Pre-trip road traffic information service	On-trip real-time road information service	Pre-trip public transport information service	Real-time passenger information	Multi-modal trip planning service and dynamic route guidance	Parking monitoring information
Technologies/protocols used for service provision to the end user	Dedicated apps running on mobile devices Web-based (HTML5, Javascript/JQuery, CSS) services Web services technologies SMS SMTP HTTP/HTTPS GSM/GPRS/3G/HSPA/ HSDPA GPS,GSM cells or WiFi-based positioning Radio/Television channels	Dedicated apps running on mobile devices Web-based (HTML5, Javascript/JQuery, CSS) services Web services technologies SMS SMTP HTTP/HTTPS GSM/GPRS/3G/HSPA/ HSDPA GPS,GSM cells or WiFi-based positioning system Radio/Television channels	Dedicated apps running on mobile devices HTTP/HTTPS/ Web-based (HTML5, Javascript/JQuery, CSS) services Web services technologies SMS SMTP GSM/GPRS/3G/HSPA/ HSDPA channels GPS,GSM cells or WiFi-based positioning	On-board panels/devices proprietary technology	Dedicated apps running on mobile devices Web-based (HTML5, Javascript/JQuery, CSS) services Web services technologies HTTP/HTTPS GSM/GPRS/3G/HSPA/ HSDPA GPS,GSM cells or WiFi-based positioning system In-car navigation systems technology	Dedicated apps running on mobile devices HTTP/HTTPS/ Web-based (HTML5, Javascript/JQuery, CSS) services Web services technologies SMS SMTP GSM/GPRS/3G/HSPA/ HSDPA channels GPS,GSM cells or WiFi-based positioning On-street panels technology

Table 7 Details and technological status for single features/aspects of the Smart Mobility service provision

2.3.5 Data privacy and security mechanisms

The data protection and security dimensions will be closely interrelated in MoveUs. This is so considering that protection of personal data needs, beyond organizational aspects, strong data security for safeguarding confidentiality and security of processing and the technical implementation of suitable privacy-enhancing controls. In particular, privacy solutions will support end-user rights over personal data collected, stored and processed by the system (informed consent, right to be informed and to access data, erase or object) and address key privacy principles recognized in European and national regulatory frameworks including data minimization in proportionality with the specific MoveUs purposes of processing.

Security will be addressed at different levels (distributed data storage in Cloud, communications and data sharing and security of client devices and server end-points) to ensure an adequate protection of data, in particular for personal attributes, identity-related information and any especially sensitive data related to e.g. location. User-centricity and usability will be considered as integral parts of the MoveUs approach to privacy and security to make solutions user-friendly while supporting the informational self-determination principle that will empower users to have control over their own data.

2.3.5.1 Cloud Security Dependency Model

This introduction section, takes a look at the general cloud security dependency model, with its different layers and distribution of responsibilities.

From below The cloud provider can be seen to have a greater responsibility in providing security for PaaS over IaaS and equally for SaaS over IaaS.

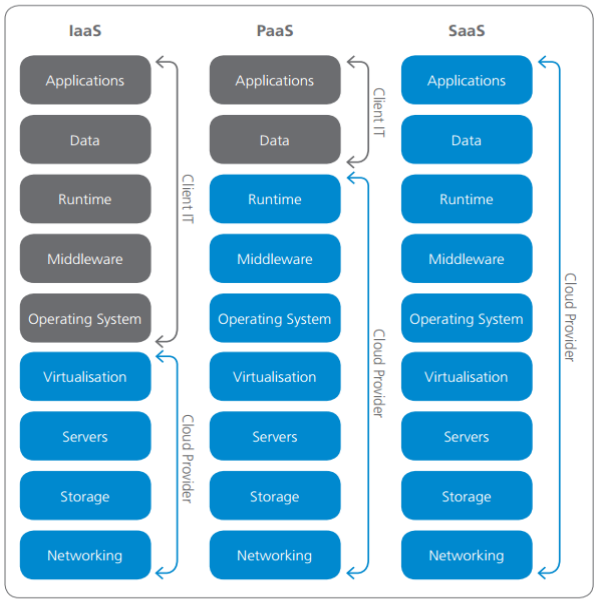

Figure 1 - Who is responsible for what in each cloud computing model? | Dimension Data White Paper: Developing a Secure Cloud Approach

The model chosen for Move-Us whether it is the private cloud provider or is a deployed in a public cloud has obvious impact on security responsibilities.

Cloud providers and customers must share the responsibility for security and privacy in cloud computing environments, but sharing levels will differ for different delivery models, which in turn affect cloud extensibility.

Software-as-a-Service (SaaS): Cloud Providers typically enable services with a large number of integrated features, resulting in less extensibility for the customers. Providers are more responsible for the security and privacy of application services, more so in public than private clouds where the client organization might have stringent security requirements and provide the needed enforcement services.

Platform-as-a-Service (PaaS): the goal is to enable developers to build their own applications on top of the platforms provided. Thus, customers are primarily responsible for protecting the applications they build and run on the platforms. Providers are then responsible for isolating the customers' applications and workspaces from one another.

Infrastructure-as-a-Service (IaaS): is the most extensible delivery model and provides few, if any, application-like features. It's expected that the consumers secure the operating systems, applications, and content. The cloud provider still must provide some basic, low-level data protection capabilities.

Also the end Service Provider could also implement any of the above models. However if IaaS is chosen for a Car Share scheme then the company would be responsible for implementing there security mechanisms from the Operating System up.

Cloud Computing requires a security model that reconciles scalability and multi-tenancy of the different Service Providers with the need for trust. The foundational infrastructure for a Cloud must be inherently secure whether it is a private or public cloud or whether the service is SaaS, PaaS or IaaS. Therefore, in every cloud scenario it is necessary to distinguish the following Cloud Architecture in terms of layers and their security issues:

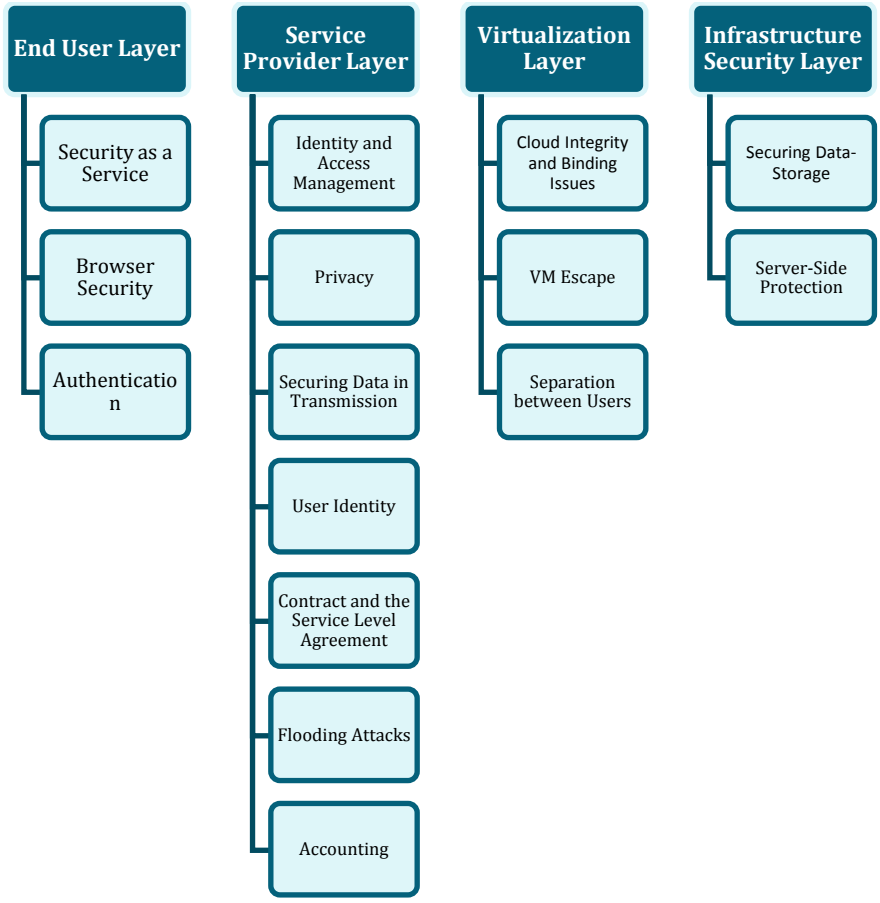

Figure 2 - Cloud Architecture Layers and Corresponding Security Issues

2.3.5.2 Cloud Security Alliance Guidance

The CIA triad (Confidentiality, Integrity and Availability), is often used to broadly classify security guidelines. These principles have been adapted for cloud deployments by the Cloud Security Alliance (CSA) which comprehensively classifies several control domains to cover the key areas critical to cloud computing security.

- AIS: Application & Interface Security.
- IVS: Infrastructure & Virtualization Security.
- IPY: Interoperability & Portability
- SEF: Security Incident Management, E-Discovery & Cloud Forensics
- IAM: Identity & Access Management
- EKM: Encryption & Key Management
- GRM: Governance & Risk Management
- STA: Supply Chain Management, Transparency & Accountability
- LSC: Legal & Standards Compliance
- MOS: Mobile Security
- DSI: Data Security & Information Lifecycle Management
- TVM: Threat & Vulnerability Management
- DCS: Datacenter Security
- BCR: Business Continuity Management & Operational Resilience

- CCC: Change Control & Configuration Management
- HRS: Human Resources Security

The security guidelines and mechanisms that are specific to MoveUs will be based on the CSA Cloud Control Matrix (CCM) [73] together with the CSA Security Guidance For Critical Areas of Focus in Cloud computing [74].

Note that the CCM is designed to map back to other well-known control frameworks such as ISO 27001, COBIT or PCI-DSS, which provides an additional guarantee of good coverage of the proposed control domains.

2.3.5.3 Privacy by Design

In today´s world it is common to have several electronic identities for such things as online governmental services, banking and social sites. The trend is towards electronic identities playing an increasing role in accessing public and private services with the result that more of our personal data is being handled online. In summation, dispersal of so much of our personal information on the internet erodes our privacy and opens our data up to abuse, potentially placing us at risk.

Therefore to properly protect a user´s identity and personal information a user-controlled privacy preserving identity management system is needed where the user is in control of the amount of information he/she shares for example is a social site service requires that the user be of a certain age then only proof of require age credential is given rather than the user´s DOB.

Privacy by design includes data minimization and security requirements analysis activities and follows a Methodological approach:

- ***Functional Reqs. Analysis:*** The first step in the design of a system with privacy embedded at the core is to clearly describe its functionality. That is, the goal has to be well defined and feasible. If the architecture has to be flexible enough to integrate additional services then these also need to be articulated precisely, so that they are taken into account in the analysis of the overall system.
- ***Data Minimization:*** For a given functionality, the data that is absolutely necessary to fulfil the functionality needs to be analyzed. This activity includes a survey of state-of-the-art research to explore which data can be further minimized, as well as an evaluation of alternative architectures, e.g., distributed, centralized, that could contribute to data minimization. In most cases, the solutions rely on advanced privacy-preserving cryptographic techniques like the anonymous credentials or cryptographic commitments.
- ***Modelling Attackers, Threats and Risks***: Once the desired functionality is settled and the data that will be collected is specified, it is possible to start developing models of potential attackers, e.g., curious third parties, the service provider; the types of threats these attackers could realize.
- ***Multilateral Security Requirements Analysis***: Besides the system's purpose itself, an engineer must account for other constraints that ensure the security and correct behavior of the entities in the system, as expected

by the different stakeholders of the system. The inclusion, analysis and resolution of these conflicting security requirements is also known as multilateral security. The objective of this analysis is to find a design in which privacy measures cannot be detrimental to other important security objectives such as integrity, availability, etc. and vice versa.

- ***Implementation and Testing of the Design:*** The final step in the design of the system is to implement the solution that fulfils the integrity requirements revealing the minimal amount of private data. Further, the potential vulnerabilities have to be scrutinized, and the functioning of the system according to the articulated functional requirements has to be validated.

Technical details on security-related reference areas to be addressed in MoveUs, their current status and potential scope of implementation are provided in Annex A1.4 to this Deliverable D2.1.

3. Checklist for current infrastructure assessment

This chapter aims at helping the Consortium cities to identify and assess the current systems, sub-systems, components and technologies than can be used to design and implement the MoveUs architecture; in fact, leveraging as much as possible existing infrastructures and already approved development plans will allow to reduce implementation costs.

3.1 Methodology

Systems, sub-systems, components and technologies are listed in the following tables, where cities should enter also information needed for assessing the current state, where:

Current status: it can be described in a free format or using a numeric value as follows (example): 5 = available; 4 = available with a few modifications/upgrades; 3 = it will be available within 6 months; 2 = it will be available within 12 months; 1 = it will be available but it is impossible to foresee when; 0 = there are no indications that it will be available.

Physical location: it is the location where data are available (if not in electronic form).

Server location: it is both the physical location of the server where data are stored and its network address (IP, DNS, etc.).

Owner: it is the public or private entity which owns systems, sub-systems components and data with which it is necessary to negotiate the terms and conditions of their use.

Technical Conditions: they are information on data formats, availability, version, frequency of update, standards

User: it is the public or private entity or individual or groups of individuals that use the systems, sub-systems components and data.

Economic Conditions: they are the terms and conditions of use negotiated with the Owner.

Constraints: it is the description of any constraint related to the use of data; they can be permissions needed by Third Parties other than the Owner, legal issues, obligation regarding the network connections (i.e. data security), security clearance needed by personnel, etc.

3.2 Genoa

3.2.1 Overall description of the pilot site

Genoa is concerned with two main issues related to mobility:

1) The high level of traffic congestion: an answer to the increasing congestion could be to switch the personal mobility from the private cars to the LPT; Genoa has done a lot on this, but it is still necessary to reduce the personal mobility of about 20% in the next years, to go below the congestion level; this is where MoveUs comes into the picture. It is believed that making available to citizens, in a user-friendly way, information on traffic and transport means could achieve strong results in reducing the congestion by voluntarily changing habits, and in increasing soft model of transport.

2) The low economic impact of tourists who visit the city and, in particular, who board the ferries to the islands: it is a transit tourism that makes the city pay externalities without having any economic impact; a set of interviews have shown that tourists could benefit of information on local attractions and events if they are easily available to them; in fact, the average waiting time before embarking is three hours, even much longer for tourists coming from abroad (Germany and Northern European Countries) and during this period tourists could spend time visiting the city while at the same time choosing sustainable and green means of transport.

3.2.2 Inventory of the existing Mobility & ITS infrastructures in the city

3.2.1.1 Overall architecture and concept

In Genoa, the current technological infrastructures for mobility users include a Wi-Fi network in proximity of the main points of interest of the city; this public network is directly managed by the Municipality or by other Public administrations.

The points of interest are:

- All the intermodal exchange point (railway, port, airport, ferry terminal)
- Main cultural point of interest (monuments and libraries)
- Almost all the Bike Sharing parking areas

In addition to this public Wi-Fi network, other private owned networks have been installed (i.e. in the Ancient Harbour, the Aquarium, and other points).

- Availability of general GIS-based data about population and economic activities;

- Availability of traffic and pollutant emissions simulation models;
- Existing wide sensors networks (traffic, parking, public transport fleet);
- Several ITS applications developed in the field of urban mobility including:
    - "AMT app mobile" a mobile app for public transport information
    - "Free WI-FI Genova", a mobile app to be informed about the coverage of the free WI-FI network in Genoa
    - "IoGuido" a mobile app for using the Car Sharing service in Genoa
    - "Mobilitypoint mobile" a mobile web site (soon available also as a smartphone app) with multimodal travel and traffic information in Genoa
    - Parking goods monitoring system
- Free wi-fi areas available around the city;
- Several transport opportunities within the city (bus, metro, train, lifts).

3.2.1.2 Functional Architecture

The main ITS systems currently available in Genoa are outlined below. Further details on this functional architecture are provided in Annex A2.1.1 to this Deliverable D2.1.

Traffic Management

SIGMA+ Traffic lights control: centralized system for supervision and control of road traffic.

TCT System: aimed at monitoring traffic through the retrieval of video streams from cameras conveniently located on the territory.

Incident control database: monitoring Center of road accidents in the City of Genoa (known as "CMI"), built thanks to the European project Civitas-Caravel.

Pollutant emission data collection: acquisition of data about pollutant emissions achieved with monitoring stations, stored in a repository.

MobiGIS: a repository that collects data (mostly georeferenced) from various systems related to mobility.

Public Transport management

SIMON (integrated monitoring system): system for monitoring the Fleet provided by AMT SpA, Public Transport operator of the city of Genoa.

Traveller Journey Assistance

VMS system: management system for the variable messaging panels.

Infopark: software dedicated to the supervision of the parking lots and the presentation of the data from these.

Electronic Fee collection

Public Transport SMS ticket: the PT company Amt offers its passengers the opportunity to purchase tickets for the urban network by phone and smartphone by charging the cost directly to the credit or phone bill.

Law Enforcement

LTZ control: sub-system of electronic gates to control access to the city of Genoa, with the aim of ensuring that the area is accessed only by authorized vehicles

CELERITAS: system to monitor the average speed of the overpass A. Moro, in order to improve the level of security.

In-vehicle systems

Though they are not strictly considered as "In-vehicle systems", a number of mobile apps are available for pre-trip and on-trip information.

- "AMT app mobile" a mobile app for public transport information
- "Free WI-FI Genova", a mobile app to be informed about the coverage of the free WI-FI network in Genoa
- "IoGuido" a mobile app for using the Car Sharing service in Genoa
- "Mobilitypoint mobile" a mobile web site (soon available also as a smartphone app) with multimodal travel and traffic information in Genoa

FreeWiFiGenova

Open access Wi-Fi network infrastructure deployed by the Municipality of Genoa for free internet navigation.

System connections to the Traffic Supervision System

Most of the systems mentioned above are connected to a central control system: the Traffic Supervision System, developed during 2012/2013 and expected to be operative in 2014.

The external systems are connected to the supervision system in a proprietary/custom way to different sub-systems of the supervisor. These sub-systems allow different operations on the respective data, primarily:

- Planning,
- Control

- Configuration
- Report

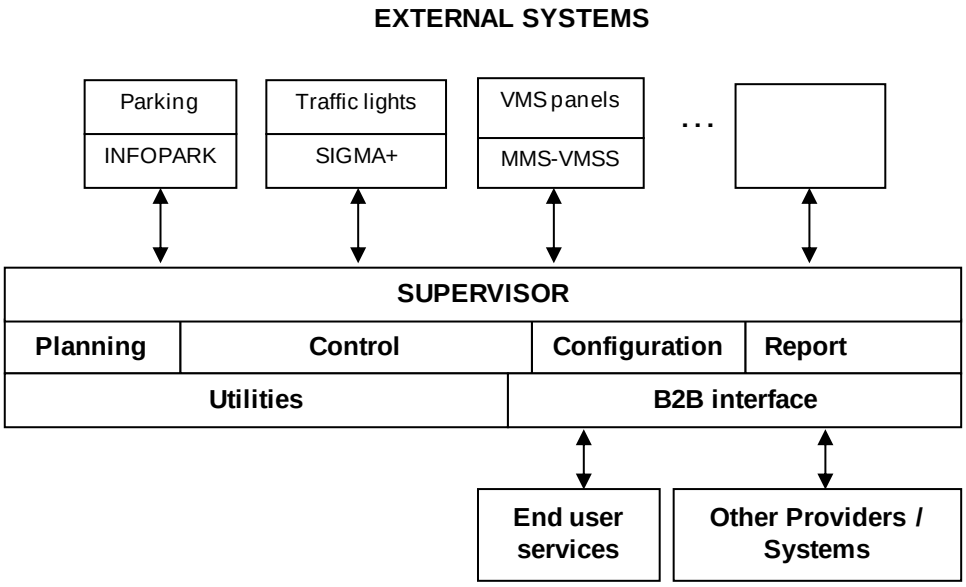

Figure 3 - Connection of input (external) systems with the central traffic supervisor in Genoa

3.3 Madrid

3.3.1 Overall description of the pilot site

The following needs have been identified in Madrid pilot site:

- Fostering the use of green and shared (efficient) modes of mobility in Madrid city
- The prioritization of green mobility modes over private vehicles for environmental efficiency
- Optimizing the efficiency of the mobility of the users of public and green transport in terms of time of travel, cost, and real time information.
- Personalized mobility information according to the profile of the target user.
- Provision of new mobility services in a transparent way for the user and facilitating its use through personal mobile devices like smartphones, etc.

All these will be addressed in MoveUs by using the following technologies:

- Open data, which will be used to share the public mobility data into the data platform repository
- Wireless communications and
- Urban traffic detection technology, which will be used to analyze and predict the traffic flow in the urban network, and to predict possible traffic incidents.

Preliminary studies indicate that the target users will include:

- Shared and/or public vehicles users: especially car sharing users and public bus users, having a platform in which advanced information services will be provided to public buses users and that will be benefited also from the development of a smart multi-criteria traffic control system for the better performance of the bus fleet in Madrid.
- Pedestrians: especial focus will be on pedestrians with some mobility impairment that find mobility difficulties in crosswalks.
- Visitors and tourists of the city, a very relevant portion of mobility users in such a big city
- Municipality of Madrid, that will benefit from the development of a smart multi-criteria traffic control system for the city, and that will foster a greener and shared mobility in Madrid.
- Mobility Service companies that will benefit from having a MoveUs platform and mobility open data from Madrid city and public bus system infrastructure that will enable the development of new mobility services.

3.3.2 Inventory of the existing Mobility & ITS infrastructures in the city

3.3.2.1 Overall architecture and concept

3.3.2.1.1 ITS Infrastructures in the Mobility Control Centre of the Municipality of Madrid

This section is a description of the overall architecture and systems that are involved for traffic and mobility management. This architecture is showed on the figure below:

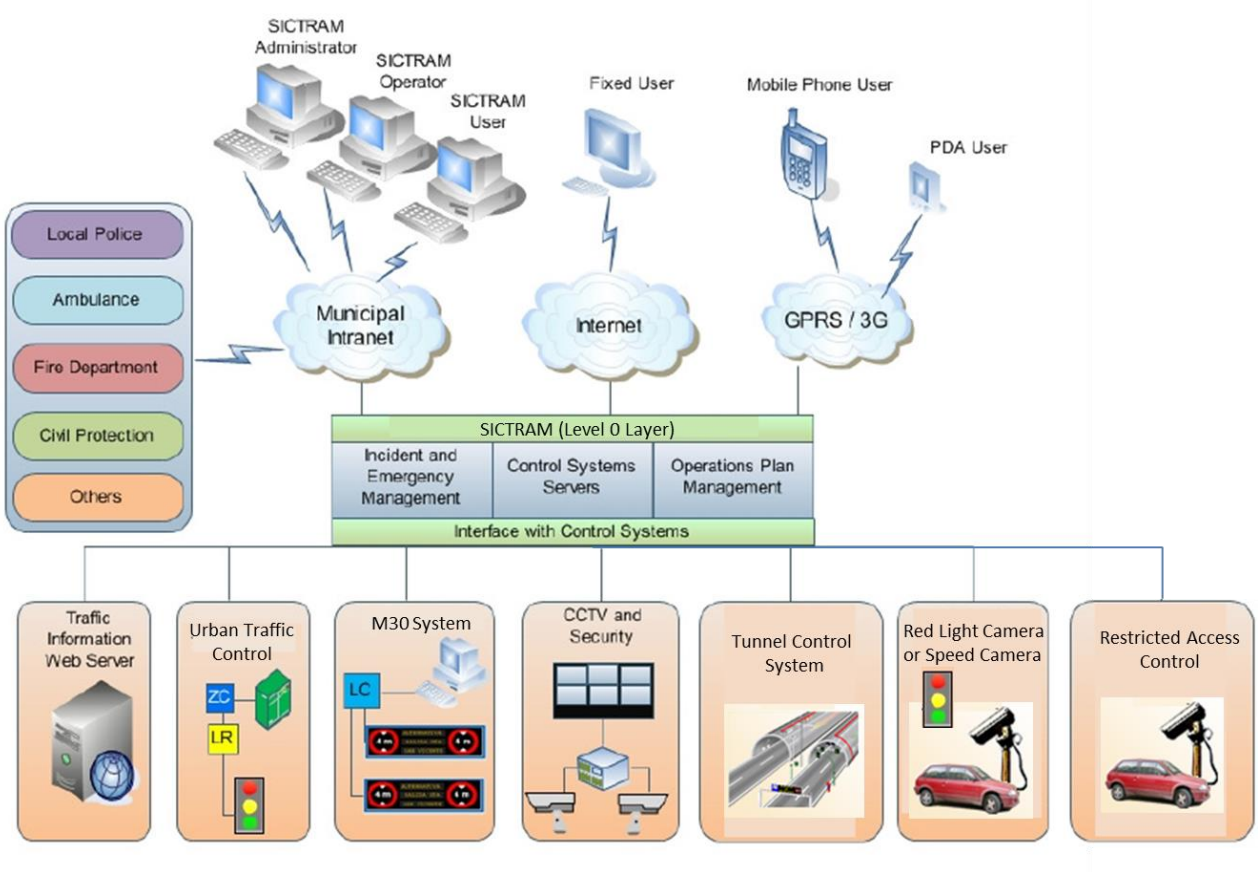

Figure 4 – Overall architecture on Madrid Mobility Control Centre

The Traffic Management Systems provides the capability to support and operate a wide variety of subsystems from the Mobility Control Centre including:

- **SICTRAM** is a level 0 layer application that facilitates the integration of the different Urban Traffic Control systems (UTC systems) and subsequent control systems through a variety of interfaces and protocols and allows the management of such systems under a single, common, visual interface. By defining standard interfaces and methods of connectivity, and integration

details, it is possible to integrate additional sub systems easily and offer the option of multiple sourcing of equipment and systems. This system may be involved in MoveUs in Madrid Pilot.

- Various **Urban Traffic Centralized Systems (UTCs)** that act on the traffic lights controllers network of Madrid for optimizing the traffic flow. From traffic lights control point of view, Madrid is divided into three geographical areas controlled by different UTC systems. The next chapter describes the so-called ADIMOT (Adaptive Multialgorithmic Optimisation Technique) UTC that will be involved in Madrid Pilot.

- The **M30 Surveillance and Control Application (SCA)** that enables monitoring and control of M-30 Urban Highway Road Side Equipment (RSE). The SCA provides the ability to retrieve and manage data from traffic sensors for establishment of Variable Message Sign (VMS) messages automated by the plans and rules wizard. This application may be involved in Madrid Pilot.

- The **Tunnel Surveillance and Control Application (T-SCA)** enables monitoring and control of different Urban Tunnels Road Side Equipment (RSE) existing in Madrid. One of the crucial video components for tunnel monitoring and control operations is the video-based Automatic Incident Detection (AID) system and the Incident Management System which is an existing module/process of the SCA application with a user interface that allows an operator to manage and control all the tasks associated with the definition of operational and emergency plans required for the safe and effective operations of the T-SCA electrical and mechanical systems (fans, tunnel access control, emergency exit, lighting, etc.). The execution of the steps/activities defined for an operational plan can be configured to be automatic, semi-automatic or manual. This may be used in Madrid pilot.

- The **Closed Circuit Television System (CCTV)** uses IP technology to provide personnel with traffic management and real-time remote surveillance of the city road for detection of traffic incidents. This is used in order to observe traffic flow and to monitor the deployment response of Police, Fire and Emergency personnel during emergency incidents.

- The **Access Control System to restricted urban areas, as well as the Red Light Cameras and Speed Cameras**, are both formed by one or several on-site control Points with autonomous number plate recognition and capture system and a central server that centralizes all the information captured by the control points. The server integrates the storage, operation, management and synchronization systems for the vehicle infractions.

- **Traffic Information Web Server** provides mobility information to citizens through a SIG-based web site [75] and mobile Apps. It provides with mobility information such as traffic flow and service level, incidents, on-line images from CCTV, or mobility points of Interest as Taxi stop, EV Charging Points, etc.

- **Mobility Information Web Site**, all mobility information web site, from Municipality, to citizens [76]

Some procedures are deployed enabling to share information with external entities but they are only executed for emergency incidents.

3.3.2.1.2 ITS Infrastructures in EMT

The Bus Fleet Management System (EMT-SAE) supports the public transport operations and provides with means to centralize the management of public transport. EMT-SAE is a real time control instrument and a true support for service planning and offers the following basic functionalities to operators:

- Continuous, instant and automatic location of Buses Network to allow the control, regulation and operation.
- Provision of the means to understand and operate in real-time the management of the resources available.
- Use of control tools to continuously operate the lines in order to maintain the Quality of Service.
- Use of data collected and processed to inform the Customers, Operators and Public Transport Authorities.

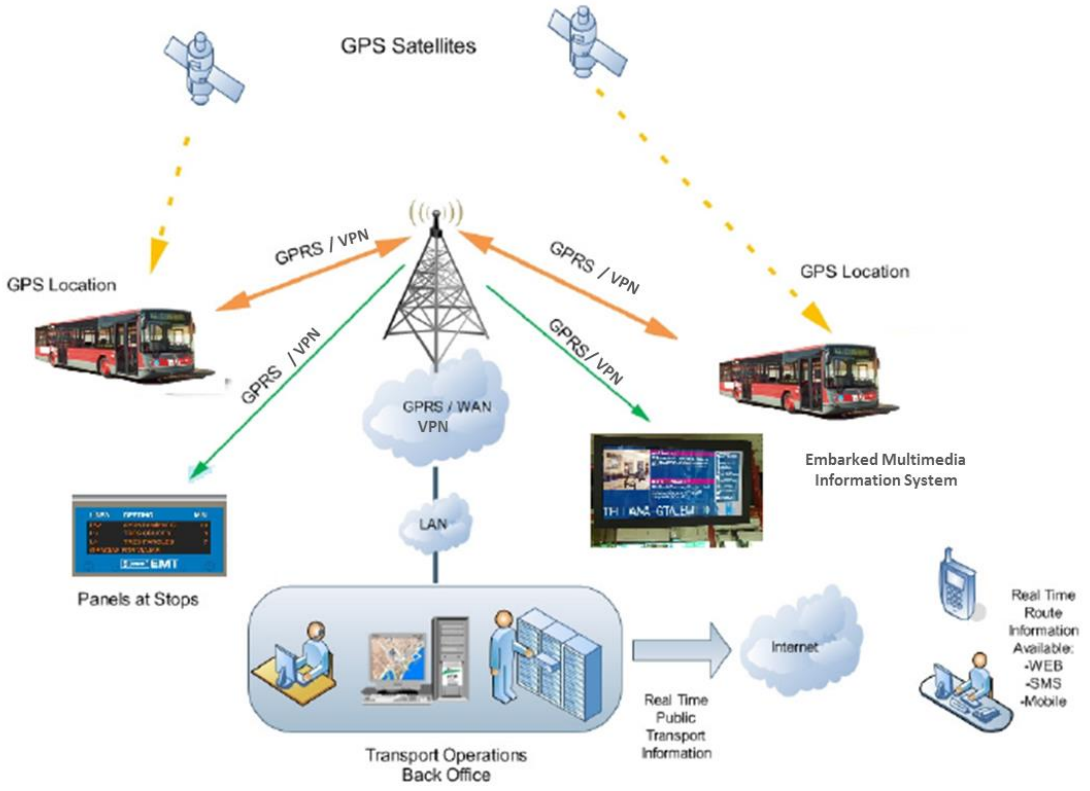

Figure 5 – General Architecture EMT-SAE System in Madrid

Open Data from EMT

EMT is providing an Open Data Platform on the URL http://www.emtmadrid.es/movilidad20/opendata.aspx; therefore, some services can be provided by signing an agreement of use.

Figure 6 – Open Data description and access in Madrid

3.3.2.1.3 Other ITS Infrastructures in Madrid

Level of integration between ITS system (only on web site http://www.muevetepormadrid.es/)

- **EMT SAE**. Level of integration with MAD ITS systems: only on web site http://www.muevetepormadrid.es/
- **Bike Hiring**. Level of integration with MAD ITS systems: only on web site http://www.muevetepormadrid.es/
- Car Sharing. Level of integration with MAD ITS systems: None.
- **Small Local Area with Bluetooth devices**. Level of integration with MAD ITS systems: None.

3.3.2.2 Functional Architecture

This section is described in full detail in Annex A2.2.1 to this Deliverable D2.1.

3.4 Tampere

3.4.1 Overall description of the pilot site

Tampere targets pioneership in climate change. One of the strategic targets of the city represents a 40% reduction in CO2 by 2025, compared to the 1990 levels[6]. The transportation sector can significantly contribute to achieving this goal, by shifting the modal split in favor of cycling and public transport.

The most important step towards effectively managing journey choices is to quantify the environmental footprint of available choices.

Having said this, the main issue of focus for Tampere is to enable integrated awareness of energy/CO2 consumption of all possible journey (i.e. mobility & routing), per user. The general objective is to reduce the environmental impact of the urban traffic in Tampere allowing fluent, environmentally friendly and safe flow of public and non-motorized traffic.

MoveUs developments in Tampere will rely on ITS Factory – a new innovation, experimentation and development environment, where companies and individual developers can develop, test and productize traffic solutions. The solutions can be built on top of a continuously updated base of traffic open data[7]. For guaranteeing the sustainability of the MoveUs applications in Tampere, ITS Factory supports the partners in 6 categories:

- Test field: maintenance of a network of traffic sensors which provides a model of the TRE region traffic infrastructure as a testing platform.
- End-user experience: ITS Factory is an environment for testing services and systems so that they can be made to fit the needs of the end users. This enables partners to design tailor made services for citizens, businesses and the public sector.
- Standardization: ITS charts existing and future standards with the aim of publishing open data in a standardized format, which allows scaling and duplication.
- Road mapping: keeping track of open interfaces and data and standardization.
- Marketing and export support.
- Open data and developer support: allowing the development of new applications and services.

Tampere's target users will be essentially the same as in Genoa and Madrid:

- Public transportation users
- Municipality of Tampere
- Managers of public transportation services

[6] Tampere City Strategy, available online: http://www.tampere.fi/material/attachments/t/5m6pXm17U/Tampere_City_Strategy.pdf
[7] ITS Factory, Available online: http://wiki.itsfactory.fi/index.php/ITS_Factory_Developer_Wiki

- Engineers of public transportation services

3.4.2 Inventory of the existing Mobility & ITS infrastructures in the city

3.4.2.1 Overall architecture and concept

Tampere's infrastructures are rich and convenient for MoveUs. The Municipality of Tampere owns the entire urban traffic infrastructure, data and services for public transportation, parking facilities, charging stations for electrical vehicles. Tampere offers, to its mobility users, 21 information displays at bus stops, 170 crossings with traffic detection sensors, 30 intelligent traffic monitoring units and the ITS Factory platform, providing open data about traffic in Tampere. The region's infrastructure is conveniently sized to work with, and open data is readily available.

Raw data feeds are in variable formats behind variable interfaces. Any applications depending on raw data do not easily transfer to another city or to another system. More data feeds will emerge as more sensors are added on the roads and in the vehicles connected to network. Currently SIRI and DATEX-II standards support most traffic data content. In the future, the standards are extended and potentially new widely accepted standards will emerge.

The following technologies are planned to be used for turning the pilot into a reality: Wireless communication and open data. On this last, let us mention that the following data format standards will provide a convenient way of using traffic information and enable scalability of services:

1) DATEX II: provides a standardized way of communicating and exchanging traffic information between traffic centers to enable better management of road network. It covers a wide range of content describing travel times, weather conditions, road infrastructure status, incidents and accidents, and traffic related measurements.
1) SIRI (Service Interface for Real Time Information): specifies how to exchange information about the planned, current or projected performance of real time public transport operations.
2) GML (Geography Markup Language) serves as a modelling language for geographical data. It is used to indicate roads, buildings, highways, bridges and other map data.

The architecture that will be involved in Tampere pilot site for the provision of the defined services to users in the different Uses Cases is illustrated in Figure 7.

Existent systems that will be **directly** involved in Tampere pilot site for the provision of the defined services to users in the different Uses Cases are: Journey Planners for Bus / Bike, and Smart prioritization Service.

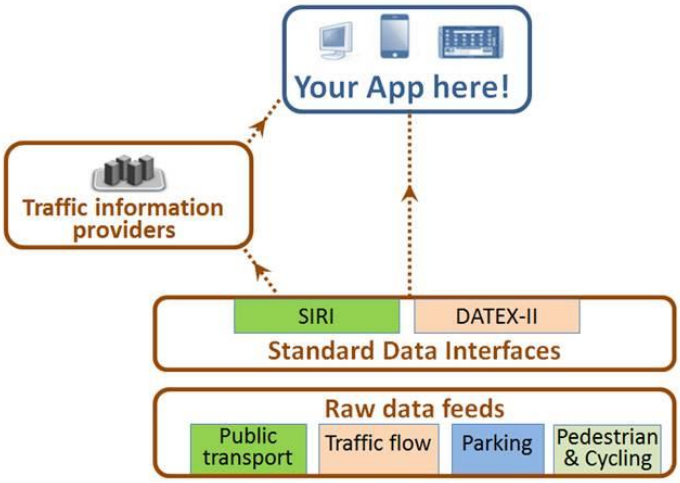

Figure 7 Tampere ITS Factory applications architecture

The Dataserver consists of two separate servers (Figure 8):

- The Frontend server handles the following tasks: - Receiving / Pulling of the data from different data sources - Transforming / migrating / filtering the data before insertion to database - Running OneBusAway (OBA) WebApp and export functions giving access to the SIRI and GTFS export APIs.
- The Database stores the data.

Developer environments can be installed either into the same ITS sandbox cloud (run by CyberCom) or can be run in separate server.

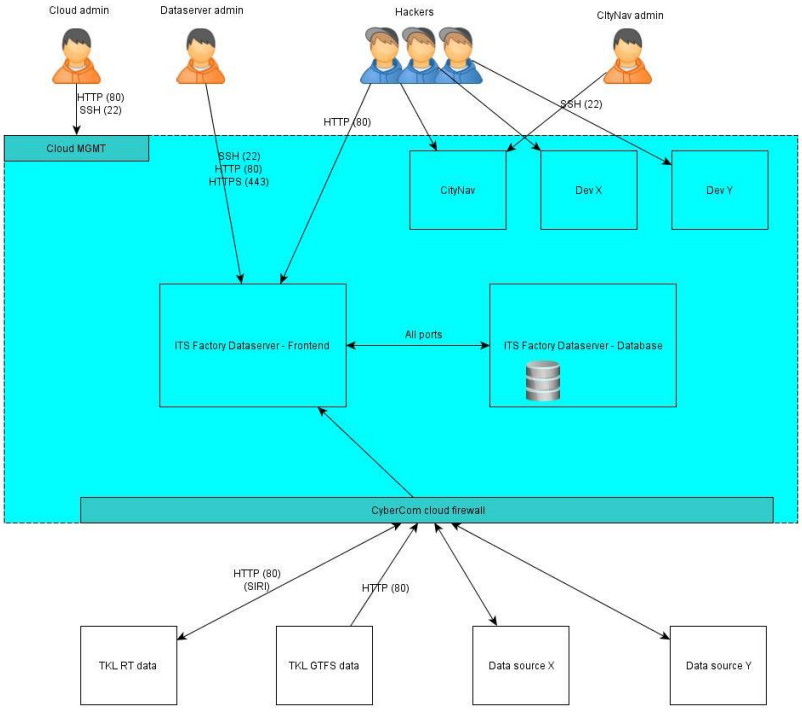

Figure 8 ITS Factory Developer Sandbox architecture

3.4.2.2 Functional Architecture

Reference ITS Areas	Systems implementing the ITS Area	Processes	Data Flows	Actors
Traffic Management	**Digitraffic**[8] is a service offering real time and historical information and data about the traffic on the Finnish main roads. The service is provided by the Finnish Transport Agency, and it is addressed for organisations developing information services or working with traffic management and planning. **Digiroad**[9] is a national database which contains precise and accurate data on the location of all roads and streets in Finland as well as their most important physical features (covering a total of 483,000 km or 300,000 miles). **LiikenneNyt, Tampere** real time traffic situation from streets. Data is available to pilot free of charge. **Parking Data,** parking halls and on-street parking	**Open Data** **Limited Open Data (while pilot)** **Limited Open Data**	**Real Time** **Real time (15 min.) and history Data** **Real Time**	**Drivers, Finnish Transport Agency** **Drivers, InfoTripla Ltd.** **Drivers, Finnpark**
Public Transport Management (Traveller Journey Assistance)	**Lissu**[10] Traffic Monitor: monitoring of Tampere bus traffic in real time (every one second) and visualization of predicted bus arrival times on stops. Public Transport Data in available both static and	**Open Data**	**SIRI**	**Public Transport passengers City of Tampere**

[8] http://www.infotripla.fi/digitraffic/english/index.html
[9] http://www.digiroad.fi/hyodyntaminen/en_GB/ordering/
[10] http://lissu.tampere.fi

	real time Data.			
Traveller Journey Assistance	**City Navigator**[11]: routing services with turn-by-turn navigation, supporting cyclists and public transport passengers. **Repa Reittiopas**[12]: recommendations on the best public transport connection to your destination within city traffic. **Journey Planner for Cycling**[13]: seeking the best cycling route to user-defined points of interest in the Tampere Metropolitan area. In **STREETLIFE**-project connecting Repa Reittiopas and real time Public Transport Data.	**Open Data**	**Real Time**	**Cyclists, public transport passengers City of Tampere** **Passengers all modes**

Table 8 Summary of functional ITS architecture in Tampere

[11] http://dev.itsfactory.fi/citynav/
[12] http://reittiopas.tampere.fi
[13] http://kevytliikenne.tampere.fi

4. Mobility Requirements: including Infrastructure Requirements, Public Transport Management Requirements and Final Users' Requirements

4.1 Madrid pilot site

4.1.1 Description of the service 1: Smart prioritization of vehicles

This service is expected to give priority to specific vehicles in crossings controlled by traffic lights from the Urban Traffic Control System operating in Madrid, so as to optimize the time of travel and the travel efficiency of those modes of transport.

Priority will be assigned only to public buses and upon request in the case the bus is delayed in its route.

This service might be extended to other specific vehicles like car sharing vehicles, electric vehicles, etc. in a post-project phase.

At the end of the service, feedback information will be sent to MoveUs platform for statistical analysis purposes.

4.1.1.1 Service structure

The objective of this service is to provide a vehicle priority in the centralized traffic management system in Madrid; The priority demand will be requested by the vehicle towards the local traffic controller located in the intersection, which will attend the request (if authorized by the traffic control centre) and will actuate on traffic phases and times in the intersection, keeping the safety level in traffic conditions.

It is proposed to define the location and topology of the intersections following European and international standards, by which the different areas of influence around each crossing, lanes, directions, etc. that can be understood by different systems and devices involved in the service.

Some information should be pre-configured both in MoveUs system and in the ESS system of the public buses, in order to provide this service.

MoveUs system should have pre-loaded, at least, the following information:

- Information about the location and topology of each crossing capable of providing with the prioritization service located in each bus line route: crossing identification code and location (X,Y coordinates); identification and geo-positioning of lanes and possible trajectory and relation with the specific local traffic controller (LTC); etc.

The ESS system should have pre-loaded the following information:

- Location of the virtual loops, both in the detection section and in the re-arming section, that relate to the LTCs of the crossings included in the buses routes.

The figure 9 shows the structure of the service of priority for the public bus, with the relation of the modules involved in the service, and specifies which of them is existing, needs adaptation or will be developed in the project:

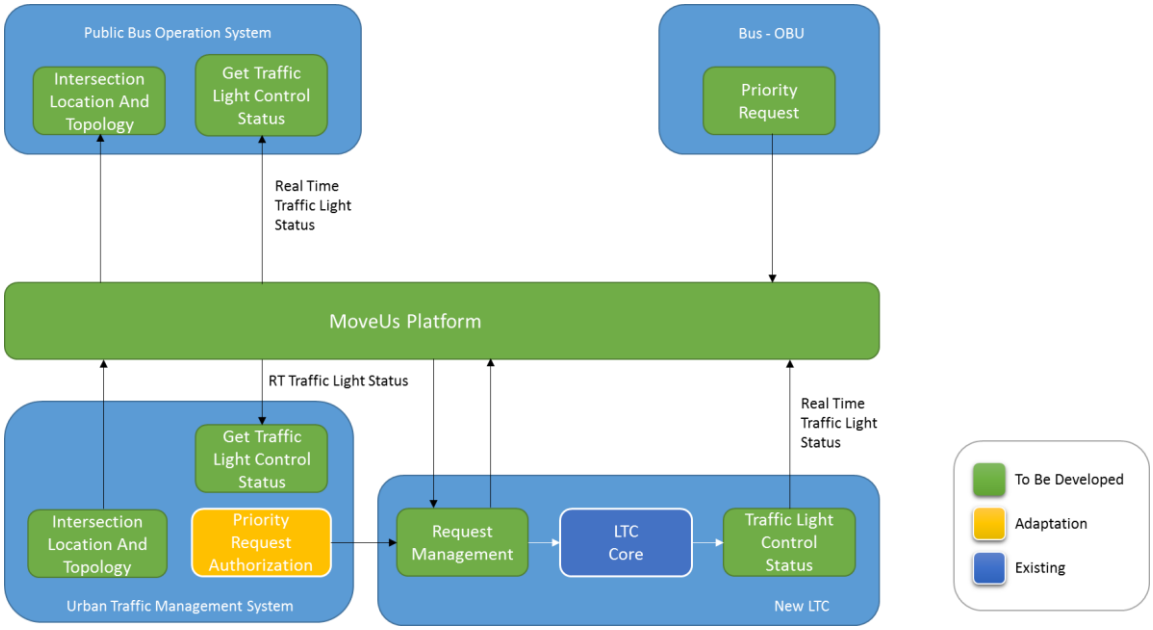

Figure 9 Prioritization of vehicles service – blocks diagram

The traffic controllers will activate the micro-regulation action at the crossing (local action) whenever a request for priority is received and the traffic conditions allow for it.

In the case that there are more than one priority requests at the same crossing, multi-demand adaptive traffic control algorithms will manage all the priority requests received and will decide, based on multi-criteria data analysis methods, the traffic light control strategy to follow.

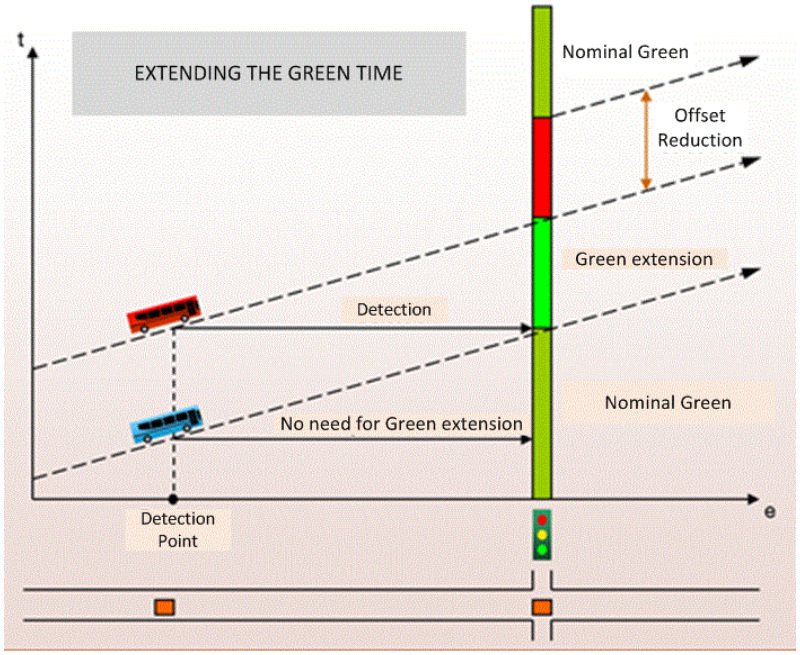

Figure 10 Micro-regulation strategy: extension of Green time for prioritized buses

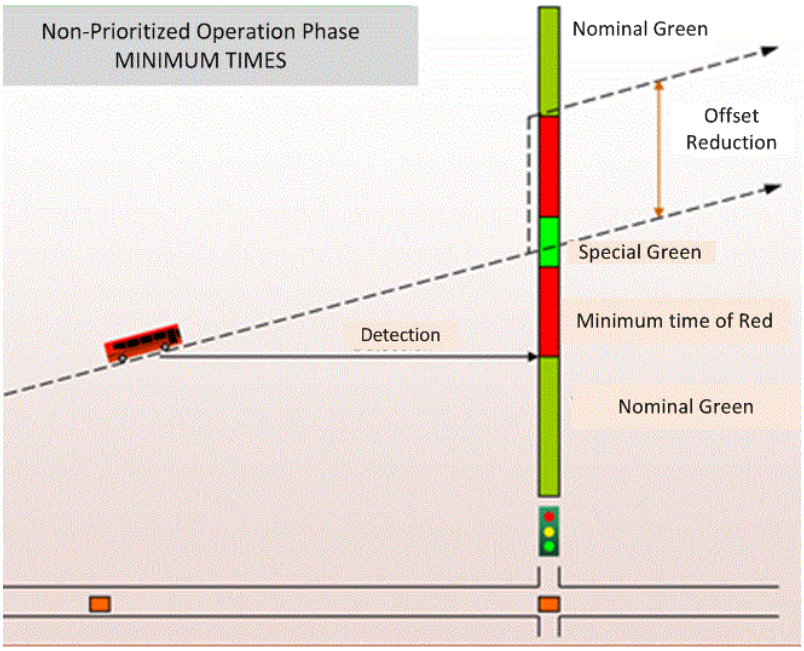

Figure 11 Minimum time of red that must be maintained in the regulation operation

The figure 12 shows the sequence of the service that will be explained in detail in section 4.1.1.1.1 Story line.

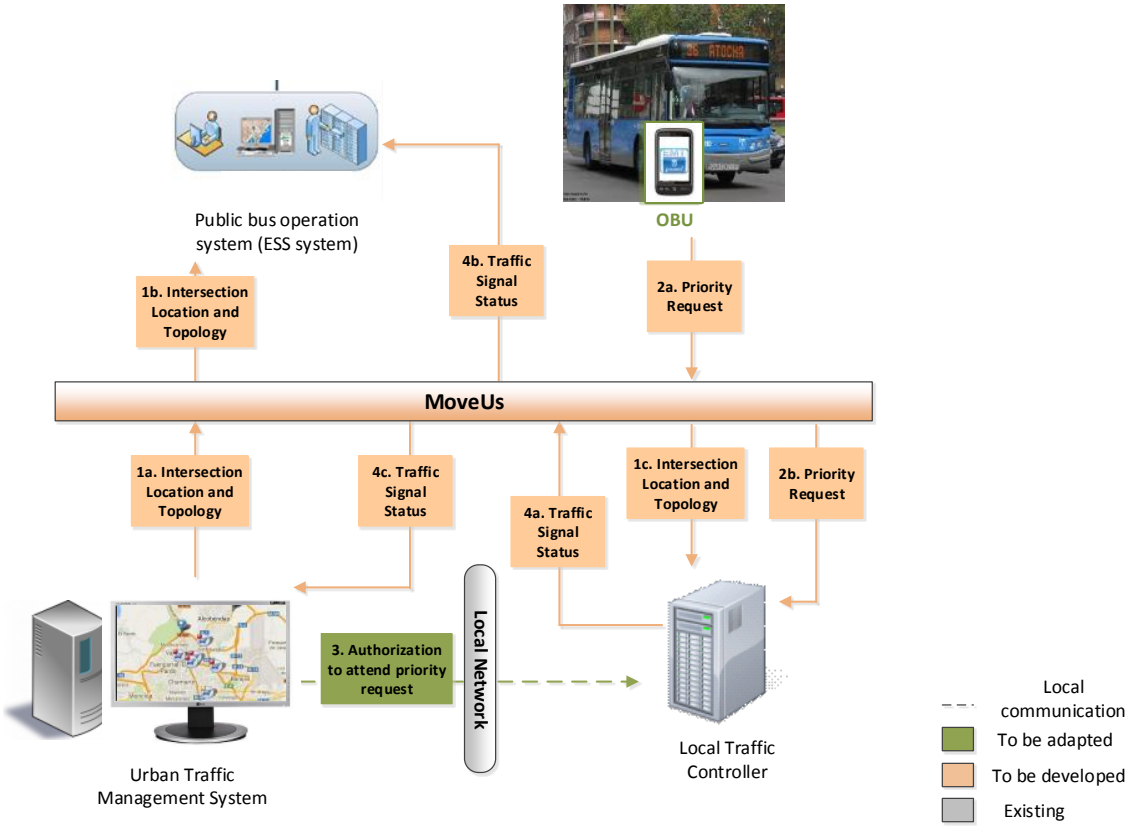

Figure 12 Explanative diagram of Prioritization of vehicles service in Madrid

4.1.1.1.1 ***Story line***

PREVIOUS STAGE TO THE SERVICE PROVISION

1.a - 1.b – 1c - Urban Traffic Management System → MoveUsS→ ESS system-> Local Traffic Controller

ESS-SAE is subscribed to a MoveUs service to be informed about Traffic Controllers with possibility of Priority Request.

When a new Traffic Controller with Priority Request functionality enabled is installed, MoveUs will be informed by the Urban Traffic Management System, and will update this information to the ESS-SAE (1.b). This information includes geo-location of the Traffic Controller, geo-location of the intersection, etc.

Also, the topology configuration is sent to the PCBox of the local traffic controller thorough MoveUs platform (1.c).

CLOSE TO REAL-TIME SERVICE PROVISION STAGE

2.a - OBU → MoveUs

The OBU of the bus detects that the bus is delayed in its route and decides to send a priority request message to MoveUs; the priority message will include complementary information like the bus identification code, the bus line, direction and trajectory, level of priority and estimation of time of the bus to reach the

following traffic light, etc. MoveUs returns an acknowledge message (ACK) when the request is received.

ON REAL-TIME SERVICE PROVISION STAGE (within a traffic controller influence area)

2.b - MoveUs →Local Traffic Controller (LTC) (Bus at the entrance zone)

MoveUs directly re-sends the priority request message with the additional information received from the ESS system to the specific traffic controller that controls the next traffic light in the bus route; this step is time critic for the correct provision of the service.

3.- Urban Traffic Management System ->LTC → MoveUs → ESS system → OBU

The traffic controller receives the priority request from MoveUs and check if the Urban Traffic Management System authorize the prioritization action.

If it is authorized, then the LTC assesses the possibility to provide the priority to the specific bus trajectory and the time to actuate on the traffic light, based on the estimated time of the bus to reach the traffic light.

Afterwards, the traffic controller will trigger the actions necessary to provide the delayed bus with priority in the crossing, only in the case such prioritization action is possible.

The LTC will send a message to MoveUs reporting the operation with information of the request and the result (it is has been conceded or not). **4.a – 4.b – 4.c - LTC → MoveUs → ESS system and OBU -> Urban Traffic Management System**

The LTC sends information towards MoveUs in close real time about the traffic light status (cycle phasing and timing, etc.) (4.a)

Once the traffic light status information arrives to MoveUs, it re-sends to subscribers like ESS system and the Urban Traffic Management System, using a standard format (4.b and 4.c).

Finally, the priority service operation in the crossing is finished and the traffic control operation is re-armed and come back to normal operation after a predefined time out.

4.1.2 Description of the service 2a: Smart routing for pedestrian

This service aims to provide pedestrians with the smartest route between their actual position and a selected destination following the mobility preferences recorded at the registration phase.

Among the smartest options -and the respective incentives related to them- offered by this service, the users can choose the way they want to move: public transport, public bike, on foot, by car, etc. and the application will guide the user to achieve the target point.

Upon request by the user, this service also offers links to websites with local information of the user interest, like leisure events, cultural visits, gastronomy, etc.

At the end of the service, feedback information will be sent to MoveUs platform for statistical analysis purposes.

4.1.2.1 Service structure

Once the user initiates the application, it is positioned through the GPS of the personal device and thus the application developer will be able to locate the user.

If it has been previously configured by the user, the application will automatically send to him/her links with information about any leisure or cultural activity in the area.

Once the user has selected its destination, and according to his/her mobility preferences and position the application will provide with different eco-efficient possible ways of arriving to the selected point to be chosen by the user.

The mobility options provided to the user will take into account the information available in MoveUs platform about traffic incidents and congestions, travel times by car, etc., in order to ease the creation of the smartest route.

The structure of the service is shown in the diagrams block in figure 13.

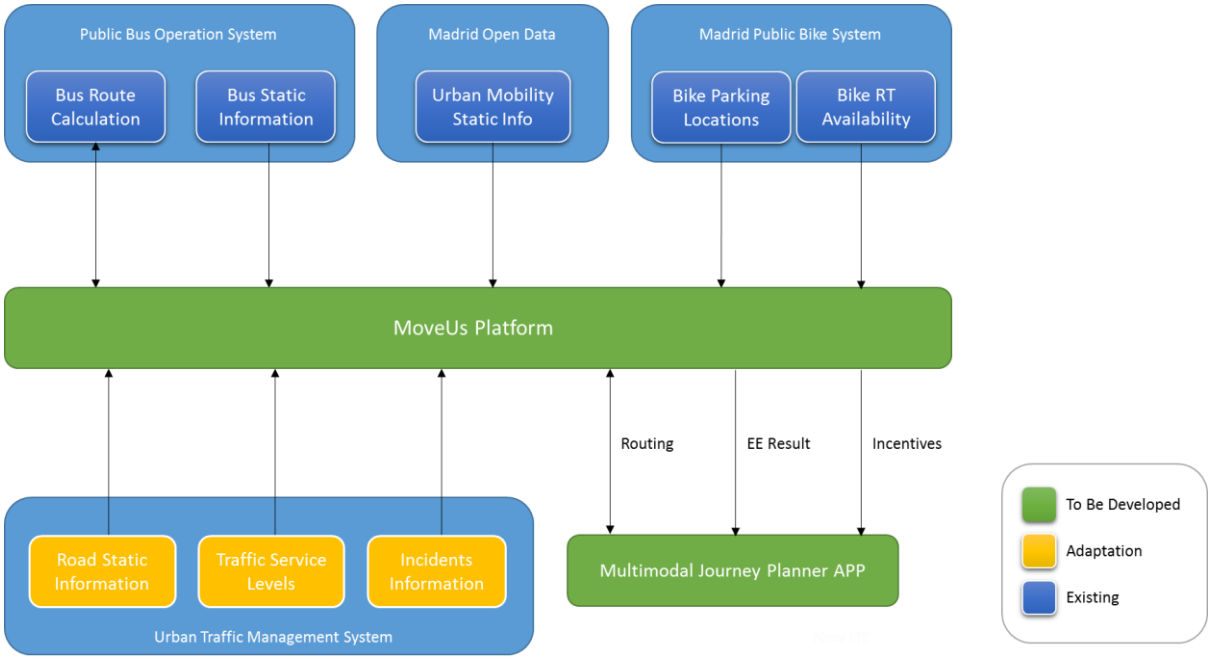

Figure 13 Smart Routing for pedestrian services - blocks diagram

The sequence of the service is shown in figure 14, and it is explained in detail in section 4.1.2.1.1 Story line.

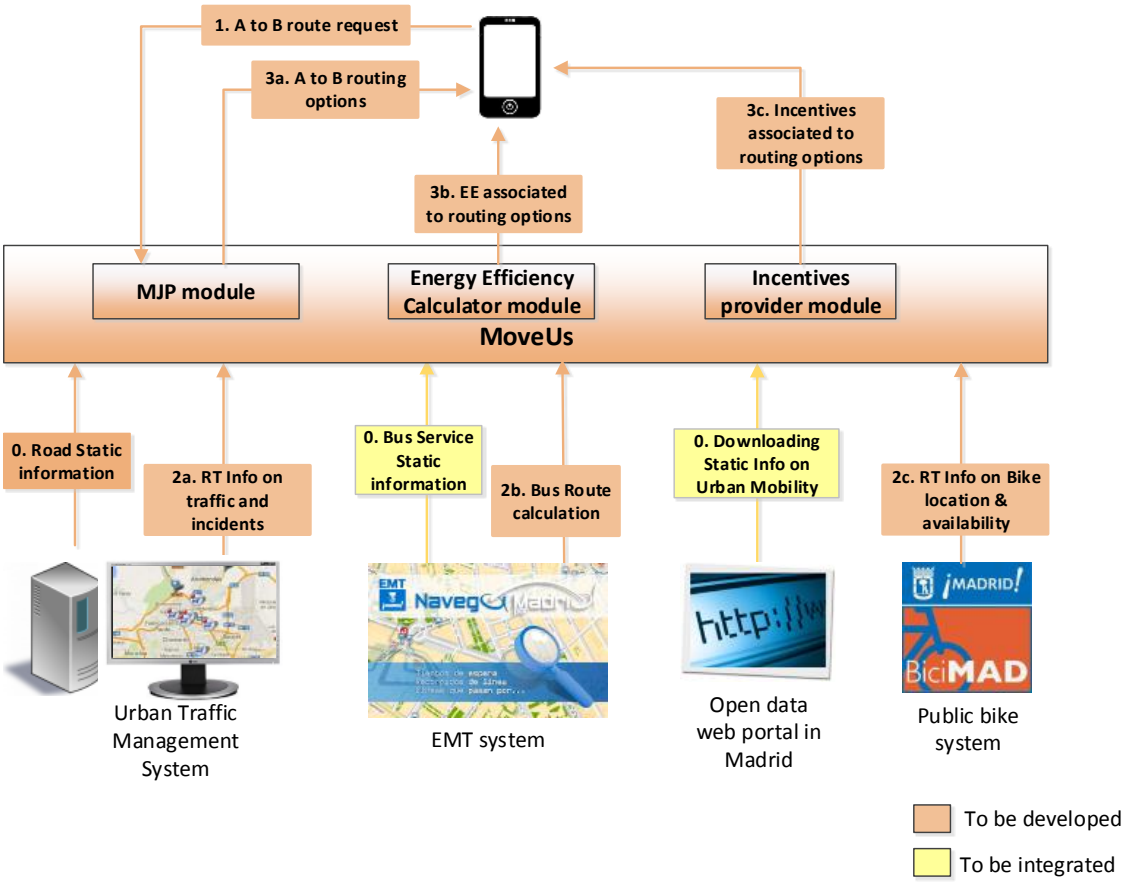

Figure 14 Explanative diagram of Smart routing service in Madrid

4.1.2.1.1 ***Story line***

PREVIOUS TO THE SERVICE PROVISION STAGE

A.- User → Application developer (Service consumer)

User subscribes to the application service by filling in an initial survey adding its own mobility preferences like:

- I am a regular walker;

- I want to know the safest mobility ways

- I do not know the city and want to see it while moving, etc.

The user will also indicate if he/she is interested in any type of culture and leisure activities/events in the city where he/she is.

REAL TIME SERVICE PROVISION STAGE

0.- EMT system + Open portal in Madrid + Urban Traffic Management System-> MoveUs1.- User with the MoveUs app → MoveUs platform

When the user starts the application, the location of the user is automatically detected by the GPS and the user profile is uploaded in the smartphone application.

If previously configured by the user, the application will automatically show links with information of activities and events that will take place in the surroundings, according to the user preferences previously registered.

The user selects its destination, and types it into the smartphone application; the application connects to MoveUs platform so as to get the mobility information needed to route the user (from A to B) according to his/her mobility preferences, and also to provide the user with any kind of incentive related to the transport mode selected and information related to the energy efficiency associated with the routing options.

2a. – 2.b – 2.c – MoveUs -> Urban Traffic Management System + EMT system + Public bike system

MoveUs platform ask the different real time mobility info sources and routing planners so as to calculate or obtain different possible routes depending on the user's request and/or preferences that will be afterwards offered to the user's smartphone application.

3a. – 3b. – 3c. - MoveUs-> Smartphone application

MoveUs will send to the user's smartphone application the possible ways of arriving to the selected point (3.a) along with energy efficiency information related to the different mobility ways (3.b) and the possible incentives related to those ways (3.c). The routes offered by the application will be as much eco-efficient as possible.

4.- User (Personal device) → Smartphone application → MoveUs Platform

The user selects the route to follow and the application will guide the user to his/her destination following the route by using a GIS based map; in addition, the smartphone application may inform MoveUs platform about which route has been selected by the user for the records, and for the possible provision of further incentives to users selecting that way of mobility in the future.

Also, the smartphone application may provide the user with updated information about mobility alarms, incidents in the mode of transport selected, congestions, etc. available in MoveUs platform which may affect the route of the user; that would be offered to the user as a premium service.

4.1.3 Description of the service 2b: Smart crossing for pedestrian.

This service aims to provide **the smartest crossing options** to the pedestrians, whether using special system to detect pedestrian at crossing points – known as **SafeCross** – or by applying a reaffirmation of a demand through the use of Bluetooth technology implemented in the personal device of the pedestrian.

The objective of this service is twofold:

- First objective is to improve the safety of pedestrian in the cities, and contributing to foster the mobility on foot at urban areas by making the street crossing safer for pedestrian, especially those with -permanent or temporal- mobility impairment, making them feel more confident when crossing the street.

Injury to pedestrians is a major safety hazard in Europe and in many countries; the recent push towards urbanization in cities has resulted in a substantial number of crashes and fatalities involving pedestrians every day, all over the world. This

service is aimed at contributing to increase safety in pedestrian crossings and to encourage a pedestrian/transit-friendly environment in cities.

Users subscribed to this service will receive the smartest way for a predefined route. This service will support the user in its route in order to cross safely in those crossings which use a camera to detect pedestrian crossing and that extends the green time until it has crossed safely or until a maximum pre-programmed time is exceeded.

With this service, the user will be able to easily request safe crossing through his personal smartphone.

Furthermore, in crossings not equipped with the camera, the application in the user's smartphone will inform him about the estimated time of the next green phase, so that he can feel confident that he will be able to cross safely in the desired street.

- The second main objective of this service is motivated by the need to create a new urban local traffic controller modular, smart, and compliant with the Internet of Things principles.

In this service, traditional local traffic controllers will integrate different modules that will enable innovative functionalities in the LTC like safe crossing that will enable enlarging the green phase for pedestrian that needs extra-time to safely cross; this functionality is mostly of interest for mobility impaired users, elder, groups of tourists in the city, etc. that can feel confident that they will be crossing the street safely.

This new LTC will also include a Bluetooth Low Energy peripheral module that will facilitate pedestrian to communicate their intention to cross through the Bluetooth channel of their own smartphone or personal device, so that the LTC will be able to know which direction the pedestrian wishes to cross, to receive request for crossing from the pedestrian and to inform the user about the current and upcoming times of red and/or green in the selected crossing; the new LTC will be able to consider the feasibility of adapting the traffic regulation according to the crossing request from the pedestrian so as to advance the green time, only in the case that traffic conditions allow for it.

As mentioned before, this new LTC will also be able to detect the presence of any pedestrian (being MoveUs user or not) crossing, through the safe cross system integrated by which a camera detects any crossing pedestrian and sends an analogic signal to the LTC in order to extend green phase if necessary until the pedestrian has crossed safely or until a maximum pre-programmed time is exceeded.

Furthermore, this new LTC will be developed, based on traditional controllers, so as to communicate with the MoveUs platform, or any other external system, following standardized protocols to send real time traffic light phase status. This communication capacity with external systems or platforms, will enable this new LTC to be integrated in a cloud based solution as MoveUs.

At the end of the service, feedback information will be sent to MoveUs platform for statistical analysis purposes.

4.1.3.1 Service structure

When the user starts the application, the personal device positions the user using the GPS application; and once positioned, the user's coordinates are sent to the MoveUs platform as well as user ID. Afterwards, MoveUs platform automatically uploads into the user's personal device the smart crossing information in a geo-referenced map of the city.

When the pedestrian enters the smart crossing area, his/her personal device will automatically zoom in to show in the smartphone the crossing where the user currently is and activate the Bluetooth communication channel in order to establish communication with the BLE peripheral.

Afterwards, the user will select the crossing direction he is intended to cross, and real time information about the traffic light phase will be automatically shown; also, the possibility to launch a crossing demand request is enabled for the user through the smartphone. The messages of the crossing intention received by the BLE peripheral from the users will be directed and managed in the new LTC, while the information about the traffic status will be launched by the LTC and delivered to the user through MoveUs platform.

This service will also inform users when he reaches a controlled smart crossing in his/her route, where a SafeCross System is installed.

Figure 15 shows the structure of the service through a blocks diagram.

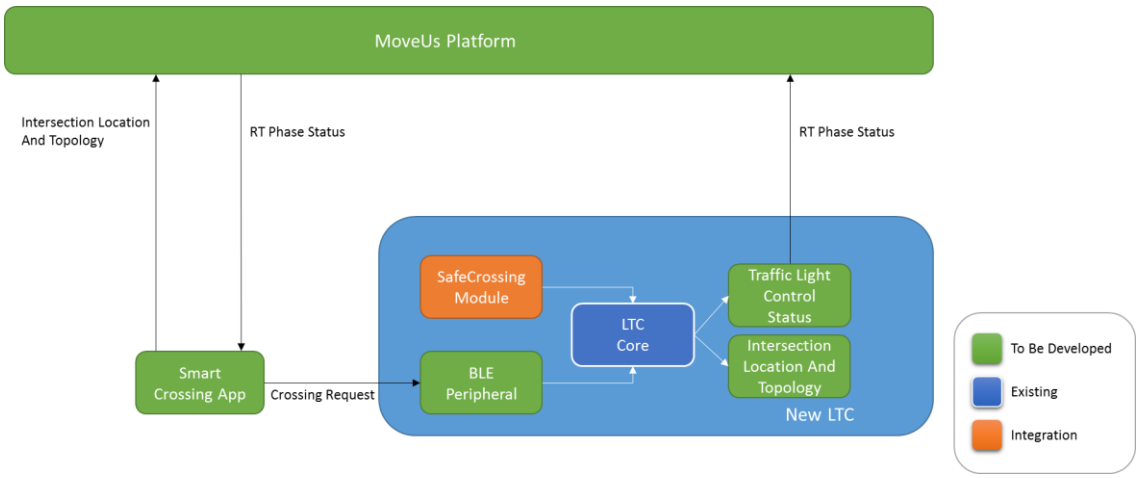

Figure 15 Smart crossing for pedestrian service - blocks diagram

The figure 16 shows the sequence of the service that will be explained in detail in section 4.1.3.1.1 Story line.

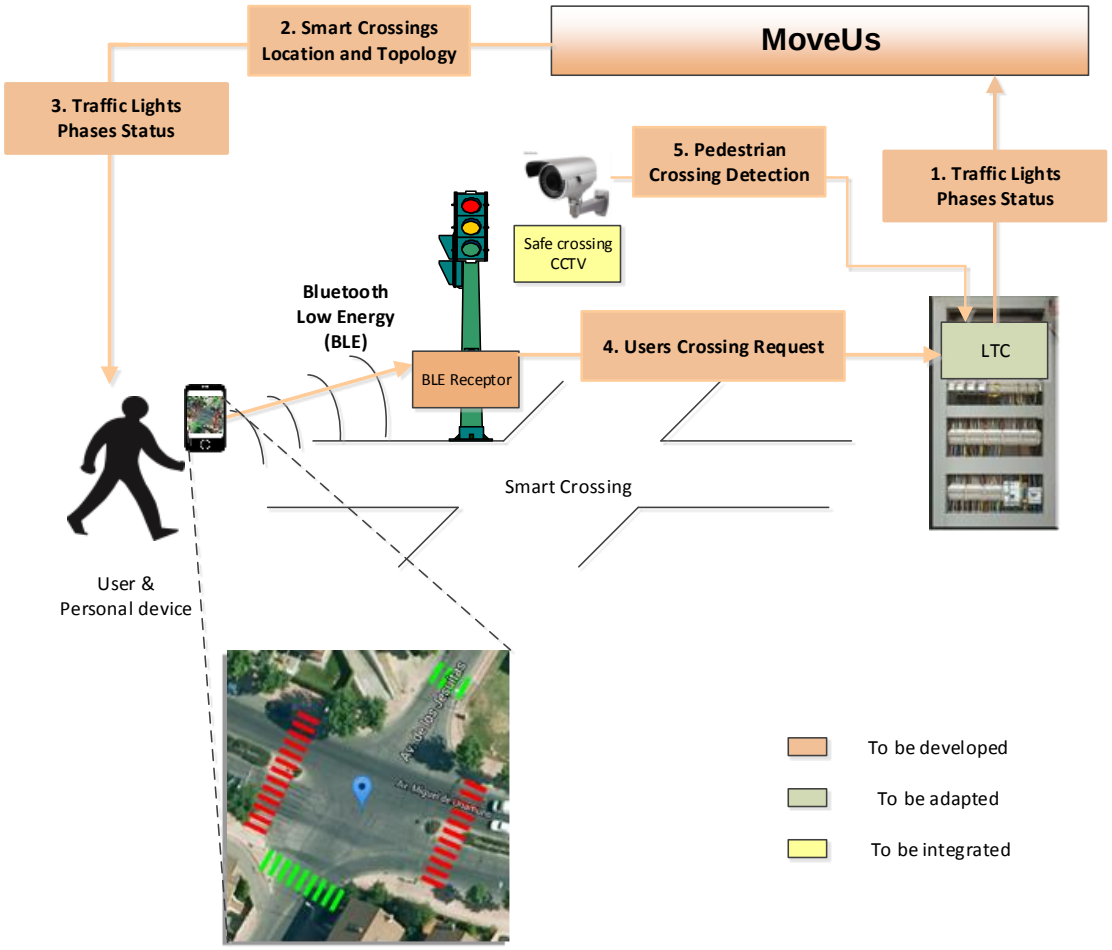

Figure 16 Explanative diagram of smart crossing service in Madrid

4.1.3.1.1 ***Story line***

1. LTC→ MoveUs

The local traffic controller periodically sends the traffic light status changes to MoveUs whenever they happen.

2 -Personal device ←→ MoveUs platform

The starts the application in his device and it connects to MoveUs and it receives or updates automatically all the smart crossing information (location and topology) of the city where the user is located.

3. MoveUs platform → Personal device

Also, the application will receive from MoveUs the information of the traffic light phases of the when the user is in the nearby of a smart crossing.

Then the service is ready to be used.

4.- Bluetooth connection: Personal device → BLE peripheral → LTC

When the GPS system of a personal device enters in the area of a smart crossing, the application automatically zoom in the crossing map and automatically activates the personal device's Bluetooth (if it's not already activated) and begin to search for the LTC's BLE peripherals.

The application of the personal device will show to the user the crossings directions of the intersection, so that the user can select the crossing direction of his interest and obtain information about the status of the phase, the time to change to the next phase and the possibility to confirm the intention to cross.

Once the user confirms his intention to cross in any of the possible crossing direction, a message will be sent from his/her smartphone to the BLE receptor controlling this crossing and then to the PC Box in the Local Traffic Controller.

SafeCross system

For those crossing which have a specific safe crossing system like SafeCross:

5.- SafeCross system (camera) → Local Traffic Controller (LTC)

The camera sends an analogic signal to the LTC when it detects a pedestrian is crossing.

If the green phase for pedestrian is about to change and the LTC receives a signal from the camera that informs that there are pedestrian still crossing, the LTC will extend the green phase until the pedestrian has crossed safely or until a maximum pre-programmed time is exceeded.

4.1.4 Description of the service 3: Eco-efficient Route Planning and Traffic prediction

This service is aimed at providing travelers with privileged mobility information like on-trip advanced traffic information, automatic incident warnings and on-trip eco-routing.

This service may considered as a premium service; it will be offered to travelers that use shared transport modes and/or green mobility modes like electric cars, bike-hiring, etc. This service may be offered also as an incentive to reward and/or foster eco-friendly mobility patterns.

At the end of the service, feedback information will be sent to MoveUs platform for statistical analysis purposes.

4.1.4.1 Service structure

One of the main problems happening in an urban traffic environment is the ability to provide users (travelers and drivers) with reliable times of travel information. This is due to the influence caused by the traffic light control strategies over the traffic.

In order to contribute to solve this problem, a Bluetooth reader network is proposed to be deployed in the street network in Madrid so as to support the process of urban travel time computation that is carried out by the operating traffic control system, which is based on loops detectors.

The principles for the development of the service prototype are seemingly simple; Bluetooth channel is used to communicate a limited quantity of data thus it is used to communicate between mobile phones, hands free, GPS navigators, etc.

Therefore, such devices have a unique identifier named MAC that emits a digital signal steadily.

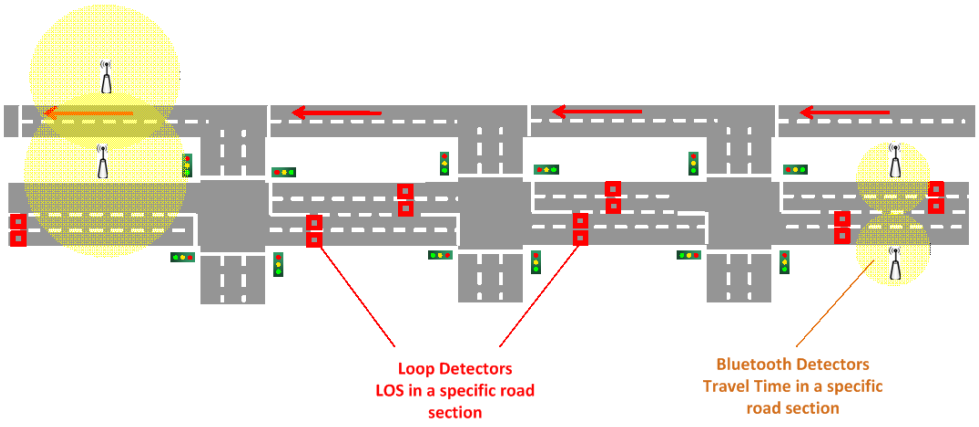

Figure 17 Loop detectors and Bluetooth detectors will provide MoveUs with different information related with different road sections.

Based on that, when a vehicle passes near the Bluetooth reader, the sensor will be able to capture the unique MAC address of the in-vehicle Bluetooth device and allow a temporary location thereof. So, it will be possible to obtain times of travel for the section between Bluetooth detectors.

On the other hand, the traffic information obtained by loop detectors allows having a picture of the Levels of Service (LOS) of the different road sections; the levels of service can be: light traffic, slow traffic, traffic with some congestion, congested traffic, street cut to traffic.

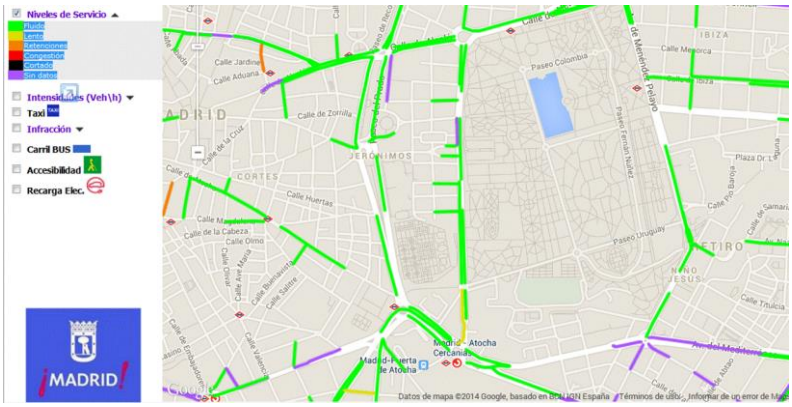

Figure 18 Levels of Service on Google Maps, extracted from Madrid City Council website for Mobility information (http://informo.munimadrid.es/)

All the information obtained from loops detectors, Bluetooth readers, traffic plans information will be integrated and computed in MoveUs so as to obtain more reliable times of travel for the different sections of the street network.

Also algorithms will be applied to all the information available so as to obtain estimations of travel times for the different sections of the road network considered in the pilot with a temporary horizon no longer than 15 minutes.

Based on the measured and on the estimated 15 minutes future times of travel, and considering the different sections of the road network, this service is aimed at providing users with optimized routes for their mobility needs.

This information would be available by using a web/mobile application where the user will be provided with information about the estimated travel time of a selected route, based on the real time data processed in MoveUs.

The optimization will consider the prediction of future traffic state in each section at different time intervals (from minute 0 to minute 15), and will be set with the objective of reducing the times of travel and of increasing the mobility efficiency of the driver.

The structure of the eco-efficient routing service is shown in the blocks diagram in figure 19:

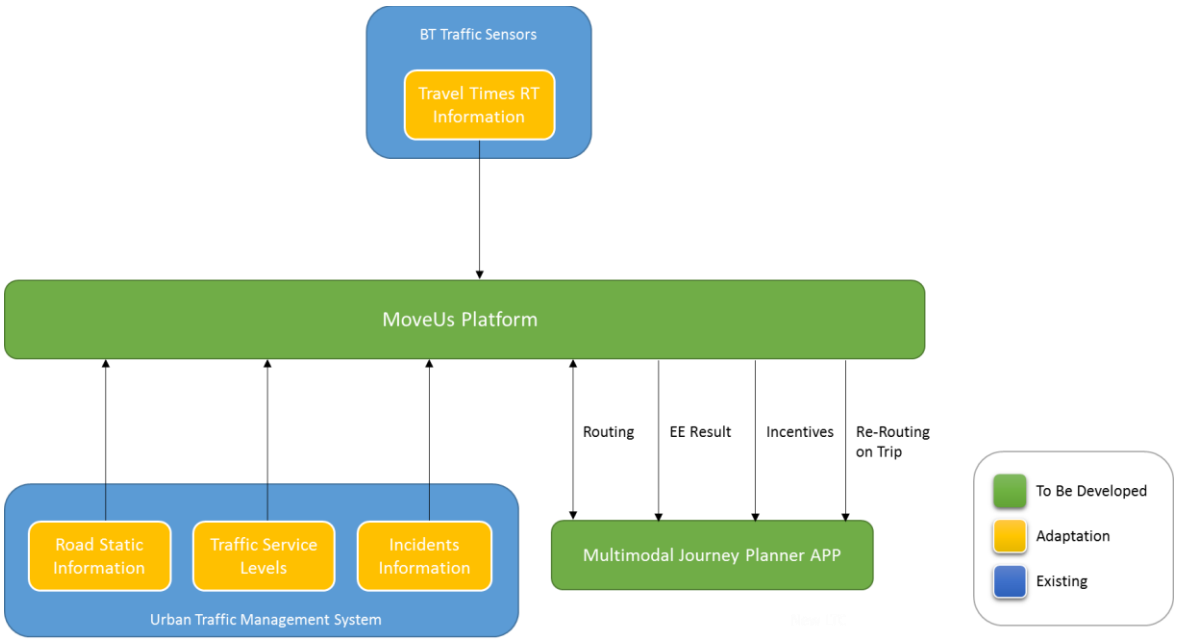

Figure 19 Eco-efficient routing service - blocks diagram

In figure 20, the sequence of the service is shown, and it is explained in detailed in section 4.1.4.1.1 Story line.

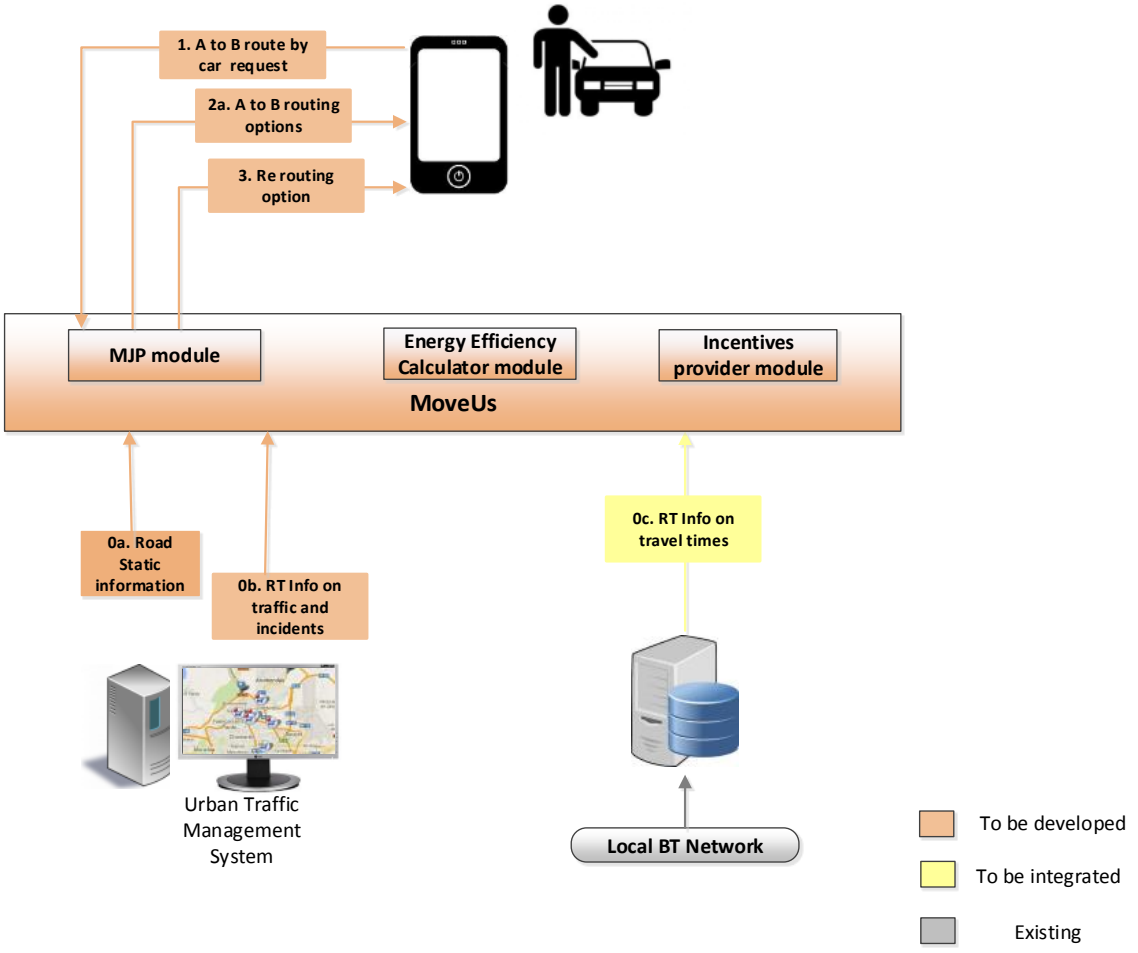

Figure 20 Explanative diagram of the eco-efficient routing service in Madrid

4.1.4.1.1 *Story line*

IN A PREVIOUS STAGE TO REAL-TIME SERVICE PROVISION

0a – 0b- ADIMOT (UTC) system → MoveUs

Traffic variables Intensity and Occupancy are continually measured by the detectors and sent to ADIMOT system (for the Urban Traffic Control) which calculates the level of service (LOS) of the different road sections of the street network. Those LOS per section and time are sent and available in MoveUs system (0.b).

In addition, ADIMOT system makes available in MoveUs the road static information about traffic plans operated at any time, and information of Cycle, Split and Offset (0.a)

0c.- Bluetooth Detectors network → MoveUs

Bluetooth detectors continually detect the MAC of Bluetooth devices located in their detection coverage area, and differentiate and filter the MACs from hands free and in-vehicle Bluetooth devices out of pedestrian Bluetooth devices. Based on the information obtained from the in-vehicle Bluetooth devices (detection location and time), times of travel are calculated for the different road sections covered by the

Bluetooth detectors network. Those times of travel per section and time are sent and available in MoveUs system.

ON REAL-TIME SERVICE PROVISION STAGE

1.- User (Smartphone Application) → MoveUs

The user starts the MoveUs app in his/her smartphone and enters his/her destination, specifying the car as transport mode.

The smartphone application validates the user and obtains his/her location through the GPS of the smartphone, and request MoveUs to obtain the route from the origin to the specified destination.

MoveUs platform manage and process the LOS in road sections selected and calculates the optimized route for the user to follow, based on the information gathered from the ITS infrastructure deployed and the times of travel predicted by the service algorithms of the different routes that start from the location of the user and ends in his/her destination point.

2a. MoveUs → Smartphone application

The optimized route is sent to the user and displayed over a GIS map (Google Maps).

3. Smartphone application ← MoveUs

The smartphone application will get from MoveUs traffic events that would modify to a certain extent -to be defined- the time of travel of the route offered to the subscribed users; in that case, the user application automatically sends user a warning about the traffic incident detected and offers an alternative route to the user on-trip, following the previous steps 1. to 2.- and taking the current location as the new starting point.

4.1.4.2 Requirements of the service 1: Smart prioritization of vehicles

MADRID SERVICE 1: Smart prioritization of vehicles				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
M_S1_FR_01	Every priority vehicle should have an OBU implemented	The IP addresses from the OBUs and the LTC should be fixed and previously configured, so as to be able to communicate	- ESS of public bus / On Board Unit (OBU) - UTC-ADIMOT system / Local traffic controller (LTC)	
M_S1_FR_02	Every LTC should be able to communicate to the internet	The IP addresses from the LTC should be fixed and pre-configured in MoveUs, so as to be able to communicate with it.	- LTC	
M_S1_FR_03	The location of the virtual loops that define the influence zone in the crossings (detection and re-arming zones and sections) must be defined particularly for every crossing considered in the pilot	Virtual loops and influence zones must be defined for all trajectories possible in the crossing, in both directions.	- UTC - ADIMOT system / LTC	
		The virtual loops must be located at a distance from the Traffic light enough for the LTC to activate priority, avoiding the vehicle to stop as much as possible.	- UTC-ADIMOT system / LTC	
M_S1_FR_04	Pre-configuration of virtual loops in the ESS of public buses	The virtual loops must be pre-configured in the ESS system of the public buses, so that the buses would be able to send both the prioritization request message and the re-arming message to MoveUs in time.	- ESS system / OBU	
M_S1_FR_05	Pre-configuration of information in MoveUs from the ESS system	Information about bus lines & routes, bus identification codes, etc. should be pre-configured in MoveUs.	- ESS system - MoveUs platform	
M_S1_FR_06	Pre-configuration of information in MoveUs from the UTC system	Information about every crossing identification code and location, identification and geo-positioning of all virtual loops and relation with the specific traffic controller, etc. should be pre-configured in MoveUs.	- UTC-ADIMOT system - MoveUs platform	

M_S1_FR_07	Univocal identification of equipment	Univocal identification of OBUs, virtual loops and LTCs in MoveUs system	- UTC-ADIMOT system - MoveUs platform - ESS of public bus / OBU	
M_S1_FR_08	Automatic updating of configuration tables	Tables of configuration in MoveUs should be automaticaly updated with new information (i.e. changes in bus lines routes, changes in street directions, etc.)	- MoveUs platform	
M_S1_FR_09	On-time and fast information flow	On-time and fast information flow must be guaranteed, as time is a especially critical aspect in this service.	- ESS of public bus / OBU - UTC-ADIMOT system / LTC - MoveUs platform - Communication network	
M_S1_FR_10	Definition of different levels of priority	Different levels of priority will be defined by the ESS system and communicated to the LTC by MoveUs, in order to assess and decide on the traffic light control strategy to take in the crossing when more than one priority vehicle coincide.	- ESS system of public bus	
M_S1_FR_11	Readjustment of the traffic light cycle	If the UTC-ADIMOT system detects that the regular circulation characteristics have been highly modified by the prioritization actions and need re-adjustment, it will be able to directly send a signal to the LTC and force the reestablishment of the traffic light cycle.	- UTC-ADIMOT system - LTC - MoveUs platform	
M_S1_FR_12	Communication language with the final user	Language of communication with the vehicle driver will be the national language, but English will be also always enabled.	- OBU	
M_S1_FR_13	Display of information to bus driver	Bus driver will get information through the OBU. This information may be displayed in the device screen or be an audio message.	- OBU	
M_S1_FR_14	24/7 Operation	The prioritization service is able to work 24 hours, 7 days a week.	- UTC-ADIMOT system / LTC	

4.1.4.3 Requirements of the service 2a: Smart routing for pedestrian

MADRID SERVICE 2a: Smart routing for pedestrian				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
M_S2a_FR_01	Service subscription	Users must subscribe to the service	- Personal device. - Service supplier.	
M_S2a_FR_02	3G/4G Data Communication	It is used to transmit information between the personal device and MoveUs in both directions.	- Personal device - MoveUs Platform - 3G/4G	
M_S2a_FR_03	GPS application activated in the personal device	A GPS application and system are needed to locate users and interest points.	- Personal device. - MoveUs database	
M_S2a_FR_04	Leisure and social events database in MoveUs	A list of links with information about leisure and events/points of interest will be available in MoveUs; MoveUs will direct the users to them in order to obtain information and decide destination to be routed to.	- Personal device. - MoveUs database	
M_S2a_FR_05	Users information database	Database inside MoveUs with user's mobility behavior; MoveUs will be able to track the mobility options taken by the user.	- Service consumer (application developer) database - MoveUs Database	To be required to application developers.
M_S2a_FR_06	Smart Mobility options database	Database inside MoveUs with several smart mobility options (car-sharing, public transport, etc)	- Smart Mobility Options database. - MoveUs Database	
M_S2a_FR_07	User identification and information selection	Information provision to the user based on its mobility preferences.	- Personal device's MAC. - User Information Database at the service consumer system	

M_S2a_FR_08	Univocal identification of the personal device	Each user will be related to a personal device that will have its own MAC, that is used to supply the information related to the registered user.	- Personal device's MAC. - User Information Database at the application developer system	
M_S2a_FR_09	Route generator application	Application generates a smart route just with user's GPS position and coordinates of the target point, according to what he/she selected.	- Personal device - Position system (GPS)	

4.1.4.4 Requirements of the service 2b: Smart crossing for pedestrian

MADRID SERVICE 2b: Smart crossing for pedestrian				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
M_S2b_FR_01	Service subscription	Users must subscribe to the service	- Personal device. - Service supplier.	
M_S2b_FR_02	Smart crossing list available in MoveUs	MoveUs must have a list of smart crossings in the city	- Smart Crossings operator - MoveUs Platform	
M_S2b_FR_03	GPS application activated in the personal device	The GPS coordinates of the user are needed for the service	- Personal device	
M_S3a_FR_04	Bluetooth activated in the personal device	In order to make use of this service the bluetooth of users' personal devices must be enabled.	- Personal device	
M_S2b_FR_05	Bluetooth receptor installed at the smart crossings	This equipment receives the signal of a personal device once a user enters into its action field.	- Personal device bluetooth. - Bluetooth receptor.	
M_S2b_FR_06	Smart - and safe - crossing	A number of selected crossings are considered as smart, and specific instrumentation must be implemented.	- Bluetooth receptor - LTC/PCBox	

			- SafeCross camera and SW	
M_S2b_FR_07	Communication BT receptor - LTC/PCBox	When a pedestrian is detected by the receptor, it sends this information to the PCBox in the LTC through a Powe Lane Communication (PLC). The information also runs in the opposite way.	- Bluetooth receptor - LTC/PCBox - PLC	
M_S2b_FR_08	Reliability of Detection SW	The detection SW of the camera system must be able to accurately detect and confirm that a pedestrian is crossing	- Video camera - Detection algorithmia and SW - LTC	
M_S2b_FR_09	Information transfer	From the camera to the MoveUs platform through the LTC. From the MoveUs platform to the Traffic Light through the UCT-ADIMOT center.	- Camera - LTC/PCBox - MoveUs Platform - UCT-ADIMOT	
M_S2b_FR_10	24/7	Smart crossing is in operation 24 hours, 7 days a week.	- All systems are involved.	
M_S2b_FR_11	Camera location	To avoid vandalism equipment should be located in a specific not easy to reach and not easy to see location.	- Camera equipment	
M_S2b_FR_12	Pedestrians detection	It is needed that the camera registers any crossing pedestrian, regardlesss of subsequent actions.	- Camera - Pedestrians	
M_S2b_FR_13	Length of the green phase	Length of the pedestrian phase can be extended when a slow moving pedestrian is crossing.	- Traffic light / LTC - UTC-ADIMOT system - MoveUs Platform	
M_S2b_FR_14	Offline and remote configuration.	Offline and remote configuration of visual detection system must be enabled.	- Camera system equipment	
M_S2b_FR_15	Univocal identification	Univocal identification of equipment.	- Camera system equipment - Traffic light / LTC - Bluetooth receptor - Personal device MAC	

4.1.4.5 Requirements of the service 3: Eco-efficient route planning an traffic prediction

MADRID SERVICE 3: Eco-efficient Route Planning and Traffic prediction				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
M_S3_FR_01	Service subscription	Users must subscribe to the service	- Personal device.	
M_S3_FR_02	Location of bluetooth detectors along the urban roads	The power autonomy of the Bluetooth readers is limited; therefore, the devices should be located in places where electricity power supply will be guaranteed (lampposts, Information panels in the street, RADAR cameras posts, etc.)	- Bluetooth detector network	
		The coverage area of the Bluetooth readers for the detection of MACs is limited; therefore, the location of Bluetooth readers should guarantee full coverage in the road section where they will be deployed.	- Bluetooth detector network	
M_S3_FR_03	Capacity of filtering raw data by the Bluetooth detectors	The Bluetooth detectors will be able to filter data obtained and to discard data which are incomplete, erroneous, noisy, etc.	- Bluetooth detector network	
M_S3_FR_04	Accuracy in the location of the user	The technology used to locate the user (mobile phone GPS) should be accurate in order to provide reliable routes.	- GPS system in the personal device	
M_S3_FR_05	Univocal user identification	The identification of the personal device (MAC ID) of the user must be univocal.	- Personal device of the user - User Information Database in MoveUs	
		The user will use the personal device registered to the service.	- Personal device of the user	
M_S3_FR_06	Provision of times of travel per road sections.	The times of travel will be calculated in relation to specific road sections, divided by following criteria like topology, operation characteristics, etc. The division of sections may not be similar to that used by the different	- UTC - ADIMOT system - Bluetooth detectors network - MoveUs system	

		data providers, and will not necessary keep a constant length.		
M_S3_FR_07	Automatic re-routing information provision	Once a traffic event is detected by MoveUs that impacts the route provided to the user, the application will automatically inform the user about the event and will offer an alternative route.	- Personal device - Eco-efficient routing application - MoveUs system	
M_S3_FR_08	User database updating	Events information and users preferences must be regularly and automatically updated.	- Event information database. - Users information database. - MoveUs database	
M_S3_FR_09	Synchronization of incentives and user databases	This service will be provided as incentive to specific users	- Incentives database. - Users information database.	
M_S3_FR_010	Univocal identification of equipment	Univocal identification of personal devices - MACs, Bluetooth detectors and LTCs in MoveUs system	- Personal devices - LTC - Bluetooth detectors - MoveUs platform	
M_S3_FR_11	Communication language	Lenguage of communication will be English, but translation to local languages will be enabled	- MoveUs on-line interface with the user: mobile applications, etc.	
M_S3_FR_12	24/7 Operation	The eco-efficient routing service will work 24 hours, 7 days a week.	- UTC-ADIMOT system / LTC - Bluetooth detectors network - MoveUs system	
M_S3_FR_13	Display of information to final user	Routes will be displayed on the personal device registered by the user and over a GIS based map (preferably Google Maps)	- Personal device - Users database in appi developer server	

4.2 Genoa pilot site

4.2.1 Description of the service 1: Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities

The service is a web application expected to allow users to fulfill all personal mobility needs in an urban environment; most functions will be also available on mobile devices like smartphone or tablet.

"Personal mobility needs" are to be understood in a broad sense, and include not only aspects related to the travels themselves but also to personal needs such as point of interests, shops, hobbies, etc.

The service will provide results in terms of criteria chosen such as time of travel, cost, energy consumption, carbon footprint, incentives, personal needs, etc.

Other relevant user categories are indicated below in the description of the use cases.

Figure 21 Personal multi-modal journey planner – A simple mock-up

4.2.1.1 Service structure

The structure of the Genoa Service 1 is shown in the following figure.

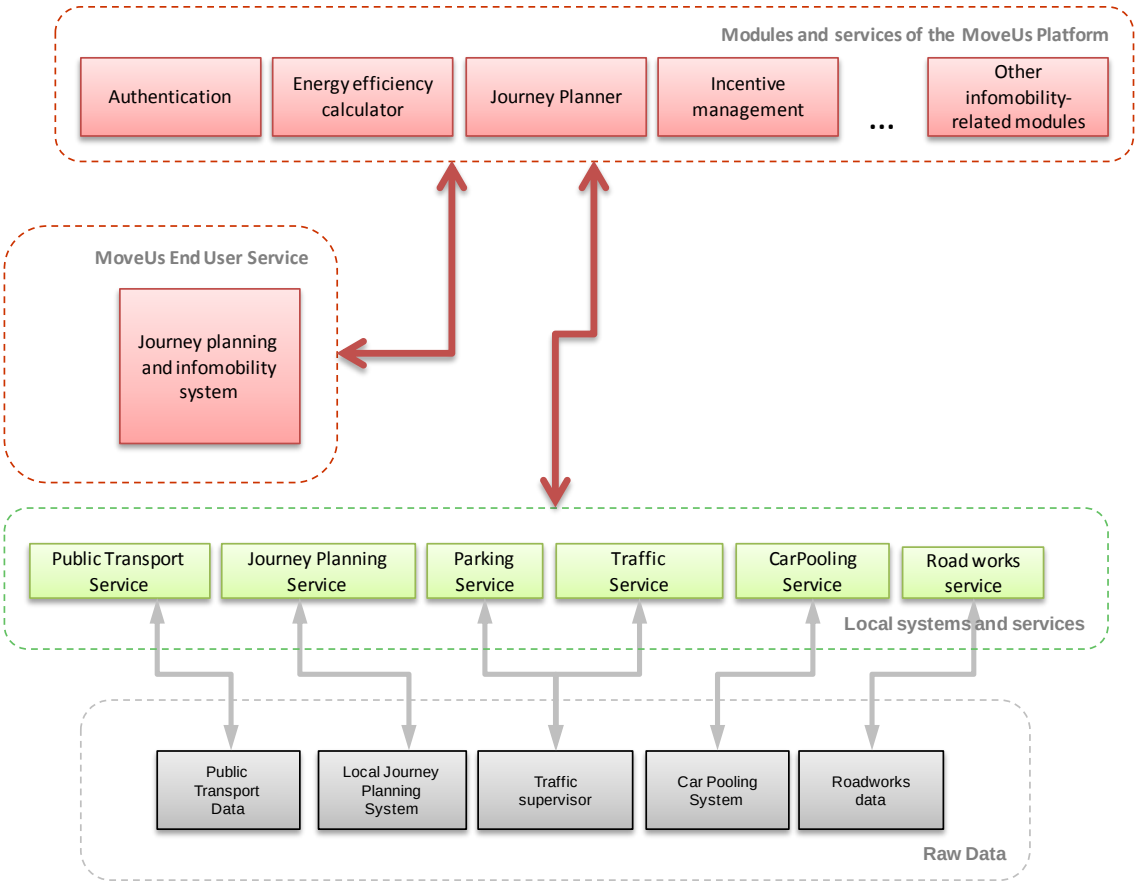

Figure 22 Structure of the Genoa Service 1

The service relies on the modules and services of the MoveUs platform (to be implemented) and is available to the end user as indicated in the "MoveUS end user service" block (also to be implemented).

This service is a bundle of sub-services, as described in the following table:

	Sub-services
	Multimodal journey planner with feedback from users; the multimodal journey planner is the "standard" function allowing to give the user indications how to go from an origin to a destination according to different modes of transport (PT, car, walking), Time to destination, Costs while receiving information on traffic congestion. **REMARK**: Region of Liguria developed a multimodal journey service; During the project the planner will be evaluated in order to understand if it meets the most mobility services requirements of MoveUs. In addition, the European Project Co-Cities developed an interface for the management of user feedbacks which can be considered for the integration of cooperative functionalities into the Journey Planning Service.
a)	**Car sharing management**; it adds to function (a) the car travel mode.
b)	**Bike sharing management**; it adds to function (a) the bike travel mode.
c)	**Carbon footprint calculator** for each travel choice; it makes the user aware of the foreseen carbon footprint vs. the optimum one.

d)	**Energy consumption calculator** for each travel choice; it makes the user aware of the impact of his choice in terms of energy consumption.
e)	**Car pooling information**; identification and notification of possible facilities for sharing trips
f)	**Incentives management**; collection, distribution to users and spending of incentives
g)	**Coupons/Vouchers/Deals**[14] **management**; collection and notification of C/V/D availability in proximity of selected trips
h)	**Electronic wallet registry**; set of payments systems (AMT tickets, Genova Parcheggi)
i)	**Identity Services**; include user identity, profiling and workspace.
j)	**Social Services**; users will be able to establish relationships among themselves and exchange comments, knowledge, etc.

Table 9 Subservices of the multi-modal journey planner in Genoa

Interaction with the MoveUs cloud services

The MoveUs Cloud is planned to host a number of centralized services, tools and facilities able to operate on the data of the Living Lab to deliver an added value output, support the service operations or provide other functionalities and results which can be eventually reused by the service providers and the end users.

The end user services, on the other hand, should be intended as the result and combination of a number of operations of data acquisition, storage, processing and includes advanced interaction procedures with the end users. All these operations and procedures should be realized as a mix of centralized and de-centralized operations. The first can be supported by or based on the services of the Cloud, the second are achieved locally or, if necessary, with the support of other data/service providers.

The above assumptions and conditions suggest that the local datasets can be partially hosted or mirrored on the Cloud itself. A similar configuration can both reduce the overhead in terms of data exchange and optimize the processing resources thus enabling more reliable, efficient and fast operations.

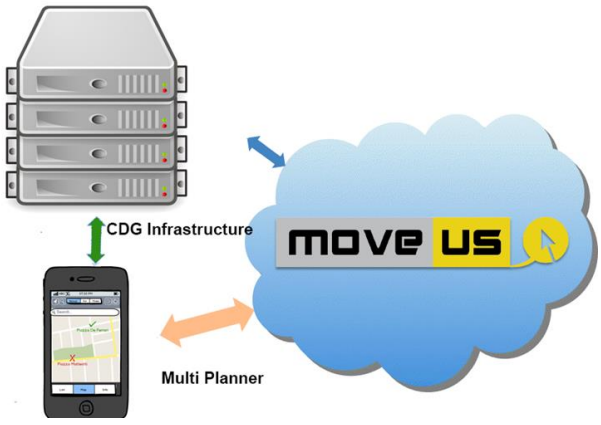

Figure 23 Interaction with the MoveUs cloud services

The selection of the specific data sets to be hosted/mirrored will be operated according to a number of basic criteria such as:

- Type and availability of cloud services Vs. specific processing/storage needs: no datasets will be stored on the cloud if there's no need of doing this (e.g. if no Cloud service will operate on a specific part of the data)

[14] **Coupon**: a digital code that allows you to get discounts; **Voucher**: a digital code that corresponds to a purchase prepaid; **Deal**: a special offer.

- Type of local data (static vs. dynamic): dynamic data (e.g. real time Bus transits) will be retrieved from the local systems and won't be mirrored on the Cloud
- No personal data will be stored/mirrored on the Cloud unless in full compliance with the applicable privacy normative.

The selection of datasets that will be mirrored on the Cloud should be defined and organized to be as much as possible dynamically re-configurable according to any future need.

4.2.1.1.1 *Story line*

Remarks:

- Unless otherwise indicated, Story lines refers to Citizens & Tourists;
- Unless otherwise indicated, all sub-services and functions are available both via web applications/pages and via a smartphone application;

REGISTRATION

- Enter the MoveUs web site
- Enter username and password and start the registration; a preliminary email for confirmation will be sent to user to check email address; the possibility to register using social networks credentials (i.e. Facebook credentials) can be considered and evaluated.
- Enter personal information on mobility:
  - Vehicles used (engine, power, fuel, etc.)
  - Usual trips (origin, destination, time of the day, calendar)
  - Preferences in term of mobility modes (PT, private vehicle, walking, carpooling, car/bike sharing, etc.); possibly a percentage of all modes
  - Availability of personal vehicles for Car Pooling
  - Personal acceptance of Car Pooling
  - Bought journal for mobility (daily, monthly, yearly)
- Enter personal information on environmental footprint:
  - Maximum amount of carbon footprint (monthly, yearly)
  - Maximum amount of energy consumption (monthly, yearly)
- Enter personal information on usual purchases or interests:
  - Loyalty cards held
  - Shops or retail chains where he usually shops
  - Hobbies
  - Point of interests (movies, theaters, other)
- Input his personal information on Social Networks
- Enable/Disable **"push" notifications:** The user could give MoveUs the **authorization to send "push" notifications rather than "pull"** (i.e. warning on traffic congestion, special offers, etc.).
- Enable/Disable **real-time tracking -** The user could give MoveUs the **authorization to lean his preferences for statistical purposes and to acquire his FCD data.**
  Note: Before possible integration of the data into a permanent databases/datawarehousing, all records must be stripped of all information that can tie it to a particular user. Moreover Data will be managed in accordance with the privacy and ethical concerns. There will be a procedure which will be agreed between local administration and the end user. CDG will

be responsible for data storage in accordance with ethical issues and agreed conditions.

In principle, **no one information at registration is mandatory**; some of them will become mandatory in case of use and some of them will improve the experience of the MoveUs user (i.e. information on Social Networks).

GET INFORMATION

User can check information on:

- Schedules
- Events
- Weather info
- Environment
- Traffic
- Incentives availability
- Coupons/Vouchers/Deals availability
- Personal accounts (see below section "PERSONAL ACCOUNT MANAGEMENT")

And can interact with MoveUs Users' community.

TRIP PLANNING

User can plan his trip as follows:

- Select origin and destination or….
- ….select usual trip
- Get results (best combination according to the criteria chosen); various trips will be shown as follows
  - Fastest
  - Cheapest
  - Lowest carbon footprint
  - Lowest energy consumption
  - Carpooling availability
  - Highest incentives gain
  - Availability on trip of coupons/vouchers/deals
  - Events
- Select trip
- Make payments/reservation according to selected trip (see below section "ELECTRONIC WALLET MANAGEMENT")
- Spend incentives
- Check personal accounts (see below section "PERSONAL ACCOUNT MANAGEMENT")

and can interact with MoveUs Users' community.

ON TRIP (only smartphone)

During trip, user can:

- Allow real time tracking ("learn by using")
- Get "push" notifications
- Change route parameters (see above "TRIP PLANNING")
- Give real-time feedback on information provided
- Make payments/reservation (see below section "ELECTRONIC WALLET MANAGEMENT")
- Spend incentives

- Check personal accounts (see below section "PERSONAL ACCOUNT MANAGEMENT")

and can interact with MoveUs Users' community.

AFTER TRIP

After trip, user can:

- Give non real-time feedback on information provided
- Make payments/reservation (see below section "ELECTRONIC WALLET REGISTRY")
- Spend incentives
- Check personal accounts (see below section "PERSONAL ACCOUNT MANAGEMENT")

and can interact with MoveUs Users' community.

ELECTRONIC WALLET REGISTRY

With this sub-service, user can potentially do:

- PT tickets payments
- Parking payments
- Access/Entrance payments
- Reservation of Coupons
- Purchase of Vouchers
- Reservation/Purchase of deals
- Events reservation and/or tickets payments
- Spend incentives

Figure 24 Ticket travel across Amt Genova's network purchased via SMS

Note: MoveUs will keep update a registry of the local payment systems. Most of our mobile services accept premium SMS payments. Here is the typical end user sms payment process:

1. The user sends a SMS with a keyword and a unique number to a premium short phone number.
2. The user receives a PIN (User billed via the short code on receipt of the PIN)
3. The user uses the PIN to access the content or service.
4. A charge is applied to the User's phone bill depending on the costs of the service

The transaction uses the most advanced security standards with data encryption.

Genova Parcheggi – Telepark

The end user can use the mobile billing option to pay the parking. First he had to buy a starter kit to activate the service, than make a simple phone call to the customer service number involving a PIN, One-Time-Password (10-digit number) and the license plate. After that the consumer's mobile account is charged for the purchase.

PERSONAL ACCOUNTS MANAGEMENT

At any moment, user can:

- Make changes on personal data provided at REGISTRATION
- Check statistics on mobility (number of trips, budget spent, etc.)
- Check carbon footprint balance
- Check energy consumptions balance
- Check incentives balance
- Check coupons/vouchers/deals statistics
- Check the Electronic Wallet Registry
- Check info on Car Pooling Usage

CAR SHARING & BIKE SHARING

The MoveUs platform will allow the **improvement of car/bike sharing energy efficiency through better multimodal solution and recharging poles displacement according to user needs**

The main goal of this sub-service service is to provide, according to user needs while preserving user's privacy, better solution in terms of:

- collection point of car/bike sharing, electrical motor bike sharing collection point, carpooling offer available;
- correct information about the level of service and available vehicles (bike, motorbike and cars);
- environmental impacts;
- collection point of recharging poles displacement available for private u.

At any moment, user can:

- access information and data elaborated from the Car Sharing and Bike Sharing Systems, electric motorcycle sharing system (financed by ELECTRA project) currently in development phase, and Car Pooling service (available only on a private access version)
- prompt the system for specific records
- visualize a list of the events
- ask for a particular event happened in a certain time instance

This sub service will also support the Decision Making team of the Mobility Department with statistics over the usage of Car & Bike Sharing in the city, offering several visualization and analysis tools such as the detection of congestion and its relation to specific events, (city market, construction works) obtained from RoadVisor Alert System. The Decision Maker will have the choice to prompt the system for specific events and visualize a list of the events with a related summarization or to just ask for the most important (i.e. abnormal) events happened in a certain instance of time. Decision Making will manage especially the analysis on how the installation of **recharging poles** will impact on the use of Bike/Car Sharing and on the overall congestion of the city. This subservice will also

offer to the Decision Maker a way to validate afterwards that the changes put in practice had the expected effect in term of improvement of car/bike sharing energy efficiency.

CARBON FOOTPRINT/ENERGY CONSUMPTIONS

The MoveUs platform shall perform the following operations:

- Store Carbon Footprint and Energy Consumptions into the CF/EC Database (CF/EC-D) for each mode of mobility and with the appropriate granularity
- Calculate the CF/EC for each selected trips
- Notify users on the CF/EC balances for the selected period.

MoveUs will make the statistics data available to the Energy Operators and the interested Stakeholders.

CAR POOLING

The MoveUs platform shall:

- Store usual trips indicated by the users into the Car Pooling Database (CPD)
- Organize the CPD
- Notify info about carpooling trips
- Organize Car Pooling Groups by linking together the interested users after acceptance

The Car Pooling service for the Genoa Pilot Site will provide just basic facilities for users willing to share a journey (or part of it) by car with other users and therefore may not have complex features found in other car-pooling systems.

Like for all MoveUs services foreseen in Genoa, the Car Pooling will be deployed, made available and evaluated on experimental basis within the MoveUs Living Labs. After this phase, the Mobility Department of the Municipality of Genoa will decide on the possibility to actually provide the services or part of it to the public.

INCENTIVES MANAGEMENT

The MoveUs platform shall:

- per each city: store Rules defined in each pilot city into the Incentive Rules Database (IRD)
- per each Interested Parties, get information on available incentives in each pilot city and store them into the Incentive Database (ID)
- per each selected trips, calculate how many incentives has the user gained after his choice
- per each user, manage the transfer of incentives among users and manage the conversion of incentives into goods/services
- per selected period, notify users the incentives balance

COUPONS/VOUCHERS/DEALS

The MoveUs platform shall:

- per each Interested Parties, get information on available Coupons/Vouchers/Deals in each pilot city and store them into the C/V/D Database (CVD-D)

- per each selected trip, notify users the availability of C/V/D in proximity of selected trips
- per each user, mange the purchase/reservation of C/V/D
- per selected period, notify users the C/V/D statistics.

4.2.2 Description of the service 2: Integration of crowd sourced data into the Genoa traffic supervisor

Crowd Sourcing is a new form of computing that is facing with several research challenges, from the social incentives to share info and data, to the technical issues of collecting and analysing a huge amount of real-time and historical data, till the most important issue in security and privacy for end users.

The second service is built over the integration of crowd sourced (sensor data) provided by users through mobile devices (smartphone, phablet, tablet) with Traffic Supervisor (see the Genoa Traffic Supervisor Logical Architecture in the following figure).

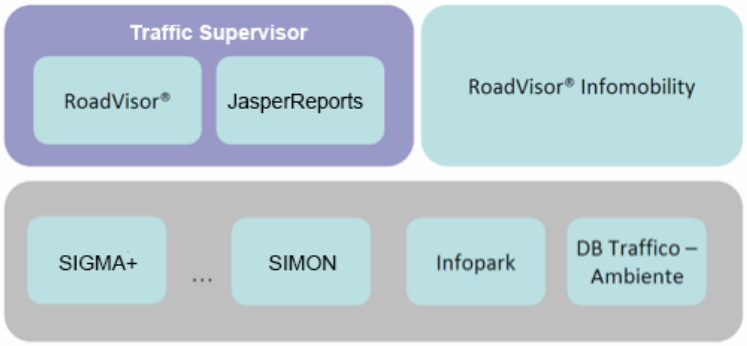

Figure 25 Genoa Traffic Supervisor Logical Architecture

In fact the mobile devices have multiple sensors embedded that could be very useful, as Floating car data (FCD).

FCD is a method to determine the traffic speed on the road network. It is based on the collection of localization data, speed, direction of travel and time using the following sensors:

- Global Positioning System (GPS) – it detects the location of the smartphone;
- Accelerometer – it measures proper acceleration in 3 axes felt by people or objects.
- Gyros – it detects the current orientation of the device, or changes in the orientation.

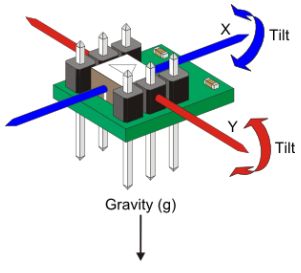

Figure 26 Service 2 - An Accelerometer

Plus more generally those embedded sensors can be used to retrieve information about: environment, weather, traffic congestion, alert or early warnings.

The integration can support the Decision Making team of the Municipality of Genoa - Mobility Department – with statistics over the dynamic flow of pedestrians and vehicles in the city creating the most accurate and advanced database of Floating Car Data.

This service can also offer several visualization and analysis tools such as the detection of congestion and its relation to specific events using the Road Visor and the Genoa Infomobility Platform called "Mobility Point".

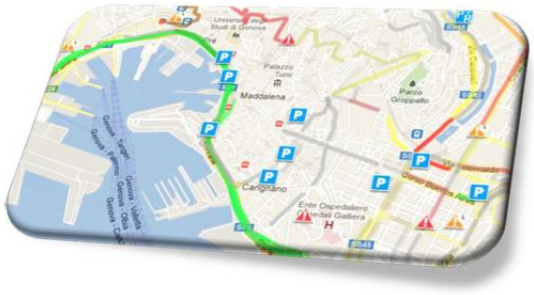

Figure 27 Floating car data on map

The Users can have the choice to prompt the system for specific events and visualize a list of the events or to just ask for a particular event happened in a certain time instance.

On the other side Decision Maker can be helped, for example:

- In the creation of parking incentive (i.e. park and ride)
- To validate the changes to put in practice.

4.2.2.1 Service structure

The structure of the Genoa service 2 is shown in the following figure.

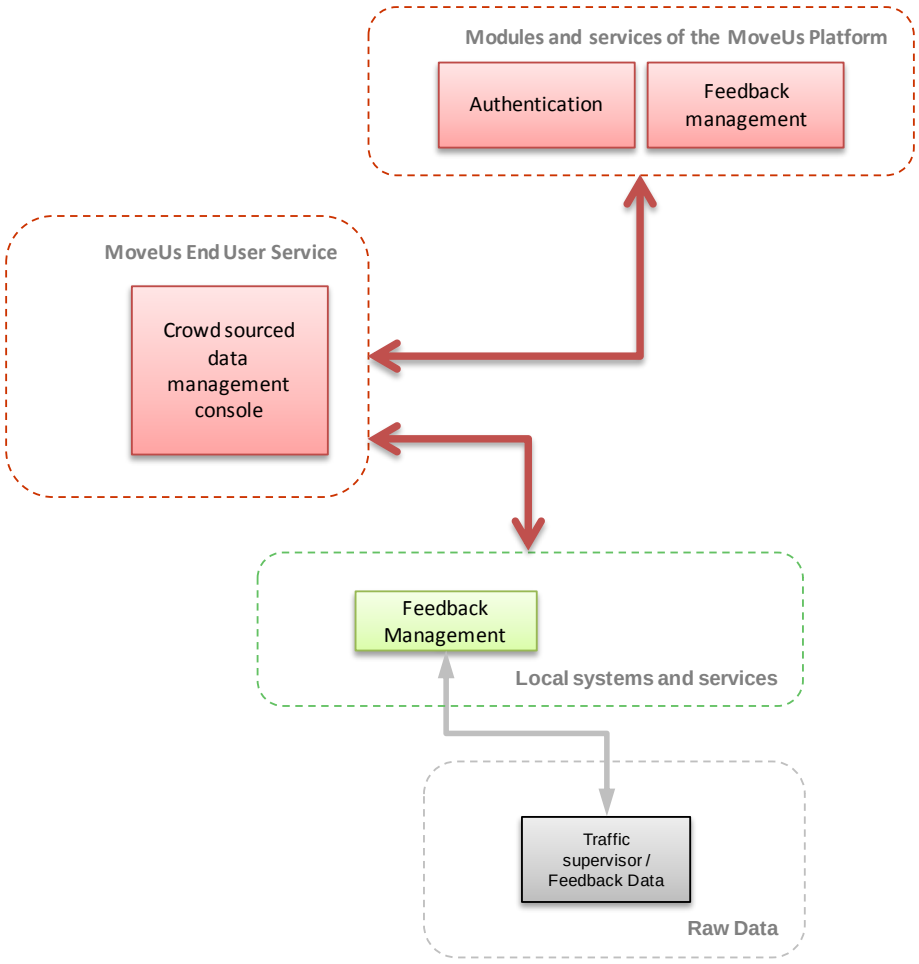

Figure 28 Structure of Genoa Service 2

The service relies on the appropriate modules and services of the MoveUs platform (to be implemented) and is available to the end user (administrator/operator) as indicated in the "MoveUS end user service" block (also to be implemented).

Services	Users				
Integration of crowd sourced data into the Genoa traffic supervisor, with the aim to share info and real-time and historical data, provided by users through mobile devices (SPOSTARE in Servizio 2)	Citizens and, Tourists	Public and private transport organizations and transport/fleet operators	Cities Authorities	Local Business	Energy operators

Table 10 Users of the integration of crowd sourced data into the Genoa traffic supervisor

Thanks to MoveUs this service will make users to become both consumers and producers of data, a mixed role, referred to as prosumer.

"**Prosumer** is a portmanteau originally formed by contracting producer with the word **consumer**." (Source: Wikipedia)

Additionally, managers of Mobility Department, being part of the platform, will receive data generated by the citizens so they can be involved quickly in addressing the city' demands.

4.2.2.1.1 *Story line*

The end-user sends the sensor data using a native app installed in his mobile device. The data will include id of the registered user, location of the observation and other observation data (data/metadata from embedded sensors).

The info are received by the Traffic Supervisor server which start to:

- Verify the reliability of the source
- Insert it in the Traffic Supervisor database – FCD Tables,
- In particular situation send alert to the specific department within the Municipality.

If the user wants to receive some service, he sends the corresponding request to the Traffic Supervisor server, which using the Service ID accesses to the Traffic Supervisor Database and sends the corresponding data to the APP.

4.2.2.2 *Requirements of the service 1: Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities*

GENOA SERVICE 1: Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
	Sub-service a) Multimodal journey planner with feedback from users			
G_S1_FR_01	Get Information (web+smartphone) on Schedules	Real time and fast information flow must be assured, as time is a critical aspect in this sub-service; results shall be available to user within seconds	CO-Cities or Liguria Region journey planner **Remark:** CO-Cities and the Region of Liguria have develop a multimodal journey planner; the first has included also a function to gather feedbacks from users; it is likely that one of the two planners will meet most mobility services requirements of MoveUs	
G_S1_FR_02	Get Information (web+smartphone) on Events	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Connection to proper datasets	
G_S1_FR_03	Get Information (web+smartphone) on Weather Forecats	"Quasi" real time and fast information flow must be assured, as time is a critical aspect in this sub-service; results shall be available to user within seconds	Connection to proper datasets	
G_S1_FR_04	Get Information (web+smartphone) on Environment	"Quasi" real time and fast information flow must be assured, as time is a critical aspect in this sub-service; results shall be available to user within seconds	Connection to proper datasets	
G_S1_FR_05	Get Information (web+smartphone) on traffic	Real time and fast information flow must be assured, as time is a critical aspect in this sub-service	CO-Cities or Liguria Region journey planner	
G_S1_FR_06	Get Information (web+smartphone) on Incentives	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Incentive Management	

G_S1_FR_07	Get Information (web+smartphone) on Coupons/Vouchers/Deals	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Coupons/Vouchers/Deals Management	
G_S1_FR_08	Get Information (web+smartphone) on Personal accounts	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds; interface shall be similar to that of Registration	Personal Account Management	
G_S1_FR_09	Trip planning: fastest trip	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	CO-Cities or Liguria Region journey planner	
G_S1_FR_10	Trip planning: cheapest trip	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	CO-Cities or Liguria Region journey planner	
G_S1_FR_11	Trip planning: trip with lowest carbon footprint	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Carbon Footprint Management	
G_S1_FR_12	Trip planning: trip with lowest energy consumption	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Energy Consumption Management	
G_S1_FR_13	Trip planning: carpooling availability	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Car Pooling Management	
G_S1_FR_14	Trip planning: highest incentives' gain	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Incentive Management	
G_S1_FR_15	Trip planning: Availability of Coupons/Vouchers/Deals	Information must be pre-configured in MoveUs and timely; results shall be available to user within seconds	Coupons/Vouchers/Deals Management	
G_S1_FR_16	Trip planning: based on events of interests by users	Information must be pre-configured in MoveUs and timely updated; results shall be available to user within seconds	Connection to proper datasets	
G_S1_FR_17	Trip selection	MoveUs must be notified and ready to provide timely information to users when the trip will start	CO-Cities or Liguria Region journey planner	
G_S1_FR_18	On Trip (only smartphone): Real Time	This function must be ON	Personal Account Management	Privacy issues

	Tracking			
G_S1_FR_19	On Trip (only smartphone): Real Time Tracking	Accurate positioning	GPS, Galileo	Privacy issues
G_S1_FR_20	On Trip (only smartphone): Notifications	This function must be ON	Personal Account Management	
G_S1_FR_21	On Trip (only smartphone): Notifications	Real time and fast information flow must be assured, as time is a critical aspect in this sub-service; notifications shall be sent to user within seconds	CO-Cities or Liguria Region journey planner or RoadVisor Notifications System	
G_S1_FR_22	On Trip (only smartphone): Trip changes	Real time and fast information flow must be assured, as time is a critical aspect in this sub-service	Trip Planning	Same Functional Requirements
G_S1_FR_23	On Trip (only smartphone) and After Trip (web+smartphone): Feedback from users	The user interface must be simple and easy to be used	CO-Cities journey planner	
G_S1_FR_24	Other: Payments/reservations	The user interface shows information on possible payments services	Electronic Wallet Registry	
G_S1_FR_25	Other: Spend incentives	The user interface must be similar to that of home banking	Incentive Management	
G_S1_FR_26	Other: Check personal accounts	The user interface must be similar to that of Registration	Personal Account Management	
G_S1_FR_27	Other: Interact with Users' community	Interface shall be similar to that of Social networks; it will be possible to evaluate the quality of services and of information provided by MoveUs	Social Networks Management	
	Sub-service b) Car Sharing Management			
G_S1_FR_28	Set Up (web+smartphone)	Enable GPS and positions recording	Connection to proper datasets	
		Set up destination points		

G_S1_FR_29	Trip planning (web+smartphone)	Check Car sharing places; results shall be ready within seconds	Connection to proper datasets	
G_S1_FR_30	After Trip (web+smartphone)	Per selected period	Personal Account Management: car sharing statistics	
	Sub-service c) Bike Sharing Management			
G_S1_FR_31	Set Up (web+smartphone)	Enable GPS and positions recording	Connection to proper datasets	
		Set up destination points		
G_S1_FR_32	Trip planning (web+smartphone)	Check Bike sharing places; results shall be ready within seconds	Connection to proper datasets	
G_S1_FR_33	After Trip (web+smartphone)	Per selected period	Personal Account Management: Bike sharing statistics	
	Sub-service d) Carbon Footprint Management			
G_S1_FR_34	Set Up (only web)	Per each mode of mobility, information must be pre-configured in MoveUs and timely updated	Store Carbon Footprint into Carbon Footprint Database	
G_S1_FR_35	Trip planning (web+smartphone)	Per each selected trip, calculation must be done in seconds	Calculate Carbon Footprint	
G_S1_FR_36	Personal Account Management (web+smartphone)	Per selected period, calculation shall be ready in seconds	Personal Account Management: Carbon Footprint balance	
	Sub-service e) Energy Consumption Management			
G_S1_FR_37	Set Up (only web)	Per each mode of mobility, information must be pre-configured in MoveUs and timely updated	Store Energy Consumptions into Energy Consumptions Database	
G_S1_FR_38	Trip planning (web+smartphone)	Per each selected trip, calculation must be done in seconds	Calculate Energy Consumptions	

G_S1_FR_39	Personal Account Management (web+smartphone)	Per selected period, calculation shall be ready in seconds	Personal Account Management: Energy Consumptions balance	
	Sub-service f) Car Pooling Management			
G_S1_FR_40	Set Up (only web)	Per each user	Store usual trips into Car Pooling Database	
G_S1_FR_41	Trip planning (web+smartphone)	Per each user	Store selected trips into Car Pooling Database	
		Notification must be done in seconds	Notify users on info about car pooling	
		Car pooling must be organized in seconds	after acceptance, organize group linking together interested users	
G_S1_FR_42	Personal Account Management (web+smartphone)	Per selected period, calculation shall be ready in seconds	Personal Account Management: Car Pooling statistics	
	Sub-service g) Incentives Management			
G_S1_FR_43	Set Up (only web)	Per each city	Store Rules into Rules Database	
		Per each Interested Party	Get info on Incentive and store it into Incentive Database	
G_S1_FR_44	Trip planning (web+smartphone)	Per selected trip	Calculate Incentive gain	
			Notify users Incentive balance	
G_S1_FR_45	Personal Account Management (web+smartphone)	Per user	Manage transfer of incentive among users	
			Convert incentives into goods/services	
		Per selected period	Personal Account Management: Incentives balance	

	Sub-service h) Coupons/Vouchers/Deals Management			
G_S1_FR_46	Set Up (only web)	Per each Interested Party	Get info on C/V/D and store it into C/V/D Database	
G_S1_FR_47	Trip planning (web+smartphone)	Per selected trip	Notify users C/V/D availability	
G_S1_FR_48	After Trip (web+smartphone)	Per user	Electronic Wallet Registry: Purchase/use C/V/D	
G_S1_FR_49	Personal Account Management (web+smartphone)	Per selected period	Personal Account Management: C/V/D Statistics	
	Sub-service i) Electronic Wallet Management			
G_S1_FR_50	Always available on web and smartphone (Pre-trip, on trip, after trip)	Per user	an update registry of Coupons/Vouchers/Deals systems	
G_S1_FR_51	Always available on web and smartphone (Pre-trip, on trip, after trip)	Per user	an update registry of ticketing systems	
G_S1_FR_52	Always available on web and smartphone (Pre-trip, on trip, after trip)	Per user	an update registry of Interested Party for incentive conversion	
	Sub-service j) Identity Services			
G_S1_FR_53	Web site (only web)	Type	Dynamic	
		Browser	Chrome, Firefox, Explorer (optional: Safari, Opera)	
		Content Management (CM)	Text, audio, video	
		User restricted area	same as smartphone functions as described below	data security issue

		User data management		data security issue
G_S1_FR_54	Smartphone app (only smartphone)	Operating systems	iOS, Android (optional: Blackberry, Windows Phone)	
		GNSS	GPS	
		Connectivity	GSM/GPRS, dual band (optional: quad band)	
G_S1_FR_55	Registration (web+smartphone)	On line activity	Automatic or activated by user	
		Personal data (all except info on financial institutions)	Available offline and uploaded into web CM	data security issue
		Personal data on financial institutions	Available only offline	data security issue
		Notifications (push)	On or OFF	
		Real time tracking	On or OFF	
G_S1_FR_56	Personal Account Management (web+smartphone)	Changes in Personal data	- Registration	data security
		Statistics on mobility	- CO-Cities or Liguria Region journey planner	
		Carbon Footprint balance	- Carbon Footprint Management	
		Energy Consumptions balance	- Energy Consumption Management	
		Incentives balance	- Incentive Management	
		C/V/D statistics	- Coupons/Vouchers/Deals Management	
		Electronic Wallet statistics	- Electronic Wallet Management	data security

G_S1_FR_57		Car Pooling usage	- Car Pooling Statistics	
	Sub-service k) Social Networks Management			
G_S1_FR_58	Establish relationships among users (web+smartphone)	User interface lust be similar to that of Social Networks	Gateway to Social Networks	

4.2.2.3 Requirements of the service 2: Integration of crowd sourced data into the Genoa traffic supervisor

GENOA SERVICE 2: Integration of crowd sourced data into the Genoa traffic supervisor				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
G_S2_FR_01	Smartphone app (only smartphone)	Operating systems	iOS, Android	
		GNSS	GPS, Galileo?	
		Connectivity	GSM/GPRS, dual band (optional: quad band)	
G_S2_FR_02	Set Up (web+smartphone)	Check personal accounts	Personal Account Management	
		Enable GPS and positions recording	GPS system	
G_S2_FR_03	Personal Account Management (web+smartphone)	Real time feedback	Personal Account Management	
G_S2_FR_04	After Trip (web+smartphone)	Per selected period	Social Networks Management	
		Interact with Users' community	Ranking evaluation of the service	
G_S2_FR_05	Data security and privacy assurance			
G_S2_FR_06	Incentives to participations			

4.3 Tampere pilot site

4.3.1 Description of the service 1: Multimodal Journey Planner

This service aims to offer the user the possibility to see all available mobility (i.e. bus/car/bike/pedestrian) and routing (streets and pathways) options between its current location and a declared intended destination.

4.3.1.1 Service structure

The service structure of the Tampere Multimodal Journey Planner Service is shown in Figure 29

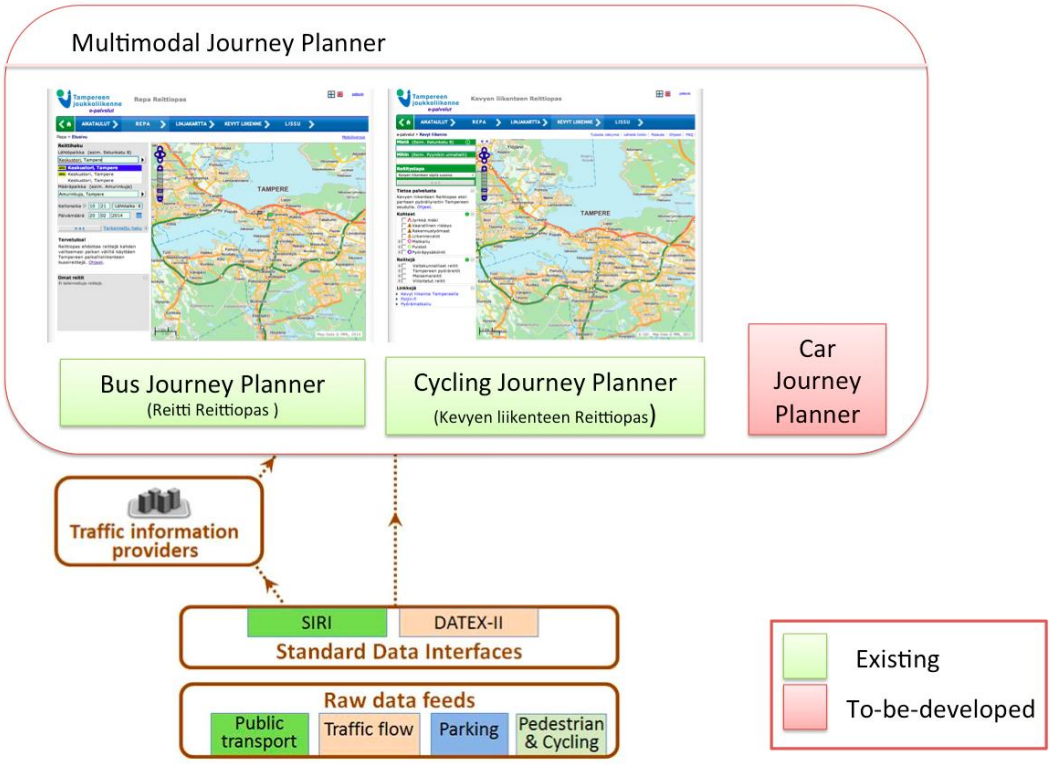

Figure 29 Tampere Multimodal Journey Planner Service structure

The sub-services that must be developed to provide the Multimodal Journey Planner Service are:

1) Car Journey Planner. This application will provide all available routing options between a source location and a desired location.
2) Integration of Bus Journey Planner with RT information concerning the location of the buses.
3) Integration of Multimodal Journey Planner with RT information comming from the existing Smart Traffic Prioritization service

4) Integration of car/bus/bike journey planners. This application will integrate existing journey planners for buses and bikes in Tampere (i.e. Journey Planner for Cycling - Figure 30 and Reitti Reittiopas) with the Car journey planner app (see bulletpoint 1).

Existing sub-services

Journey Planner for Cycling Sub-Service

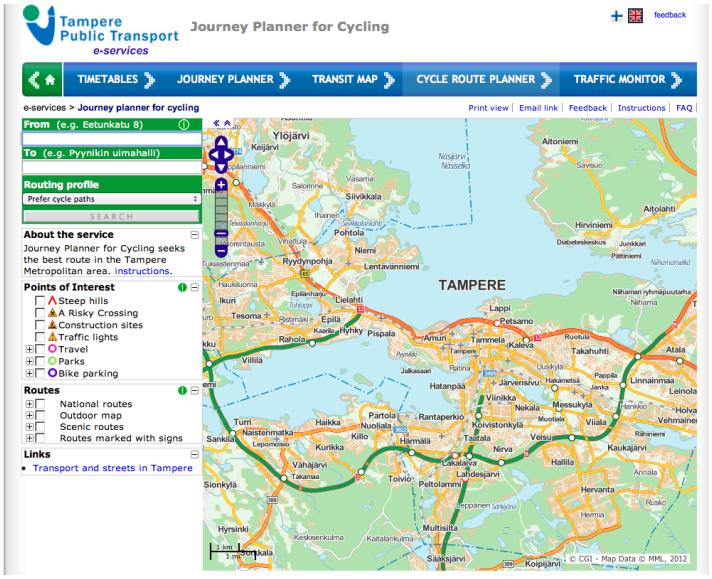

Figure 30 Tampere Cycling Journey Planner (http://kevytliikenne.tampere.fi)

Journey Planner for Buses Sub-Service

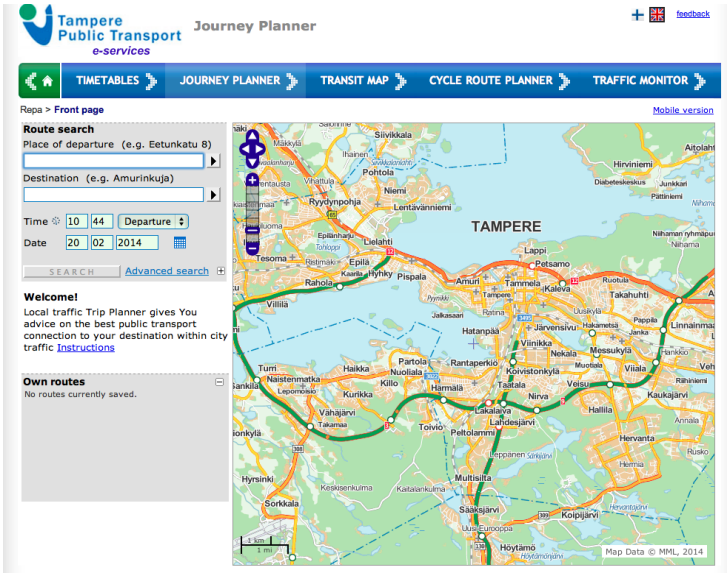

Figure 31 Tampere Bus Journey Planner (http://reittiopas.tampere.fi/)

Smart Traffic Prioritization Sub-Service

On-Board Units (OBUs) in buses send information (e.g. GPS coordinates, line number, bus circulation/direction) to a Backend at one second-apart intervals, which in turn controls real time timetable monitors, traffic light priorities and traffic disturbance information.

OBUs are connected to a Fare Collection Unit (FCU) that is aware of information concerning the bus line in use and the bus direction.

FCU and OBU data are combined and sent to the backend where data is processed to obtain accurate timetable estimations, later to be broadcast to real time timetable monitors and internet-services.

Current system:

- Possibility to adjust traffic light prioritization upon request (from the OBU of a vehicle), within seconds margin to any specific crossing, in case of e.g.:
  - delayed bus.
  - emergency vehicles (fire trucks, ambulances and police). With emergency lights on.
- Possibility to
  - prioritize from the backend e.g. during special events (concerts).
  - pinpoint from the backend virtual request- and confirmation points on system map. (automatic traffic light priority request sent after a bus crosses a virtual request point).
- Four types of priorities (Early/Extended Green light, Extra green light cycle and Cycle change in whole crossing – if possible).

- Prioritization information is sent to the traffic light control unit with 3G-mobile connection.

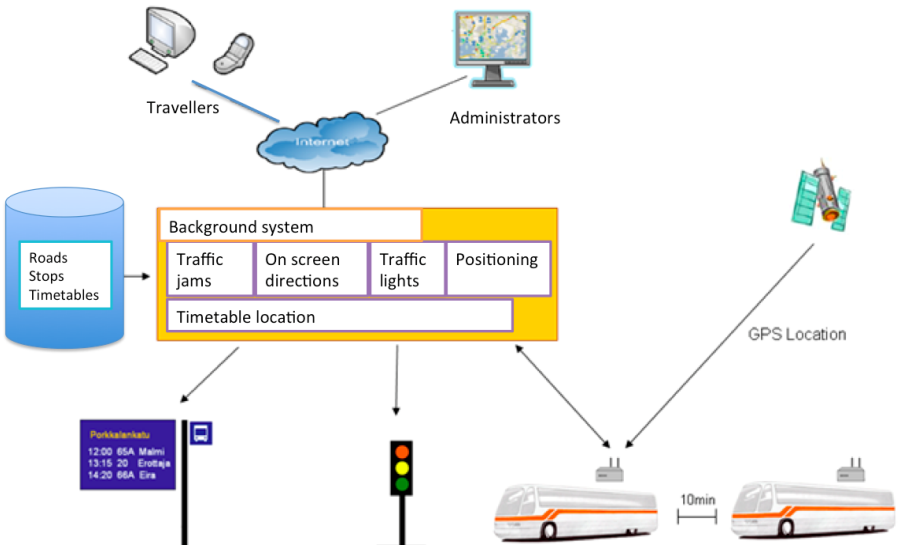

Figure 32 Tampere traffic light supported smart prioritization of public transport service structure

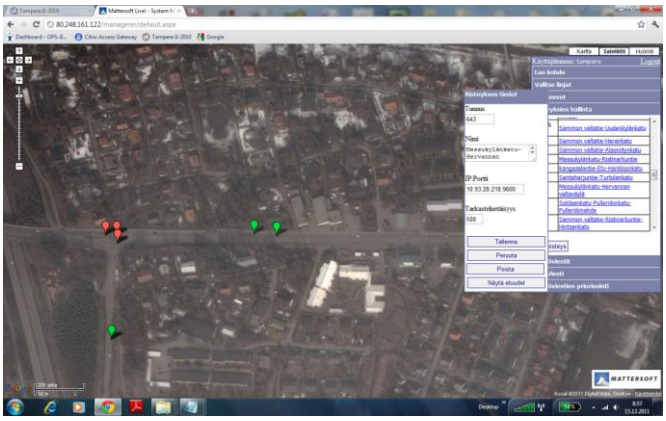

Figure 33 Virtual prioritization request

4.3.1.1.1 *Story line*

Remarks:

Story lines of Tampere services refer to a generic **MoveUs App User**, that may choose to relate to one/more **User Profile**s.

Each **User Profile** describes:

- Special roles (e.g. tourist)
- Direct influencers of personal mobility choices (e.g. passion for biking / running, personal acceptance of car/bike sharing)
- Indirect influencers of personal mobility choices (e.g. preference to commute to work / school in groups, i.e. predisposition to sync with other people's mobility choices)
- Direct influencers of personal routing choices (e.g. aversion towards specific places in the city)
- Habits (e.g. regular itineraries undertaken)
- Particularities of personal vehicles the user is regularly driving (fuel needs, consumption, etc.)

The MoveUs App User:

- starts the MoveUs App
- enters a desired destination and requests an assessment of journey options

The MoveUs (Tampere) Multimodal Journey Planner service:

- identifies the GPS location of the requestor
- computes possible options available in terms of mobility and routing (Tampere Service 1)
- displays in a user friendly manner (a set of) the best available journey options

4.3.2 Description of the service 2: Energy efficiency / CO2 assessment of journey options

This service aims to assess the energy efficiency and / or CO2 cost of input journey (i.e. mobility & routing) options between a source and a destination point, per user.

4.3.2.1 Service structure

The service structure of Tampere Energy Efficiency Assessment service is shown in Figure 34.

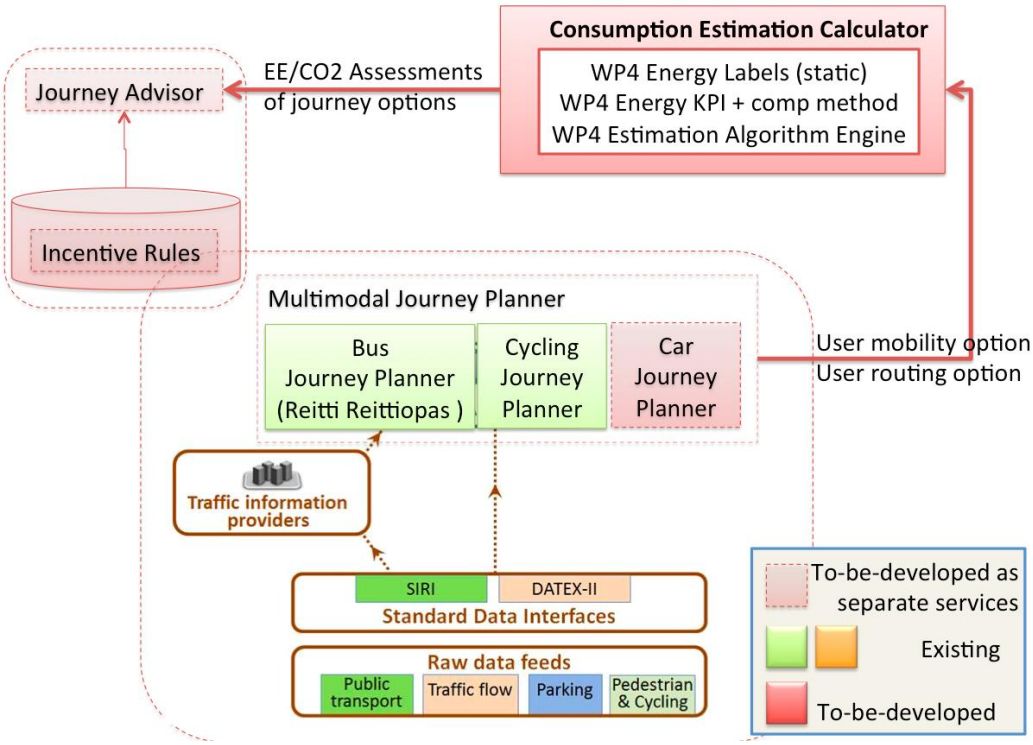

Figure 34 Tampere Energy Efficiency Assessment service structure

4.3.2.1.1 ***Story line***

Remarks:

Story lines of Tampere services refer to a generic **MoveUs App User**, that may choose to relate to one/more **User Profile**s.
Each **User Profile** describes:

- Special roles (e.g. tourist)
- Direct influencers of personal mobility choices (e.g. passion for biking / running, personal acceptance of car/bike sharing)
- Indirect influencers of personal mobility choices (e.g. preference to commute to work / school in groups)

- Direct influencers of personal routing choices (e.g. aversion towards specific places in the city)
- Habits (e.g. regular itineraries undertaken)
- Particularities of personal vehicles the user is regularly driving (fuel needs, consumption, etc.)

The MoveUs App User:

- starts the MoveUs App
- enters a desired destination and requests an assessment of the EE/CO2 cost of the journey

The MoveUs (Tampere) EE/CO2 assessment service:

- identifies the GPS location of the requestor
- computes posible options available in terms of mobility and routing (Tampere Service 1)
- computes automatically the Energy Efficiency and /or CO_2 consumption associated to each identified journey option

4.3.3 Description of the service 3: User-tailored incentive-based visualization service

This service aims to give an incentive oriented view of input transportation options information, per user. It acts as an adaptor for user-friendly meaningful display of backend computed information.

In MoveUs, for the Tampere pilot, this service targets the mapping of EE/CO2 labels to incentive points (and subsequently relevant incentives) for the user considered, based on a Set of Incentive Rules stored in a dedicated DB.

4.3.3.1 Service structure

The service structure of Tampere User tailored incentive-based visualization service is shown in Figure 35.

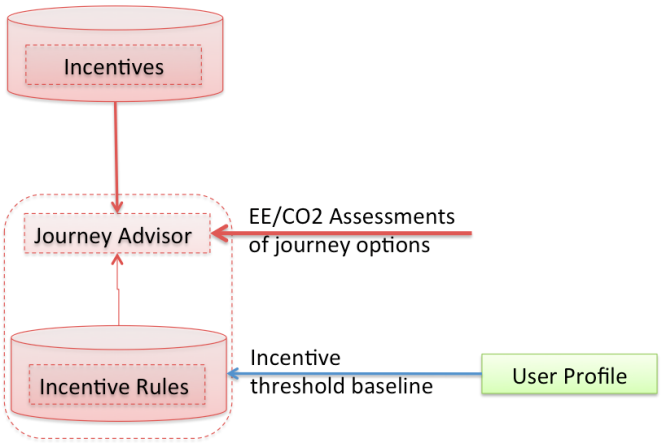

Figure 35 Tampere user tailored incentive-based visualization service structure

4.3.3.1.1 *Story line*

Remarks:

Story lines of Tampere services refer to a generic **MoveUs App User**, that may choose to relate to one/more **User Profile**s.

Each **User Profile** describes:

- Special roles (e.g. tourist)
- Direct influencers of personal mobility choices (e.g. passion for biking / running, personal acceptance of car/bike sharing)
- Indirect influencers of personal mobility choices (e.g. preference to commute to work / school in groups)
- Direct influencers of personal routing choices (e.g. aversion towards specific places in the city)
- Habits (e.g. regular itineraries undertaken)
- Particularities of personal vehicles the user is regularly driving (fuel needs, consumption, etc.)

The MoveUs App User:

- starts the MoveUs App
- enters a desired destination and requests an assessment of the EE/CO2 cost of the journey

The MoveUs (Tampere) EE/CO2 assessment service:

- identifies the GPS location of the requestor
- computes posible options available in terms of mobility and routing (Tampere Service 1)
- computes automatically the Energy Efficiency and /or CO_2 consumption associated to each identified journey option (Tampere Service 2)
- displays in a user friendly manner (a set of) the computed EE/CO2 options

4.3.3.2 Requirements of the service 1: Multimodal Journey Planner

TAMPERE SERVICE 1: Multimodal Journey Planner				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
T_S1_FR_01	**Required inputs to** Multimodal Journey Planner Service	Computation of the GPS position of the user must be enabled OR the user must be pinpointed to indicate his start location on a map.	Multimodal Journey Planner	
T_S1_FR_02	**Criteria** for searching journey options	Must be able to embed search criteria into the request to find journey options.	Multimodal Journey Planner / Car Journey Planner	Search criteria e.g. fastest, least number of traffic lights, avoid traffic jams, etc.
T_S1_FR_03	**Continuous updates** of journey options displayed to the user	The user must be notified by the MoveUs app should there arise traffic situations that prevent the completion of a current route.	Multimodal Journey Planner	Traffic situations e.g. Accidents / jams
T_S1_FR_04	**Continuous updates** of journey options displayed to the user	The user should be notified by the MoveUs app should there be ongoing smart traffic prioritization requests that interfere with the chosen route (from the backend or from other en-route vehicles)	Multimodal Journey Planner + Smart Traffic Prioritization	e.g. Priority on for en-route emergency vehicles
T_S1_FR_05	**Accuracy** of journey options assessment, per user	Real time winter road maintenance situation to be taken into account when computing available journey options between a source and a destination point, per user.	Multimodal Journey Planner (MJP)	RT winter maintenance information from maintenance vehicles equipped with GPS to be fed to MJP
T_S1_FR_06	**Manageable computational**	All available journey options must be displayed within seconds from the initiation of user request.	Multimodal Journey Planner	

	complexity			
T_S1_FR_07	Storage of user profile data	User sensitive data must not be stored in the cloud, unless it is required input for the services requested by the user AND the user agrees to the transfer of information.	ALL	
T_S1_NFR_01	Language	Appl. Language is English. Translate enabled.	User Interface	irrespective of services accessed and means of access (web/smartphone app)
T_S1_NFR_02	Visualization	User-friendly GUI, EE/CO2 assessment results translated to meaningful information, per user.	User Interface. Journey Advisor. Incentive Rules DB.	Meaningful' = incentives appealing to the user, according to a user profile

4.3.3.3 Requirements of the service 2: Energy efficiency/CO2 assessment of journey options

TAMPERE SERVICE 2: Energy efficiency/CO2 assessment of journey options				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
T_S2_FR_01	**Required inputs** to Energy Efficiency Assessment Service	Inputs must include Computed Mobility & Routing Options between source and destination points, per user.	Consumption Estimation Calculator	Defined in WP2. This input must be fed to the MoveUs App EE/CO2 estimation module, irrespective of the pilot.
T_S2_FR_02	**Required inputs** to Energy Efficiency	Inputs must include a set of static atomic Energy / CO2 labels, associated to lowest level granularity journey (mobility and routing)	Consumption	Defined in WP4

	Assessment Service	options.	Estimation Calculator	
T_S2_FR_03	**Manageable computational complexity**	EE/CO2 assessment must be calculated within seconds from the receiving of the journey options to label.	Consumption Estimation Calculator	
T_S2_FR_04	Historical **information storage**	Per user profile, EE/CO2 consumption levels associated to selected journeys must be stored for computing the periodic EE/CO2 footprints of the user.	Consumption Estimation Calculator, Journey Advisor	If the user agrees. Indirectly this requirement affects all modules: Multimodal Journey Planner options selected per user + Consumption Estimation Calculator + DB associated to the user profile
T_S2_FR_05	**Accuracy** of EE/CO2 assessment	Real time road and weather condition data to be taken into account in the EE/CO2 cost estimation algorithm.	Consumption Estimation Calculator	And datasets: Road weather forecasts & Frostheave information
	Storage of user profile data	User sensitive data must not be stored in the cloud, unless it is required input for the services requested by the user AND the user agrees to the transfer of information.	ALL	
T_S2_NFR_01	Language	Appl. Language is English. Translate enabled.	User Interface	irrespective of services accessed and means of access (web/smartphone app)

T_S2_NFR_02	Visualization	User-friendly GUI, EE/CO2 assessment results translated to meaningful information, per user.	User Interface. Journey Advisor. Incentive Rules DB.	Meaningful' = incentives appealing to the user, according to a user profile

4.3.3.4 Requirements of the service 3: User-tailored incentive-based visualization

TAMPERE SERVICE 3: User-tailored incentive-based visualization				
ID	**General Requirement definition**	**Specific Requirement definition**	**System/subsystem/module or component**	**Consideration**
T_S3_FR_01	**Required inputs** for granting incentives	EE/CO2 level threshold baselines (per user) OR a methodology to infer threshold baselines (per user) must be defined.	Consumption Estimation Calculator, Incentives Rules, Journey Advisor	Threshold baseline: i.e. User dependent EE/CO2 consumption levels above which incentives ought to be granted.
T_S3_FR_02	**Continuous updates** of the Incentives DB	Incentives must be added as soon as they are available to the DB / removed from the DB as soon as they are consumed/expired.	Incentives DB	
T_S3_FR_03	**Continuous updates** of the Incentive Rules DB	Incentive rules could be updated to impose new weights on highly sought incentives.	Incentives Rules DB.	Open to determine how it is determined what constitutes a highly sought incentive. This is not a primary goal of Tampere Service 3, but room for improvement after MoveUs

				in this sense should be left.
T_S3_FR_04	**Manageable computational complexity**	Translation of EE/CO2 assessments to incentives, per user, must be processed and displayed within seconds from the receiving of the input EE/CO2 labels.	Journey Advisor, Incentive Rules DB, Incentives DB.	
T_S3_FR_05	**Historical information** storage	Information concerning incentives chosen / preferred by a user could be stored for fine tuning future recommendations.	Journey Advisor, Incentives DB.	If the user agrees.
T_S3_FR_06	Storage of user profile data	User sensitive data must not be stored in the cloud, unless it is required input for the services requested by the user AND the user agrees to the transfer of information.	ALL	
T_S3_NFR_01	Language	Appl. Language is English. Translate enabled.	User Interface	irrespective of services accessed and means of access (web/smartphone app)
T_S3_NFR_02	Visualization	User-friendly GUI, EE/CO2 assessment results translated to meaningful information, per user.	User Interface. Journey Advisor. Incentive Rules DB.	Meaningful' = incentives appealing to the user, according to a user profile

5. Identification of mobility and users' information sources and sinks for each piloting city

5.1 Methodology

The analysis was done in connection with the Assessment of current infrastructure since most of them are sources of information useful for this project.

Each DATA are described according to the following general **attributes**; not all attributes will be relevant according to the types of DATA.

Brand name: if any

Content: it is the description of DATA.

Physical location: it is the location where DATA is available (if not in electronic form).

Physical DATA format: i.e. XML, JSON, bytestream, DDBB (which one/s and what kind; engine used), webservices, etc.

Server location: it is both the physical location of the server where DATA are stored and its network address (URL, etc.).

DATA Owner: it is the public or private entity which owns DATA and with which it is necessary to negotiate the terms and conditions of their use. It could be also the DATA Provider.

DATA Provider: it is the public or private entity which delivers DATA and with which it is necessary to negotiate the terms and conditions of their use; it could be the Owner itself or a Service Provider

Standards: i.e GDF for road network data, RDS/TMC, Alert-C for traffic messages, DATEX, etc.

DATA Users: it is the public or private entity which uses DATA (Information sinks)

DATA export: how to extract and use DATA in case of non Standard formats

Geographic coverage: i.e. building, street, city, national level, etc.

Update cycle: minutes, hours, days, etc.

Other relevant DATA attributes: i.e. geometry (point, lines) dimensions (2d, 3d), coordinate reference system, network model standard, accuracy (cm, m, km), etc.

Types of communication channels: mobile and/or land networks, broadcasters, kiosks, information screens, etc.

End user device/Media: it is the device where DATA can be used; i.e. smartphone, tablet, lap top, desktop, in-car navigator, in-car radio receivers, etc.

Type of output: i.e. file, text, maps, graphics, audio messages, video streaming, animations, etc.

Pricing Model: i.e. free, pay per use, subscriptions, etc.

Usage restrictions: it is the description of any constraint related to the use of DATA; they can be permissions needed by Third Parties other than the Owner, legal issues, obligation regarding the network connections (i.e. data security), security clearance needed by personnel, etc.

5.2 DATA to be collected

The various ITS DATA sets are grouped according to the reference ITS Areas defined in the European ITS Architecture - eFRAME Project:

- Traffic Management.
- Emergency Notification and Response.
- Public Transport Management.
- Traveller Journey Assistance.
- Electronic Fee Collection.
- In-Vehicle Systems.
- Law Enforcement.

In addition, the following DATA were collected

- Communications
- Demography & Economics
- Tourism
- Businesses
- Crowd Sourced Data

5.2.1 Traffic Management

- Road network data
- Traffic flow
- Traffic messages
- Variable Message Signs (current message that is displayed)
- Road work information
- Congestion and incident messages
- Location of traffic cams
- Dynamic parking information
- Map data

5.2.2 Emergency Notification and Response.

- Pollution sensors (GHG, Particulate, NOx, SOx, etc.)
- Road weather information
- Public Events
- Map data
- Hospital locations and availability

5.2.3 Public Transport Management.

- Public transport network data
- Public transport time table
- Public Transport event data (events disturbing the PT service)

5.2.4 Traveller Journey Assistance.

- Travel time/delay information
- Point of Interests (Gas station, bus and train stations, rest areas, garages, park-and-ride areas, parking places, etc.)
- Car/Bike sharing (locations, costs, availability)
- Limited Traffic Zones
- City (toll) tariffs information

5.2.5 Electronic Fee Collection.

- City (toll) tariffs information (static and dynamic)

5.2.6 In-Vehicle Systems.

- Floating car data

5.2.7 Law Enforcement.

- Location of traffic cams
- Automatic Licence Plate Recognition
- Speed sensors

5.2.8 Communications

- Fixed Open WiFi areas
- Mobile Open WiFi locations (on buses, trains, etc.)

5.2.9 Demography & Economics

- Census
- Demographics
- Education
- Consumptions
- Surveys on economic activities (shops, businesses)
- Public services (libraries, public parks, public offices): locations, availability, opening hours, etc.

5.2.10 Tourism

- Point of interests (location, opening hours, tickets, availability…)
- Events

5.2.11 Business

- Location of economic activities
- Events

5.2.12 Crowd Sourced Data

- Smart mobility (i.e. car pooling)
- Environment
- Traffic
- Events
- Business offers/discounts/sale
- Smart mobility

5.3 DATA/Content Providers

Examples for different public and private content providers are:

- Traffic information centers (TIC) (dynamic traffic data)
- National, regional or local road authorities (dynamic traffic data, parking data, static road network data)
- Commercial traffic data and traffic information provider (like TrafficMaster, DDG etc.)
- Toll system operators
- Parking facilities operators
- Public transport operators (static and dynamic public transport data)
- Automobile clubs
- Private road operators (dynamic traffic data, static road network data)
- Private address and POI data provider (address data and POI data)
- Weather services (weather data)
- Map agencies (map data for background map, address data)
- Commercial map enterprises (road network data, road maps)
- Municipalities offices, departments, web sites
- Service Providers in Smart Cities solutions
- Research Centers and Academies
- Event organizers
- Tour Operators
- Business Associations
- Social networks (Linkedin, Twitter, Facebook, FourSquare, Waze, etc.)

5.4 Results

Each datasets is described with its attributes in details in the attached spreadsheets.

In the following paragraphs, each pilot city summarizes in tables the state of the art in relation with each mobility service to be implemented, with a qualitative evaluation of the availability and effectiveness of datasets according to this scale:

- **NR**: datasets Not Relevant
- **NA**: not enough information on datasets
- **6**: datasets are sufficient for the service and ready to be used without criticisms
- **5**: datasets are sufficient for the service and ready to be used with some criticisms
- **4:** datasets are sufficient for the service and ready to be used with many criticisms
- **3**: datasets are partially sufficient for the service and ready to be used without criticisms
- **2**: datasets are sufficient for the service and ready to be used with some criticisms
- **1**: datasets are sufficient for the service and ready to be used with many criticisms
- **0**: datasets are not sufficient for the service

- **Sufficient**: the service can be implemented with no restrictions/reductions on functions
- **Partially sufficient**: the service can be implemented with some restrictions/reductions on functions
- **Not sufficient**: the service cannot be implemented.
- **Some criticisms**: it could be the case of data not maintained or difficult to be accessed etc.
- **Many criticisms**: it could be the case of very expensive data or very difficult to be accessed since the owner requires restrictions, etc.

5.4.1 Madrid

Service	Traffic Management	Emergency and Notification Response	Public Transport Management	Traveller Journey Assistance	Electronic Fee Collection	In-Vehicle Systems	Law Enforcement	Communications	Demography & Economics	Tourism	Business	Crowd sourced data
1.- Smart Prioritization of	5	NR	6	NR	NA	6	NR	NR	NA	NR	NA	NR

vehicles (public buses)		NA			NR		NA		NR		NR	NA
2a- Smart Routing for pedestrians	4	NR NA	6	4	NA NR	NR	NR NA	NR	NA NR	5	NA NR	NR NA
2b.- Smart Crossing for pedestrians	6	NR NA	NR	6	NA NR	NR	NR NA	NR	NA NR	NR	NA NR	NR NA
3. - Eco-efficient route planning and Traffic prediction.	2	NR NA	NR	4	NA NR	NR	NR NA	NR	NA NR	NR	NA NR	NA

Table 11 Qualitative evaluation of datasets in Madrid

General comments:

By NA it is understood not the fact that there is not enough information on datasets, but the reality that there is no dataset. It could be owed to not be applicable in the pilot of Madrid (NApp), not be implemented (NI) or not be available by MoveUs partners (NAM).

Comments on specific services:

- **Smart Prioritization of vehicles (public buses):** Data from the Traffic management systems are not open data now, but we have started collaboration with MAD in the Open Data process of such information.
- **Smart crossing and Smart routing services** don't need In-Vehicle System datasets (NR); the information related to traffic management and information will be provided by the infrastructure.
- The **public transport option for pedestrian**, the **car-sharing** and the **bike hiring** are considered as part of 'Smart Routing Service'.
- the 'Eco-efficient route planning and traffic prediction Service':
  - Bluetooth detectors network must be deployed as additional traffic management system for the provision of the service; once the system has been deployed and operating, the corresponding code in the table will turn to 4 or 5.
  - The navigation application is based on a commercial solution of which MoveUs will have no control of the accuracy provided (Google Maps).

5.4.2 Genova

Service: Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities	Traffic Management	Emergency and Notification Response	Public Transport Management	Traveller Journey Assistance	Electronic Fee Collection	In-Vehicle Systems	Law Enforcement	Communications	Demography & Economics	Tourism	Business	Crowd sourced data
A) Personal multi-modal journey planner	5	4	4	4	NA	4	4	5	4	5	1	0
B) Car sharing management	5	4	4	4	NA	4	4	5	NR	5	NR	NR
C) Bike sharing management;	5	4	4	4	NA	NR	4	5	NR	5	NR	NR
D) Carbon footprint calculator	5	4	4	NR	NR	4	1	NR	4	NR	NR	0
E) Energy consumption calculator.	5	4	4	4	NR	4	4	NR	NR	NR	NR	0
F) Car pooling information;	0	0	0	0	0	0	0	0	0	NA	NA	NA
G) Incentives management;	0	0	0	0	NA	NA	NA	0	NA	NA	NA	0
H) Coupons/Vouchers/Deals[15] management;	0	0	0	0	NA	NA	NA	0	NA	NA	NA	0
I) Electronic wallet management;	1	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA
L) Identity Services; include user identity, profiling and workspace.	NA	NA	NA	NA	NA	NA	NA	5	4	5	1	0
M) Social Services; users will be able to establish relationships among themselves and exchange comments, knowledge, etc.	NA	NA	NA	NA	NA	NA	NA	5	4	5	1	0

Table 12 Qualitative evaluation of datasets in Genoa for the personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities

[15] **Coupon**: a digital code that allows you to get discounts; **Voucher**: a digital code that corresponds to a purchase prepaid; **Deal**: a special offer.

Service: Integration of crowd sourced data into the Genoa traffic supervisor, with the aim to share info and real-time and historical data, provided by users through mobile devices	Traffic Management	Emergency and Notification Response	Public Transport Management	Traveller Journey Assistance	Electronic Fee Collection	In-Vehicle Systems	Law Enforcement	Communications	Demography & Economics	Tourism	Business	Crowd sourced data
Integration of crowd sourced data into the Genoa traffic supervisor, with the aim to share info and real-time and historical data, provided by users through mobile devices	5	1	4	4	NR	4	NR	NR	NR	NR	NR	0

Table 13 Qualitative evaluation of datasets in Genoa for the Integration of crowd sourced data into the Genoa traffic supervisor

General comments:

In this paragraph are listed the two main reusable platform (eMixer and GeoServer) with the aim to share data within the Consortium proposed by Genoa municipality.

e-miXer provides a service-oriented middleware infrastructure enabling the integration of data/services supplied by different operators in our domain of Traffic and Travel Information. Key interoperability feature and element in e-miXer a multi-standard interface, which is able to interconnect and combine data from different systems and map them to a common data and service model. Diversified content/services offerings are then made accessible and suitable for use by Traffic Information Service Providers (TISPs) via a standardized access layer: a B2B interface implementing several European ITS reference standards in the various addressed mobility domains (traffic, public transport, parking, etc.).

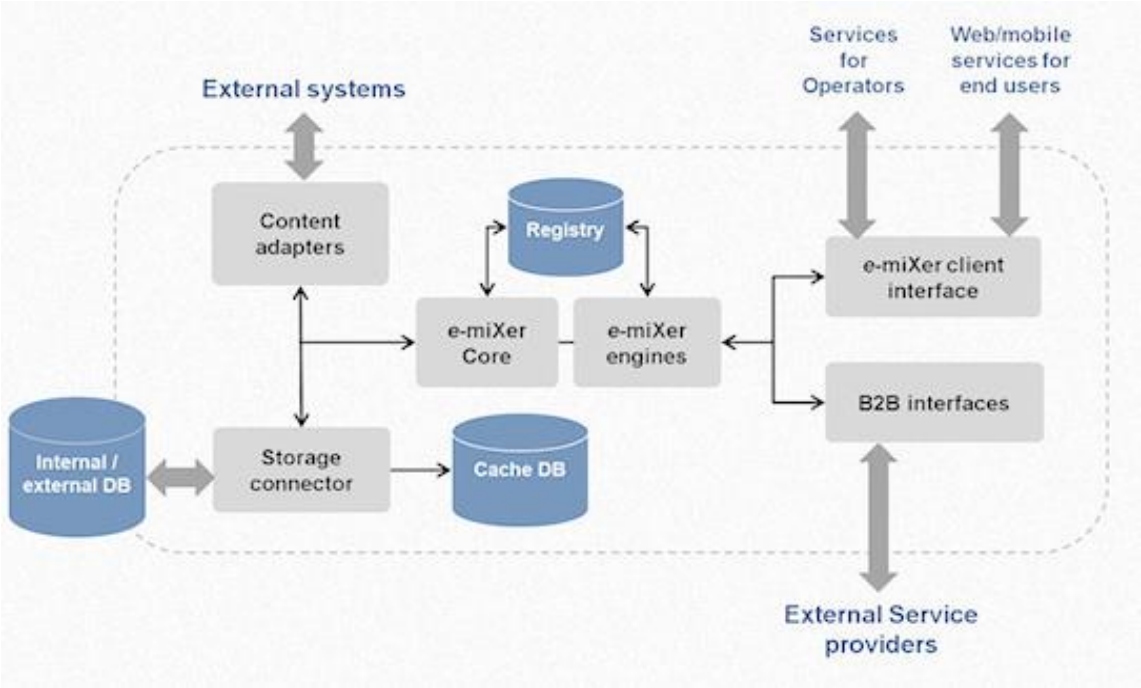

Figure 36 e-miXer General Architecture

The e-miXer core drives the process of data acquisition based on parameters hosted by the registry. The storage connector enables a temporary caching or permanent storage of the information. e-miXer engines process data for specific purposes.

e-miXer provides both B2C and B2B services:

- The e-miXer client interface enables the provision of services for the end users (both public and restricted access)
- B2B interfaces are available for external service providers whenever necessary (e.g. providers of IVR, SMS, email services)

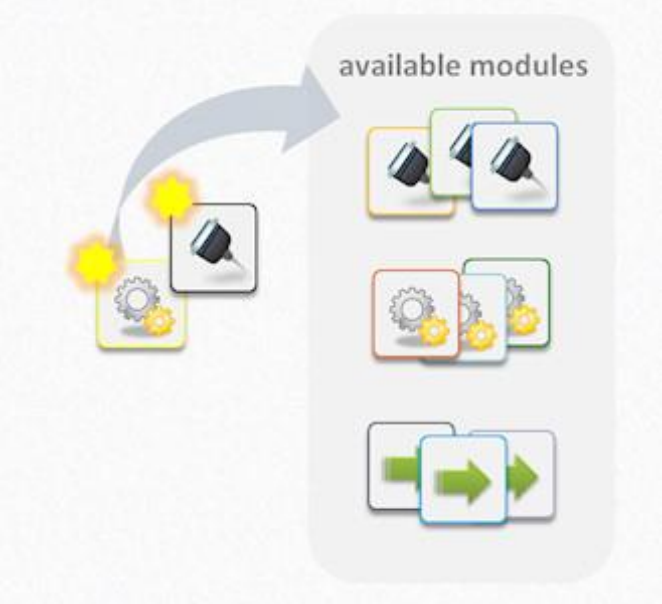

Figure 37 e-miXer Interfaces

GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.

Being a community-driven project, GeoServer is developed, tested, and supported by a diverse group of individuals and organizations from around the world.

GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS). GeoServer forms a core component of the Geospatial Web.

GeoServer can create maps in a variety of output formats. OpenLayers, a free mapping library, is integrated into GeoServer, making map generation quick and easy. GeoServer is built on Geotools, an open source Java GIS toolkit.

Geoserver is a free software.

The municipality of Genoa has implemented a Geoserver solution to handle some geo-data related to safety (Civil Protection, Industrial Areas, Public Works, Safety).

Dataset will be available in json, GeoJSON, XML format using REST webservices (Spatial Reference WGS 1984, EPSG:432.)

Comment on specific dataset

Communications: It is necessary underline that the AAA Wi-Fi provider service could change during the project development, with possible impacts on the availability of datasets.

5.4.3 Tampere

Service	Traffic Management	Emergency and Notification	Public Transport Management	Traveler Journey Assistance	Electronic Fee Collection	In-Vehicle Systems	Law Enforcement	Communications	Demography & Economics	Tourism	Business	Crowd sourced data
a) Multimodal Journey Planner	6	5	5	6	NR	0	NA	0	NR	0	NA	0
b) Energy efficiency / CO2 assessment of journey options (*)	*6*	5	*5*	NR	NR	0	NR	0	NR	0	NR	0
c) User tailored incentive-based visualization	6	NR	*5*	6	NR	0	NA	0	NR	0	NR	0

Table 14 Qualitative evaluation of datasets in Tampere

(*) These services rely on the data generated by the users through the app registration which should contain attributes related to each services such as carpooling allowance, travelling route, mobility choice, fuel input etc.

Specific Comments:

Service a) – Multimodal Journey Planner: 5 is granted to the Public Transport. Datasets are ready to use for buses and bike planners. A Car Journey Planner must be developed as a last step towards achieving full integration.

Service b) - Energy efficiency / CO2 assessment of journey options

- Relies **indirectly** (through service a Multimodal Journey Planner) on Traffic Management and Public Transport Management datasets.
- 5 is granted to the Emergency Notification datasets. At this moment maintenance vehicles collecting RT Winter road maintenance data are equipped with OBUs, but the actual collection of the datasets has not yet started. All other needed datasets (road weather, frost heave) within the Emergency Notification datasets are of qualitative evaluation 6.

Law Enforcement datasets exist, but are in use by official authorities only, not made public to all developers. An extra layer could be added (post MoveUs) on top of MoveUs Tampere Multimodal Journey Planner, to include these datasets.

6. Conclusions

This document is an exhaustive report on

- the legal framework for smart mobility at national (Spain, Italy and France) and at local level
- plans and measures on urban mobility management
- reference organizations, associations and forum

undertaken in the three piloting cities of **Madrid**, **Genoa** and **Tampere**.

Most technologies related to smart mobility have been taken into consideration:

- mobility data acquisition
- data integration and analysis
- cloud computing
- mobility service provision
- data privacy and security.

Systems, sub-systems, components and technologies have been assessed in the three piloting cities:

- Overall Architectures
- Traffic management
- Emergency Notification and Response
- Public Transport management
- Traveler Journey Assistance
- Electronic Fee collection
- In-vehicle systems
- Law Enforcement
- Communications
- Demography & Economics
- Tourism, and Business
- Crowd Sourced data.

The analysis has shown that all the three cities and local partners have control of the main aspects needed for the implementation of the MoveUs services, which were defined as follows:

- **Services in Madrid**:
  - Smart prioritization of vehicles
  - Smart routing for pedestrian
  - Smart crossing for pedestrian
  - Eco-efficient Route Planning and Traffic Prediction
- **Services in Genoa:**
  - Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities; it is a bundle of sub-services: multi-modal journey planner, car and bike sharing management, carbon footprint and energy consumption calculator, carpooling, incentives and coupons/vouchers/deals management, electronic wallet registry, social network management.
  - Integration of crowd sourced data into the Genoa traffic supervisor
- **Services in Tampere:**
  - Multimodal journey planner
  - Energy efficiency / CO2 assessment of journey options
  - User tailored incentive-based visualization

Datasets are generally available, with the need to clarify some issues related to ownership and availability to the public.

Per each service, **users and requirements are now well defined**; this will enable the description of use cases in Task 2.5, where it will be also identified the common specifications for the end users, the service providers and the developer community for the MoveUs pilots.

Finally, **the list of stakeholders, identified per each service, will facilitate the exploitation of results**.

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A1. Annex 1: Detailed technology status

A1.1 Mobility data acquisition technologies

A1.1.1 Data acquisition technology from the mobility infrastructure systems

Inductive -loops sensors- detection technology

The technology based on induction loops is able to detect, count and classify vehicles. These induction loops will form a pair of rectangular loops per detection site.

Loops are located in different points of the road, specifically before an intersection itself, in order to know urban intensity (vehicles flow) and occupation (stationary vehicles).

An inductive loop sensor is an electric cable that creates a magnetic field when a vehicle passes over it; then the loop sends an electric signal to the Local Traffic Controller (LTC) for its interpretation as a detected vehicle.

An inductive loops-based detector is a highly accurate electronic device. One of its most important components is that in charge of translating a physical reality (the presence of a vehicle) into an electric signal that will be processed afterwards by different intelligent algorithms. This component is buried in the road pavement.

The inductive detector includes the use of a microprocessor for the digital treatment of the obtained inputs transmitted by the induction loops; the output of such processing is real traffic data that can be aggregated upon different time basis (usually minutes).

The traffic detector units may have a high variability in sensor configuration, having capacity to cover high number of lanes, in a double-loop configuration, or with in a loop-treadle-loop configuration for weigh-in-motion uses.

Traffic detector units elaborate the following primary information:

- Intensity (Vehicles/ hour)
- Occupancy (%)

The following additional information is usually detected for highways too:

- Speed (km/h)
- Length (Decimetres)
- Distance between vehicles (tenths of second)

- Categories in vehicle classification, according to speed, length and axle number
- Automatic traffic direction detection

Those datasets are –real time- sent to a remote unit acting as a data acquisition station (Local Traffic Centre LTC) where data will be aggregated and will be sent to the Traffic Management control center.

Video-Based traffic surveillance technology

The video surveillance system allows real-time visual coverage in special places where incidents are likely to happen in order to take the appropriate measures against incidents that may happen on the urban roads, highways and on entrance ramps and exits.

This system also allows the operator to register different situations for a later analysis to be made. This action will prevent future incidences from occurring and allow the operators to better respond to these incidences.

Therefore, this system constitutes a basic visual aid to ITS operators located in the Traffic Control Centre (TCC). The traffic data that can be obtained with this system are intensity (flow), average speed, and traffic composition (light and heavy vehicles).

The Close Circuit TV system (CCTV) offers certain important advantages for the successful management of road network that include:

- Traffic monitoring: the ability to visualize traffic in the road network and on entrance ramps and exits serves as a support tool for operators as they can verify the state of the traffic, either by direct observation, or by cross verification with other systems such as incident detection, etc.
- Monitoring of meteorological conditions: visualizing the environment conditions of the road network, of upmost importance in surrounding areas near the tunnel portals, and serves as support for the operators as they can verify visually the climatic conditions of the zone and their possible influence on road safety.
- Visualize daily operations. Visualizing traffic flow is the only possible way to verify certain circumstance (correct operation of part of the system, validation of phases in a determined protocol of performance as closing of lanes, etc.).
- Management of incidents. The video surveillance systems constitute one of the key elements in the control and tracking of the various phases when an incident occurs: detection, verification, information, answer, roadside work and cleaning.

Image management and monitoring is carried out in the TCC. In order to achieve this goal it is necessary to provide certain equipment at the TCC. Besides it, there will be equipment in term of video servers to allow the video to be managed, shared and stored. Moreover, it will be able to shape, modify and manage the station systems parameters of transmission.

The system will also be able to make automatic sequences, selecting the order of the cameras whose images need to be watched. In order to provide these functionalities, a monitor display system properly configured for the operators must be installed in the TCC.

Video-based detection technology

Video detection technology provides real-time data and image information for optimal traffic control and fast accurate incident detection.

The video signal from the monitoring traffic camera is used as input for the detection module. This module is placed within the video cabinet, ground mounted close to the camera pole. It analyses these video images to generate traffic information useful for traffic control and management. The outcome of this video image processing process is a wide range of traffic data such as volume, speed, occupancy or an event notification in case an incident is detected.

The incidents to be detected are varied and can be configured in the detection module, including the following: vehicle stopped in the road shoulder, vehicle circulating in opposite direction, etc. The detection is made by comparison of pixels from the digitized images, which are light colored when there is not any stopped vehicle but turn darker when a vehicle is shown in the image.

On the other side, video streaming systems are also used for the visualization and verification of the pedestrian detection in pedestrian ways or at specific road points like crossing zones at road intersections.

The video detection of pedestrian is aimed at improving the protection of the pedestrian when he/she is either crossing or waiting to cross the road, by transferring such information to the Local Traffic Controller (LTC) that will assess which control strategy to take in order to i.e. extend the duration of the green phase for pedestrian, enabling a more safe and comfortable crossing, or to reduce the red phase for pedestrian so that they have to wait less to cross, etc.

Bluetooth technology

Bluetooth is an accurate and inexpensive way to measure travel time and make origin/destination analysis.

Bluetooth is a wireless standard used to communicate between electronic devices like mobile/smart phones, headsets, navigation systems, computers etc.

Bluetooth road sensors are able to detect Bluetooth from Bluetooth devices; the MAC (Machine Access Control) address is univocal to each device, and the type of device can also be identified in passing vehicles. If these sensors are interconnected (as being part of a network) they are able to calculate travel time and provide data for origin/destination matrices. Compared to other traffic measurement technologies, Bluetooth measurement has some significant advantages:

- Inexpensive per measurement point.
- Inexpensive on physical installation compared to other technologies

- No roadside maintenance needed
- Quick and easy configuration and calibration of complete solution

Bluetooth detection uses similar techniques to other traffic measurement technology, and can be as accurate as these other systems.

The Bluetooth detectors are able to detect Bluetooth devices from the following entities:

- Pedestrian and Public transport commuters;
- Vehicles in urban roads (maximum speed lower than 50 km/h)
- Vehicles in motorways and inter-urban roads

Information detected and collected by Bluetooth detectors may be wirelessly communicated to a remote unit: Local Traffic Controller (LTC), Traffic Control Centre (TCC), etc.

Bluetooth detectors units can elaborate the following information:

- Entities -Bluetooth devices- counting
- Entities type identification
- Times of travel of entities detected between two detectors, meaning the time it takes a detected device to cover the distance between one detector and the following. This is of upmost interest in vehicles.

Optical Character Recognition (OCR) technology

This technology lies in the recognition of a printed text in an image, and its digitizing into an electronically readable text, so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as key data extraction and text mining. OCR is a field of research in pattern recognition, artificial intelligence and computer vision.

Before the process itself, images need to be pre-processed to improve a successful recognition, through techniques like: De-skew (to align the document), despeckle (remove positive and negative spots, smoothing edges) binarization (convert an image from color or greyscale to black-and-white), line removal (clean up non-glyph boxes and lines), zoning (layout analysis), line and word detection, segmentation (character isolation) and aspect and scale normalization.

There are two types of algorithm for character recognition. The one known as "pattern matching", which compares an image to a stored glyph on a pixel-by-pixel, is used for typewritten texts, and enables OCR technology to be used for Automatic Number Plate recognition, what is of use for the following systems:

- Traffic enforcement Camera system
- Vehicle identification and tracking systems in parking facilities, in restricted zones, etc.

This technology allows the identification of a specific vehicle in two determined control sections of the road (entry and exit), and thus it is possible to calculate the time it takes that vehicle to cover the distance between the entry and the exit sections. This information is very valuable from the traffic management viewpoint, as it is an objective measurement of the traffic flow state.

A1.1.2 Data acquisition technology from in-vehicle systems

"Floating car" or "probe" data collection (FCD) is a set of relatively low-cost methods for obtaining travel time and speed data for vehicles traveling along streets, highways, freeways, and other transportation routes. Broadly speaking, three methods have been used to obtain the raw data:

- **Triangulation Method**. The phone(s) contained in each vehicle periodically transmit their presence information to the mobile phone network, even when no voice connection is established. In the mid-2000s, attempts were made to use mobile phones as anonymous traffic probes. As a car moves, so does the signal of any mobile phones that are inside the vehicle. By measuring and analyzing network data using pattern matching or cell-sector statistics (in an anonymous format), the data can be converted into traffic flow information. With more congestion, there are more cars, more phones, and thus, more probes. In metropolitan areas, the distance between antennas is shorter and in theory accuracy increases. An advantage of this method is that no infrastructure needs to be built along the road; only the mobile phone network is leveraged. But in practice the triangulation method can be complicated, especially in areas where the same mobile phone towers serve two or more parallel routes (such as a freeway with a frontage road, a freeway and a commuter rail line, two or more parallel streets, or a street that is also a bus line). By the early 2010s, the popularity of the triangulation method was declining.
- **Vehicle Re-Identification**. Vehicle re-identification methods require sets of detectors mounted along the road. In this technique, a unique serial number for a device in the vehicle is detected at one location and then detected again (re-identified) further down the road. Travel times and speed are calculated by comparing the time at which a specific device is detected by pairs of sensors. This can be done using the MAC (Machine Access Control) addresses from Bluetooth devices, or using the RFID serial numbers from Electronic Toll Collection (ETC) transponders (also called "toll tags").
- **GPS Based Methods**. An increasing number of vehicles are equipped with in-vehicle GPS (satellite navigation) systems that have two-way communication with a traffic data provider. Position readings from these vehicles are used to compute vehicle speeds. Modern methods may not use dedicated hardware but instead smartphone based solutions using specific applications.

A1.2 Cloud computing technologies

Cloud computing technologies

The Cloud IaaS technologies usually include DsaaS technologies as a whole solution of a cloud infrastructure platform. This section lists some of the most important open-source cloud software solutions for IaaS and DsaaS.

IaaS and DsaaS technologies

1. **OpenStack**

Founded by Rackspace Hosting and NASA, OpenStack is an open-source cloud software initiative for producing the ubiquitous open source cloud computing platform for public and private clouds. The technology consists of a series of interrelated projects delivering various components for a cloud infrastructure solution. In particular, OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacentre, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface [77].

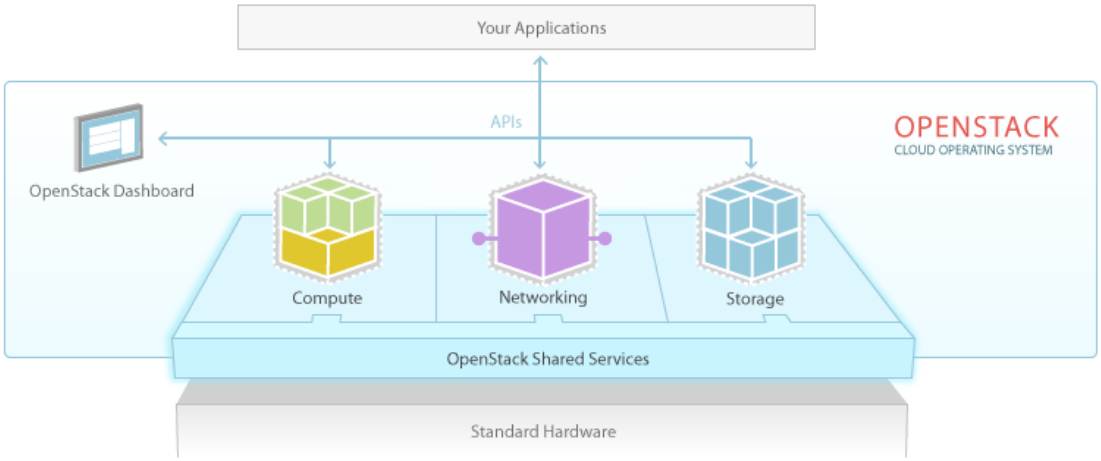

Figure 38 – OpenStack software diagram

(adopted from http://www.openstack.org/software/)

The OpenStack Storage project, known as Swift [79], offers cloud storage software so that you can store and retrieve lots of data in virtual containers. It is based on the Cloud Files [80] offering from Rackspace.

2. **OpenNebula**

OpenNebula [81] provides a **flexible solution** for the comprehensive management of virtualized data centers to enable on-premise IaaS clouds. The OpenNebula technology is the result of many years of research and development in efficient and scalable management of virtual machines on large-scale distributed infrastructures.

It has been used in several international large research and infrastructure projects such as RESERVOIR [82], StratusLab [83] or BonFIRE [84].

3. **Red Hat CloudForms**

Red Hat CloudForms [85] is an enterprise cloud management product that lets deploy, manage, automate, and optimize private and hybrid clouds, and virtualized datacentre infrastructures. Its management platform provides a single interface for unified monitoring, management, and automation across enterprise clouds and globally distributed, virtualized data centers. Red Hat CloudForms gives the option of use existing virtualization and cloud investments from Red Hat, Vmware, Microsoft, Amazon and OpenStack.

4. **Eucalyptus**

Eucalyptus [86] is **open source private cloud software** for building private and hybrid clouds, which are compatible with **Amazon Web Services (AWS).** With AWS-compatibility, the open source software pools together existing virtualized infrastructure to create private or hybrid cloud resources for compute, network, and storage.

PaaS technologies

1. **CloudFoundry**

Cloud Foundry [87] is an open platform as a service, providing a choice of clouds (private or public infrastructures including AWS and OpenStack), developer frameworks (including Spring for Java, Ruby for Rails and Sinatra, node.js, Grails, Scala on Lift and more (PHP, Python, etc.)) and application services (including RabbitMQ, PostgreSQL, MySQL, MongoDB, Redis).

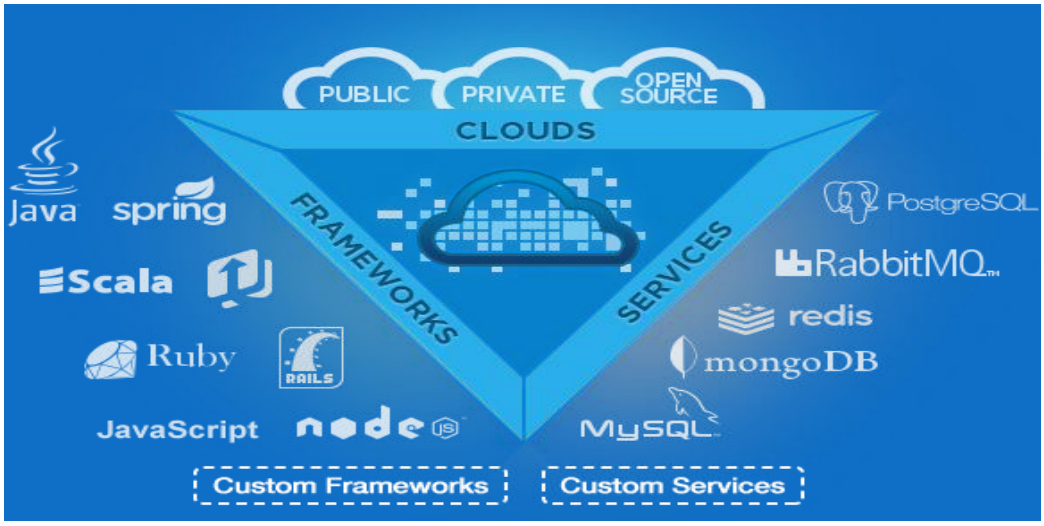

Figure 39 – CloudFoundry deployment choices

(adopted from http://www.cloudfoundry.com/)

Cloud Foundry allows building, testing, deploying and scaling applications. It is an open source project and is available through a variety of private cloud distributions and public cloud instances.

Cloud Foundry was developed by Vmware and released under the terms of the Apache License 2.0. Nowadays Cloud Foundry is being handled by the Pivotal Initiative, a software company founded by VMWare and EMC Corporation [88].

2. **OpenShift**

OpenShift [89] is Red Hat's Platform-as-a-Service (PaaS) that allows developers to develop, host, and scale applications in a cloud environment, providing a choice of deployments (public, private and community), a choice of developer frameworks (including Java, PHP, Ruby, Node.js, Python, and Perl), and a choice of application services (such as MySQL, MongoDB, PostgreSQL and Jenkins).

3. **AppScale**

AppScale [90] is an open-source platform for Google App Engine applications. AppScale implements Google App Engine APIs and as it is an open-source implementation of the Google App Engine, the user can run a PaaS based on AppScale on its own clusters or in other clouds. Like Google App Engine, AppScale supports several developer frameworks such us Java, Python and Ruby.

Data Compute as a Service technologies

Dealing with large volume of data makes necessary to distribute data and workload over many servers efficiently [73]. The appearance of the Cloud Computing together with the high availability, scalability and computational and storage resource pooling that it provides, supports perfectly the needs for big data computing. And new designs for databases and efficient ways to support massively parallel processing have led to a new generation of data technologies such as the so called noSQL ("not only SQL") databases and the Hadoop map-reduce platform [91].

One of the new data technologies currently used in cloud computing environments is the *NoSQL databases*. The NoSQL databases are characterized by being non-relational, distributed and horizontally scalable. The list of existing NoSQL databases is huge [91], but we can mention the following ones because of its proven relevance and wide use in the cloud world: Hbase/Hadoop, Cassandra, MongoDB, DynamoDB, and Azure Table Storage.

The *Apache Hadoop* [92] (Hadoop) is an open-source software for reliable, scalable, distributed computing. Hadoop is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage.

There are multiple cloud providers that are offering Big Data services based on Hadoop as the core technology [93], such as AWS Elastic MapReduce [94], Microsoft Azure HDInsights [95], Google Compute Engine [96], and Rackspace Cloud Big Data Platform [97].

Cloud computing providers

This section covers the existing cloud computing providers that can provide the required cloud technologies for MoveUs. This study is based on the analysis of three projects in the smart mobility area. And besides these projects' results, the list includes other alternative cloud providers owing to the interesting cloud technologies for MoveUs they are offering (like DcaaS).

FI-WARE

The FI-WARE platform [98] is a novel service infrastructure, building upon core elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. It eases the creation of innovative applications by lowering the complexity of serving large numbers of users globally and handling data at large-scale. FI-WARE is the cornerstone project of the Future Internet Public-Private Partnership (FI-PPP), the European programme for Internet-enabled innovation.

The Instant Mobility project [99] (FI-PPP Phase 1) has reused a large number of technologies from the FI-WARE platform. This project has developed multimodality services for people and goods in urban areas based on Future Internet technologies.

Among all generic enablers part of the FI-WARE platform, the Cloud Hosting [100] element plays the cloud provider role. The Cloud Hosting is the fundamental layer which provides the computation, storage and network resources in which services are provisioned and managed. The other generic enable to be considered is Data/Context Management [101], the layer for effective accessing, processing, and analysing massive data volumes, transforming them into valuable knowledge available to applications.

The Cloud Hosting generic enabler offers IaaS (based on OpenStack), PaaS, and DsaaS [102]; and the Data/Context Management generic enabler offers DcaaS [103] (including technologies such as Apache Hadoop and MongoDB). In addition, FI-WARE platform offers services for event data analysis in real-time; this service is based on the Complex Event Processing element provided by IBM [104] (IBM Proactive Technology Online – Proton).

Windows AZURE

Windows Azure [105] is Microsoft's application platform for the public cloud, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. It provides a wide variety of cloud solutions:

- Infrastructure solutions (related to IaaS). Windows Azure provides on-demand infrastructure that scales and adapts to the business needs.

- Web applications (related to PaaS). A PaaS solution provides a choice of several programming languages (such as ASP.NET, PHP, Phyton, Node.js) and a choice of application services (including SQL Database or MySQL).
- Data management (related to DsaaS). Microsoft Azure SQL Database (relational database), and NoSQL capabilities (MongoDB).
- Big Data (related to DcaaS). Windows Azure HDInsight, a Big Data solution powered by Apache Hadoop.
- Big Compute (related to DcaaS). Windows Azure provides on-demand compute resources that enable the user to run large parallel and batch compute jobs in the cloud, or to readily extend its on-premises High Performance Computing (HPC) cluster to the cloud when more capacity is needed.
- Storage, Backup and Recovery (related to DsaaS). Windows Azure provides scalable, durable cloud storage, backup, and recovery solutions for any data, big and small.

In addition, Azure provides more solutions such as identity and access management solution, media distribution solution and mobile apps solution offering a cloud backend for the apps.

There are two mobility projects in which Microsoft AZURE is being used as the cloud provider:

- Ford SYNC [106][107]′ powered by Microsoft
- Transport for London [108]

Amazon Web Services

Amazon Web Services (AWS) is a cloud computing platform that provides a complete set of cloud computing services that enable the user to build scalable applications. Like Azure, AWS offers a wide variety of products, from which we highlight the following:

- Compute & Networking (related to IaaS). Amazon Elastic Compute Cloud (Amazon EC2) is the solution that manages virtual servers in the cloud. It is a web service that provides resizable compute capacity in the cloud.
- Storage & CDN (related to DsaaS). Amazon Simple Storage Service (Amazon S3), a scalable file storage in the cloud; Amazon Glacier, low-cost storage for data archiving and backup; Amazon Elastic Block Store (Amazon EBS), which provides block level storage volumes for use with Amazon EC2 instances.
- Database (related to DsaaS). Amazon Relational Database Service (Amazon RDS), managed relational database service for MySQL, Oracle and SQL Server; Amazon DynamoDB, fast and high-scalable NoSQL data store; Amazon ElastiCache, in-memory cache service; Amazon RedShift, Petabyte-scale data warehouse service.

Analytics (related to DcaaS). Amazon EMR, Hosted Hadoop framework; Amazon Kinesis, real-time data stream processing; AWS Data Pipeline, orchestration service for periodic, data-driven workflows.

A1.3 Mobility service provision

In order to identify the status and possible problems unsolved of the current technology status for service mobility, by considering the different aspect of service provision highlighted before, in the following, a more detailed analysis is achieved in relation to a number of end user services which belongs to the following main categories:

- **Multi-modal trip planning and route guidance (navigation):** these services aim to facilitate a modal shift towards more advantageous mode of travel.
- **Real-time traveler information:** these services are used to provide the traveler with information useful to reduce or avoid delays on the network and to support the decision in terms of travel choices. The information can be of different type and related to different situations, features or elements of the domain of interest. This includes for example: pre-trip road traffic, parking or public transport information, on-trip real-time road or passenger information, etc.

The services are described in the following tables.

Pre-trip road traffic information service
With this service the traveler receives the relevant information on the actual and expected status of the network as it affects the proposed trip before actually starting a trip by road (at home, at the office or at other location as origin of a trip, even if the traveler is outside yet connected to a mobile information service using a personal electronic device). All foreseen information relevant to the journey should be available regardless on the country and road operators involved. • The Pre-trip service is used at the origin of the journey (e.g. at home, at the office). • Route planning is the main "basic" service used because the service is typically used for a specified route. • The service make use of all types of dynamic traffic information for the road traffic like traffic flow information, traffic messages or road weather information as well as real-time data about current and forecast network status. The relevant content/data providers have then to be connected to the service providers who operate the service. • The service is expected to be available on all common devices users may want to use for pre-trip information

On-trip real-time road information service

The service provides users with real-time information on the status of the road network: incidents, congestions, travel times, delays, re-routing advice, affected roads and locations.
 	
• The service can either provide:
  ○ The same information to all road users without personalization.
  ○ Personalized information based on:
  ▪ Temporal preferences (one or more preferred timeslots and day of the week).
  ▪ Spatial preferences (a preferred trip or geographical area)
• On-trip information is available for on the trip "in-car" users.
• The reference service is navigation or trip planning when road traffic information affects a portion of the planned trip or the journey planning has re-routing capabilities considering traffic information.
• The service uses all types of road traffic dynamic information like levels of congestion, traffic or weather alerts etc. as well as real-time data about current and forecast network status. The content/data providers have then to be connected to the service providers who operate the service.
• The service is expected to be available on common end user devices for on-trip and in-car services mostly mobile devices (smartphone and tablets) and in-car or portable navigation systems.

Pre-trip public transport information service
The service provides information before the trip start (at the origin of the trip) including static and dynamic timetables and status of the public transport services, independently of the operators involved. • The *pre-trip* service is used at the origin of the journey (e.g. at home, at the office or at a station). • Route planning is the main "basic" service used because the service is typically used for a specified route. • The service uses all types of dynamic public transport information in combination with the static timetables as well as real-time data about current and forecasted status. The content/data providers have then to be connected to the service providers who operate the service. • Service is expected to be available on all common devices users may want to use for pre-trip information.

Real-time passenger information

The service provides users with information on the status of the public transport: next departure to destination with deviations to the planned schedule, disruptions, etc.
• The service can be available to the public at stops and/or on board with information common to all users.
• The service can be personalized with information provision based on personal preferences like:
  ○ Preferred stops, lines or services
  ○ Preferred type of information (e.g. only information on special events like strikes etc.)
• On-trip an pre-trip information can be obtained with "in-car" devices, at the stations on board and with personal mobile devices.
• The service uses all types of dynamic public transport information as well as uses real-time data about current status. The relevant content/data providers have then to be connected to the service providers who operate the service.
• Service is expected to be available on all common devices users may want to use for this information.

Multi-modal trip planning service and dynamic route guidance

The service calculates the route and transport mode for the traveler from a start point to a destination which is most efficient according to a number of criteria before starting a trip, possibly taking into account delays and the status of the network (actual and expected).
• The start or end point can be dynamically retrieved from the user position
• More journey possibilities are returned for different modes of transport
• The service includes details about the expected time of arrival not only at destination but also at interchange points.
• Instructions are present depending on the mode of transport about:
  ○ Interchanges
  ○ Turn-by-turn directions
• The **Multi-modal trip planning service** can be used at the origin of the journey but may be also queried along the trip if dynamic re-planning is present.
• The **Multi-modal trip planning service can be seen as part of a more complex navigation system where navigation instruction is given for the planned trip.**
• The service is expected to be available on common end user devices for pre-trip, on-trip and in-car services.

Parking monitoring information

• The service monitors parking availability in order to instruct the users to the parking place which can be most convenient and suitable for the needs.
• The service provides static and dynamic information on free spaces, tariffs, opening times and other. It can be used for pre-trip planning or on-trip information
• The reference basic service is route planning whenever a destination parking has to be found
• Personalized information can be provided based on:
  ○ Preferred location.
  ○ Type of parking (or single features of the parking like: covered, open space etc.).
• A parking place can be used as a start or destination of the trip.
• Park and ride features are available with combination of different modes of transport with parking as interchange point.
• The Service uses real-time data about current and forecast status of parking occupancy. The relevant content/data providers have then to be connected to the service providers who operate the service.
• The service is expected to be available on all common end user devices for pre-trip and on-trip information.

A1.4 Data privacy and security mechanisms

Reference areas to be addressed in MoveUs:

Identity & Access Management (IAM)

In general the IAM encompasses a number of aspects involved with users' access to networks, services and applications, including secure and private authentication from users to devices, networks and services, Authorisation & Trust management, User Profile management, 3rd Party Login, Federated identities from users´ IdPs and Single Sign-On (SSO) to service domains.

The exact scope required for MoveUs of IAM/IDP implementation is still to be defined.

Reference projects are as follows:

- **FI-WARE** [98]

FI-WARE is an EU-wide project aimed at building a core platform of the Future Internet. The architecture is made up of enablers that support cloud deployments for such things as smart city services. One such enabler is an IdM component and their implementation could serve as useful reference as it supports 3rd party login and federated identities as well as SSO.

- **Ciudad 2020** [109]
  Smart City mobility project can be used to reference Identity server solution proposed on WSO2 architecture.

- **Mobiguide** [110]
  Reference for OpenAM based identity management solution.

Privacy and Sensitive Data handling

Cloud provider offerings, need to be able to ensure privacy, data confidentiality, integrity and repudiation.

Privacy protection enables digital identities to be available to other entities without exposing these identities to privacy threats such as traceability (the digital traces left during transactions), linkability (profile accumulation based on the digital traces), unsolicited marketing (spamming), and loss of control over personal data and identity theft.

Privacy-friendly attribute-based access control system, which targets mainly sensitive data, can store information together with an attached privacy policy, which regulates its usage. Thus, the system could reveal certain attributes, according to specific supplied conditions.

Secure Data Storage: Data items must be identified in terms of public and private fields (e.g. the fields that have been tagged 'public' can be read by anyone). The private one can be read by trusted service providers (SP) only where a trusted SP is a service which is authenticated by a certificate which has been delivered by a dedicated Certification Authority.

Content-Based Security (CBS) refers to the concept of protecting data and its metadata at its source and integrating access control in a managed way. The data is protected (e.g. by encrypting or signing) at the time of its creation. The cryptographic means, e.g. the algorithm or key, is chosen according to the sensitivity of the data. Instead of controlling access to the information at processing entities, access to the data is managed by restricting access to the cryptographic material needed to remove protection from the data. This type of content protection allows the data to be freely distributed over the physical networks.

Reference Projects:

- **FI-WARE** [98]
  - Reference their Privacy enabler implementation which provides trustworthy, yet privacy-friendly authentication, using privacy-enhanced attribute-based credentials (Privacy-ABCs).

    - Also Data Handling GE that provides attribute-based access control system.
    - Secure storage service.
    - Content Based Security Optional Generic Enabler.
- **PICOS** [111]
    - Reference the developed privacy-enhanced identity and trust management features.

Data Mining - Bulk Data

Large businesses hold thousands of terabytes of datasets about their customers or their activities. They often have to release data files containing private information to third parties for data analysis, application testing or support. To preserve individuals' privacy and comply with privacy regulations, part of released datasets have to be hidden or anonymized using various anonymization techniques, before data release.

Reference Projects:

- **FI-WARE** [98]
  Refer to DB Anonymizer.

Context Based Security Compliance

A lot of current work is being done on trying to find ways to certify Cloud Security based on identified security properties and defining them.

Reference Projects:

- **FI-WARE** [98]
  The USDL-SEC language is used to describe the available security service features as well as the rules to be fulfilled and the interfaces specification.

- **Cumulus** [112]
  CUMULUS will address these limitations by developing an integrated framework of models, processes and tools supporting the certification of security properties of infrastructure (IaaS), platform (PaaS) and software application layer (SaaS) services in cloud. CUMULUS framework will bring service users, service providers and cloud suppliers to work together with certification authorities in order to ensure security certificate validity in the ever-changing cloud environment.

Security Monitoring

In spite of the fact that technical security solutions are deployed, there are numerous instances of processes or transactions being compromised. It is sometimes said that "what you cannot measure, you cannot manage". Cyber Security is an area of great global focus, yet it is both hard to manage and arguably

even harder to measure. In order to provide high-level situational security awareness, a next-generation Security Information and Event Management (SIEM) environment is thus needed, which should provide an architecture for trustworthy and resilient collection of security events from source systems, processes and applications. In addition, an anticipatory impact analysis should enable us to predict the outcome of threats and mitigation strategies and thus enable proactive and dynamic response.

Reference Projects:

- **FI-WARE** [98]
  Reference Security Monitoring GE and security management system.
- **Massif** [113]
  MASSIF (MAnagement of Security information and events in Service Infrastructures) provides a next-generation Security Information and Event Managemen (SIEM) framework for service infrastructures supporting intelligent, scalable, and multi-level / multi-domain security event processing and predictive security monitoring.

End User Terminals

Reference Projects:

- **FutureID** [114]
  Reference Trusted Execution Environments: Trusted Platform Modules (TPM), Mobile Trusted Modules (MTM).
- **FI-WARE** [98]
  Reference Android Vulnerability Assessment Tool is an OVAL (Open Vulnerability and Assessment Language) interpreter for Android devices.

Secure Internet Applications

Reference Projects:

- **OWASP** [115]

A2. Annex 2: Detailed inventory of the existing Mobility & ITS Infrastructures in the pilot cities

A2.1 Genoa

A2.1.1 Functional architecture

This chapter describes in detail the functional architecture and systems that will be involved in Genoa pilot site for the provision of the defined services to users in the different Uses Cases.

A2.1.1.1 Traffic Management

SIGMA+ Traffic lights control:

The centralized system for supervision and control of road traffic Sigma + achieves the following main functions:

- management of traffic lights connected to the system to coordinate and regulate time, depending on traffic conditions, present in 169 traffic lights;

- control and supervision of the plant to view, store and process all available information about management, planning and maintenance of the system;

- Automatic acquisition and processing of traffic data provided by the sensors at 15 traffic data collection stations and sensors connected directly to the regulatory management of traffic lights.

TCT System

The TCT system has the objective of monitoring traffic through the retrieval of video streams from cameras conveniently located on the territory.

The system is formed by: n. 1 server, n. 4 client (three of which have a double monitor) for the management and viewing of the cameras, no. 38 cameras located on the territory.

The system is interfaced to the videowall present in the operations room of the Municipal Police on which it is possible to display up to 12 cameras

Incident control database

Thanks to the European project Civitas-Caravel concluded in April 2009, it was built a Monitoring Center of road accidents in the City of Genoa (known as "CMI"). The Database has the following characteristics:

- Considers data not strictly related to the incident;

- Relates more incidents between them;

- Perform initial analysis of preventive road safety, which serve to indicate the priority of intervention;

- Allows monitoring the evolution of accidents in space and time;

- Lays the groundwork for developing models for risk mitigation.

Pollutant emission data collection

The acquisition of data about pollutant emissions is achieved with monitoring stations

The data is acquired to the Province of Genoa, which shall transfer to the City, according to an agreement, a Database called "Traffic - Environment".

MobiGIS

MobiGIS is a repository that collects data from various systems related to mobility. It is for the most part georeferenced data that is made available and accessible through a WebGIS system which act as a tool for decision support.

The data contained in the repository, many of which are updated in sync with their sources, come from different sources.

A2.1.1.2 Public Transport management

SIMON

SIMON (integrated monitoring system) is the system for monitoring the Fleet provided by AMT SpA, Public Transport operator of the city of Genoa.

In detail, SIMON includes:

- 750 on-board systems
- 1 control and monitoring system comprising 11 stations operator
- 102 points of information to users on the ground
- 15 computerized kiosks
- 5 deposits equipped with short-range communication network for loading and unloading data
- 80 intersections with traffic signal priority system functionality.

A2.1.1.3 Traveller Journey Assistance

VMS system

It is the management system of the variable messaging panels. It is defined by client / server architecture, in which each Operator accesses the system data through network communication with the server.

Infopark

Infopark is a software dedicated to the supervision of the parking lots and the presentation of the data from these.

The system manages n. 16 parking spaces in covered structure and no. 16 indicators of the state

Any information panel, consisting of alphanumeric matrices, has the availability of 10 characters on a single line and is composed of:

- an arrow indicating statically (panel with backlight) ;
- the road signs to the parking
- dynamic free spaces availability

A2.1.1.4 Electronic Fee collection

Public Transport SMS ticket

The PT company Amt offers its passengers the opportunity to purchase tickets for the urban network by phone and smartphone by charging the cost directly to the credit or phone bill. The mobile ticketing service available for customers of Telecom Italy, Vodafone Italy , Wind and 3 Italy , is organized in collaboration with Netsize (group company Gemalto) and allows to buy tickets by sending a simple text message, without pre-registering or using a credit card. The transaction takes place through the most advanced safety standards, with management of encrypted data and a direct connection to the charging systems of operators.

A2.1.1.5 Law Enforcement

LTZ control

The Genoa LTZ includes a set of procedures, actors and instruments including a sub-system of electronic gates to control access to the city of Genoa, with the aim of ensuring that the area is accessed only by authorized vehicles

The system that governs access control to the LTZ includes:

- Unified management of licenses
- Central and peripheral system of electronic gates to control access to the center
- Automatic Penalty management system

CELERITAS

The city of Genoa set up a system to monitor the average speed of the overpass A. Moro, in order to improve the level of security.

The overpass is a high-traffic fast road in the center of Genoa which connects the neighborhood of Foce at the Genova Ovest motorway exit and then to the district

Sampierdarena. It is about 5 km long and crosses, in its central part, the Old Port area. The road has two lanes in each direction (lane width = 3.5 m) without emergency lanes, with a speed limit of 60 km / h.

The system is equipped with workstations for detecting exceeding speeds along the entire path, in both directions and taking into account all tracks.

A2.1.1.6 In-vehicle systems

A number of mobile apps are available for pre-trip and on-trip information. Although these may not be intended as "In-vehicle systems" by a strict definition, their use may be envisaged during a trip, supposing it is done according to the current safety regulations about the use of mobile devices in a car. The mobile services include:

- "AMT app mobile" a mobile app for public transport information
- "Free WI-FI Genova", a mobile app to be informed about the coverage of the free WI-FI network in Genoa
- "IoGuido" a mobile app for using the Car Sharing service in Genoa
- "Mobilitypoint mobile" a mobile web site (soon available also as a smartphone app) with multimodal travel and traffic information in Genoa

FreeWiFiGenova is the name of the project of the Municipality of Genoa for the free internet navigation via wi-fi network. Among the objectives of the service there is an increased accessibility of information for citizens and tourists. The service is available in the main city squares, libraries and museums with over 90 hot-spots that allow free navigation for 300 MB per day (no time limits) on the Internet. The authentication in the Municipality of Genoa is guaranteed by the collaboration with CINECA.

The WI-Fi Network is a key infrastructure for the provision of mobility information to the users, being car travelers or PT users.

A2.1.1.7 System connections to the Traffic Supervision System

Most of the systems mentioned above are connected to a central control system: the Traffic Supervision System, developed during 2012/2013 and expected to be operative in 2014.

The external systems are connected to the supervision system in a proprietary/custom way to different sub-systems of the supervisor. These sub-systems allow different operations on the respective data, primarily:

- Planning,
- Control
- Configuration
- Report

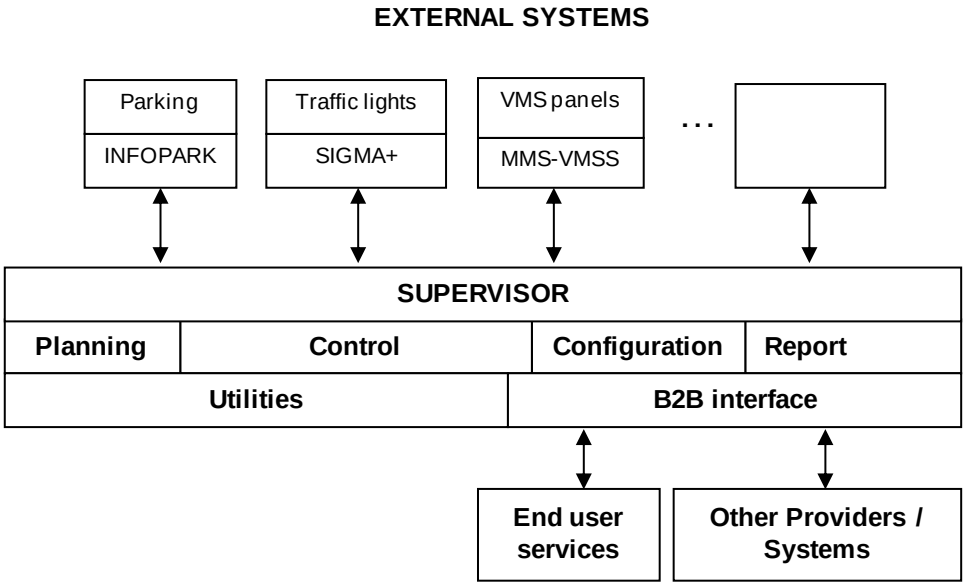

Figure 40 - Connection of input (external) systems with the central traffic supervisor

The data flow can be bi-directional whenever the output of one of the above operations should return to the external system like in the following example where data is exchanged between a VMS panel external system and the related control system of the supervisor.

```
[Data Exchange: VMS -> Supervisor]: the status of a VMS panel is accessed and
read.
[Supervisor Control operation] a new message is composed by the operator using
the control tools available in the Supervision system.
[Data Exchange: Supervisor -> VMS]: the content of the message is sent to the
VMS panel
```

The Supervisor also acts as a provider of data coming from the external systems via a unified B2B interface. The general purpose B2B interface is currently connected to a number of end user services provided by the Municipality and available as a multi-channel offering named "Mobilitypoint". The interface can also be connected to other service providers or systems, for example the MoveUs system.

The possibility of connecting the general purpose B2B interface to other systems represents the ideal and preferable situation for accessing data initially available only from the remote systems via custom connections. All connection problems and issues as well as the differences in format have, in fact, now be solved.

The B2B REST interface is composed by a number of Request/Response methods in the domains of

- Parking information (dynamic and static)
- Traffic message (real time and scheduled) including measures and travel times
- Cams
- VMS
- POIs

Security is handled between Client and Server using an algorithm in which a client produces a time variant session token to be validated for each request by the server.

More information sources handled by the Supervisor may be added in the future considering the needs. The B2B interface access point represents in any case the preferred access point for the information.

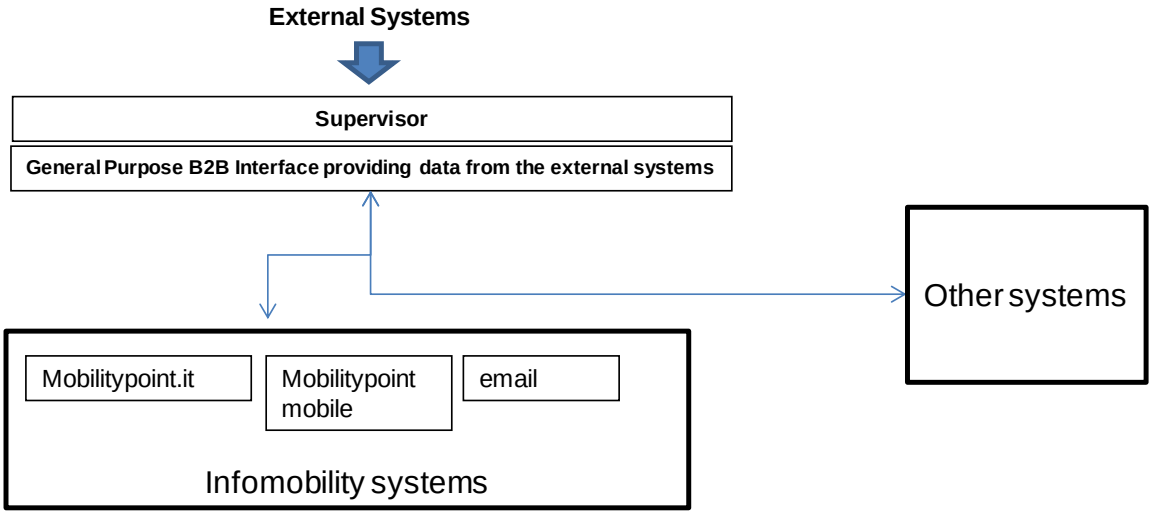

Figure 41 – Connection of infomobility systems with the central traffic supervisor

About the existing service offering, the Mobilitypoint is the multi-channel platform for the deployment of information services dedicated to the Genoese citizens and tourists moving on / from / to the territory of Genoa. From the desktop and mobile versions information can be found pertaining to the urban/highway traffic, thematic maps for the location of the points of interest in the mobility domain, images from the web cams installed in strategic points, city news on mobility.

Information about mobility facilities, parking areas, LTZ regulations, anti-pollution and parking limitation are also offered. This includes, in details information for mobility and parking for people with mobility impairments referring to the various types of transport on the territory of Genoa. News about initiatives for sustainable mobility, such as car sharing , bike sharing , the on-demand bus (Drinbus), the service dedicated to electric vehicles, etc.

The current offering is available through the following channels:

- Web portal
- HTML5 web app suitable for mobile devices

- Subscription-based email service
- iOS and Android apps expected in 2014

The detailed information available from the information services (which are also available from the general purpose B2B interface) are:

- Urban traffic:
  - Scheduled and real time events
  - Status of traffic (Level of services) in the road network
  - Alerts and news from external providers (highway operator and province)
- Parking:
  - Location of Parking places with detailed static information
  - Real time information about free places (for a limited number of parking only)
- Public Transport:
  - Train station information
  - Integration with bus/metro information planned and expected in 2014
- VMS information:
- Location and status (content) of VMS panels
- Cams
- Location and current picture of the traffic webcams

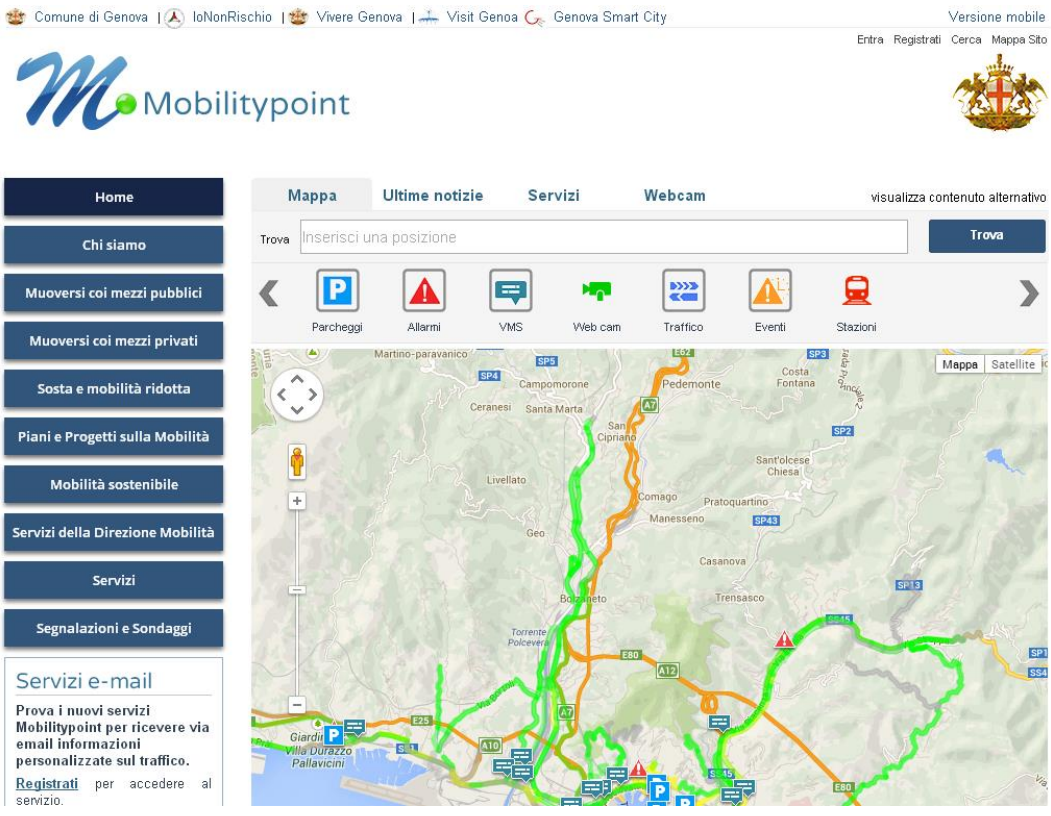

Figure 42 – Home page of the mobilitypoint web site

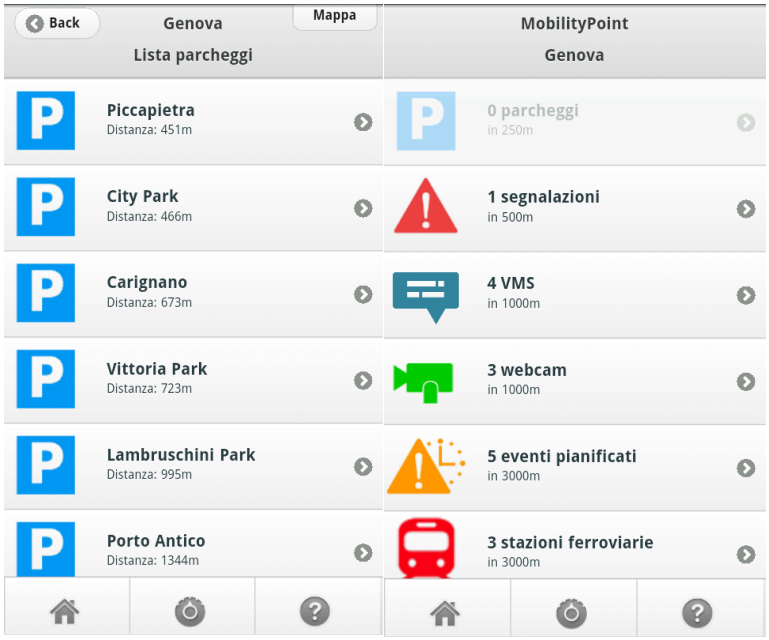

Figure 43 – Screenshots from the mobilitypoint mobile site

A2.1.2 Communication networks

Description	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Metropolitan fiber networks		Available	Metropolitan Area		Telecom Italia	Available		Subscription	None
Urban fiber networks		Available	Urban area		CdG, Fastweb	Available		Subscription	None
Mobile Operators		Available	Complete Coverage		TIN, Vodafone, 3, Wind	Available		Subscription	None
WiFi networks	Various	Available	Various		CDG, Porto Antico	Available		Subscription	None
WiMax networks		No indications that it will be available							
Tetra networks		No indications that it will be available							
Private radio networks (i.e. police networks)		Available	Various		Polizia, Carabinieri, Taxis, Emergency Services	Not Available			
Dedicated Short Range Communication (DSRC)		No indications that it will be available							
Other comms networks (specify)									

A2.1.3 Deployed software tools and information sources

Enumeration of the different software tools and information sources deployed on the different Systems ("an ITS Area is implemented by a System").

When the same element is used under exactly the same constraints and parameterization on several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Cartography		Scale: 1:5000; vectorial, Reference system: Roma 1940/Gauss-Boaga; 2D digitalization; accuracy: 3m	Available	S.I.T.		CdG Ligurian Region	In Electronic format on request		Free	None
Map server containing geo-referenced data of the Mobility Area										
Database		General	available	ISTAT	ISTAT	ISTAT	Availability: via		Partially	None

containing information about the vehicles composition of the Mobility Area		statistics on approx. registered 4- and 2-wheels					web		Free	
Database containing information about Subjects (citizens, vehicles, businesses, transporters, etc.)										
Traffic simulator										
Database from insurances, hospitals, local statistics, etc.										

A2.1.4 Data collection. Inputs

Enumeration of the different inputs managed by the different Systems. When the same input is received under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

The inputs are split between:

- Systems / Devices/Sensors and
- Vehicle identification and position

A2.1.4.1 Systems / Devices / sensors

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints	Accuracy	Frequency (refresh and report)	Measure (units)	Coverage area
Traffic Supervisor[16]	Supervision System		Expected to be operative in 2014	CdG	CdG	CdG		CdG, Municipal Police				Variable, configurable		Urban area
Traffic Signals management	SIGMA+		Active	CdG	CdG	CdG		CdG, Municipal Police						Urban area
VMS management	VMS system		Active	CdG	CdG	CdG		CdG						Urban area
Parking management	Infopark		Under maintenance	CdG	CdG	CdG		CdG						Urban area
TVCC	TCT		Active	CdG	CdG	CdG		CdG						Urban area
Public Transportation management (AVM)	SIMON		Active	AMT	AMT	AMT		CdG						Urban area

[16] The Traffic Supervisor in Genoa can be seen as a target system receiving data from the input sensors/system. It is therefore described in "Outputs" table. Nevertheless, since it includes a B2B interface for external data access, it could be also seen as a Input system

ZTL access control	ZTL access control		Active	CdG	CdG	CdG		CdG						Urban area, historical center
Accident management	CMI incident database		Active	CdG	CdG	CdG		CdG						Urban area
Traffic measurements through advanced sensors, i.e. radar, bluetooth and infrared sensors														
Speed sensors	CELERITAS		Active	CdG	CdG	CdG		CdG						Urban area
Other traffic sensors (specify)	IFR		Active	CdG	ACI	ACI						Various		CdG
GHG sensors	Coils		Active	CdG	CdG	CdG						Various		CdG
Particulate sensors														
NOx, SOx sensors														
Other pollution sensors	Pollution Monitoring		Active											

(specify)	stations													

A2.1.4.2 Vehicle identification

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints	Frequency (refresh and report)
ALPR Vehicles identification		Some cameras in Bus lanes, LTZ, Speed sensors	available	Various		Municipality of Genoa and Municipality Transport Company	CDG Intranet		Free	None	
Fleets already equipped with OBUs		Approx 2.000 Vehicles	available	Various		Taxis, Emergency Services, Car sharing	Not Available				
Private vehicles already equipped with OBUs		Approx 6.500 vehicles	available	Various		Various	Partially Available		To be negotiated	Privacy	
Smartphone equipped with GPS receiver		Penetration estimated in 8%,	available	Various		Subscribers	Partially Available		To be negotiated	Privacy	

		with an very fast expected growth									
Electronic payment systems			Available	Banca Anton Veneta, Deutsche bank		Banca Anton Veneta, Deutsche bank	Available via web		Commission Based	None	

A2.1.5 Outputs

Enumeration of the different output channels managed by the different systems. When the same output is used under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Centralized Control	Traffic Supervisor		To be launched (2014)	CdG	CdG	CdG	Active	CdG, Municipal Police	na	
Call centers										

Info-mobility web sites	Mobilitypoint		To be launched (2014)	CdG	CdG	CdG	Active	Public	Free	
Info-mobility apps	Mobilitypoint mobile		To be launched (2014)	CdG	CdG	CdG	Active	Public	Free	
Info-mobility points										
VMS	VMS system		Active	CdG	CdG	CdG	Active	Public	Free	

A2.1.6 Personal devices

Analysis of the diffusion of personal devices, which are interacting with the above described systems, subsystems and components.

Description	Diffusion (% of population)[17]	Sales in the last year (units)	Sales in the last year (percentage of sales)
Smartphones	probably same national %	probably same national %	probably same national %
Tablet	probably same national %	probably same national %	probably same national %
PDA (do they still exist?)	Not relevant		
Mobile phones without data connection			
Lap Top	probably same national %	probably same national %	probably same national %
In-car navigator (factory installed)	probably same national %	probably same national %	probably same national %

[17] Due to unavailability of local figures it is assumed that the local diffusion and sales are in line with the National figures

A2.2 Madrid

A2.2.1 Functional architecture

This chapter describes in detail the functional architecture and systems that will be involved in Madrid pilot site for the provision of the defined services to users in the different Uses Cases.

A2.2.1.1 Urban Traffic Centralized System (UTC)

This section describes the ADIMOT (Adaptive Multialgorithmic Optimisation Technique) system, which is one of the UTCs system deployed in Madrid that will be used in Madrid pilot.

An Urban Traffic Centralized System acts on the traffic lights network of a city with the double objective of (i) increasing the safety of the traffic and (ii) optimizing vehicles traffic flow. In all cases, traffic safety is the highest priority, but the adaptive algorithms implemented aim to minimize the cost to traffic flow, measured in terms of decrease of the travelling times and numbers of stops of the vehicles and also aim to increasing the general fluidity of the traffic.

The ADIMOT system is composed by three hierarchical levels:

- Central Control Equipment in the Traffic Control Centre
- Master Controllers
- Local Controllers and Vehicle Detectors

The Hierarchical system concept assures that a failure in the Control Centre or in the Master Controllers will not affect the traffic management because of the synchronized internal clock located in the local controllers.

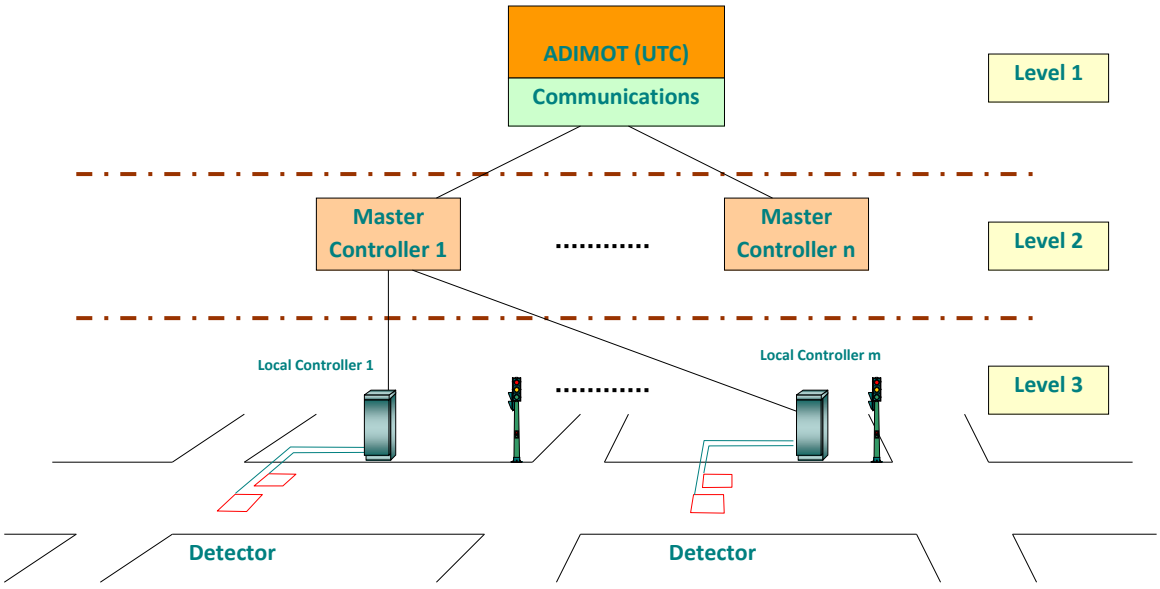

Figure 44 – Hierarchical architecture of the urban traffic control system (UTC)

The system operates a Centralized Traffic Control according to the following algorithms:

- Manual Selection of Traffic Plan
- Fixed Time table plans
- Dynamic selection of Traffic Plan
- Dynamic Generation of Traffic Plans
    - Self-Adaptive System that makes small and frequent modifications in the Cycle, Split and Offset calculated by the previous algorithms.

The equipment of the Control Centre is the following:

- Main Computer server working with Linux Operating System.
- Personal Computers with Windows as Clients.

The regulation actions are received from the Control Centre and executed at each Local Controller.

Basic Concepts to establish Control Strategies on ADIMOT Traffic Plans

An '**Area**' is defined as a set of intersections that form part of an independent entity which is the highest level the operator can work with. In small cities, the whole city is considered an area, but in big ones, like Madrid, having centralized isolated zones between them, several areas can be established.

A set of strategies allow the definition of different subdivisions of the controlled area into subareas, thus enabling to apply different Cycles and Control Algorithms in those subareas.

There are two types of strategies:

- The Topological Strategy, that defines the partition of the area into subareas.
- The Algorithmic Strategy, that defines the control algorithm that is used in each partition or subarea.

It is possible for several strategies to coexist in the same area. The following figure shows examples of the coexistence of topological and algorithmic strategies.

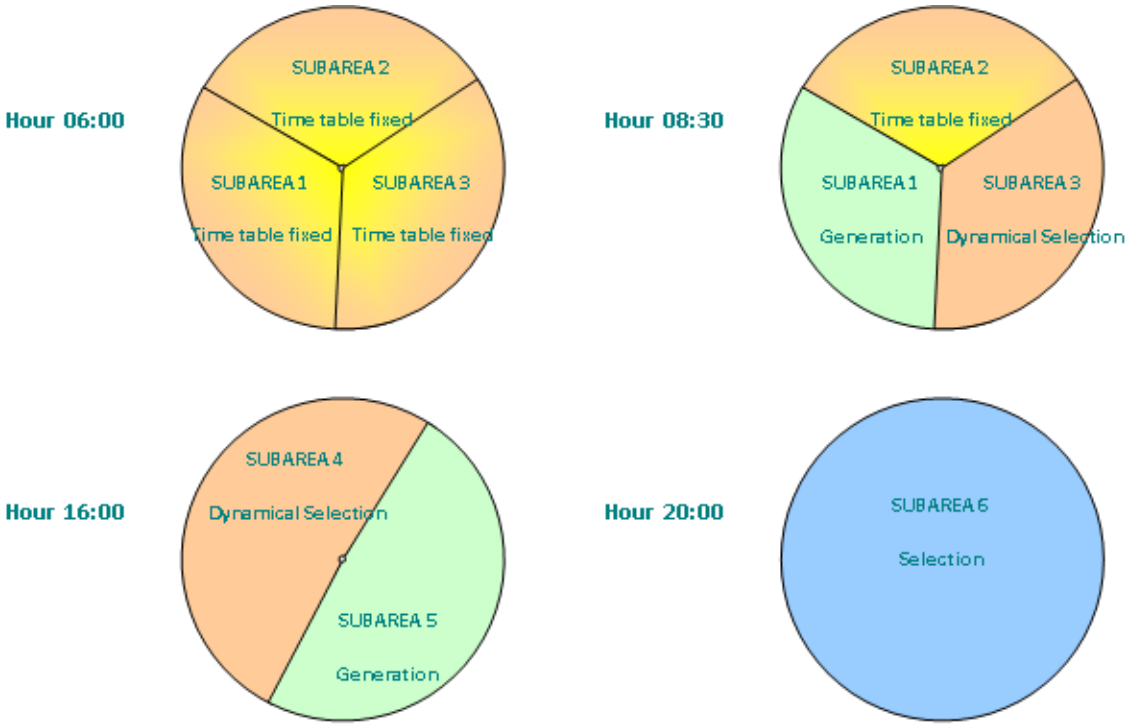

Figure 45 – Example of control strategies for traffic plans

A '**subarea'** is a set of intersections with the same cycle duration. The subareas are partitions of one area. Each partition of an area into subareas constitutes a topological strategy.

A '**coordinate Route'** is a collection of intersections and sections joined with the same cycle, whose Offset combination makes coordination. A coordinate route is the basic principle to get priority **green waves**.

An '**Intersection'** is a set of traffic lights controlled by a traffic controller. An intersection is controlled by one or more Traffic Controllers, but the system treats the couple controller - intersection as a unique element, so an intersection with two traffic controllers is treated like two different ones.

The ADIMOT system includes a **decision rules module** which is an expert system that acts as an automatic operator of the system according to variables measured directly by the detectors (flow and occupancy of detectors and measurement points) and considers calculated variables (cycle, Offset, Split, Alarms, etc.)

The rules are executed periodically, evaluating continuously the variables, based on which the programmed functions will be triggered.

For example, ADIMOT allows the function named **gating** that consists basically on restricting the entry of the traffic to a critical zone where the congestion may cause important problems. So, the Gating function acts on the green times of the intersection and operates as "access doors" to the zone where it is desired to

alleviate of traffic; it is done after evaluating occupancy measurement provided by the loop detector.

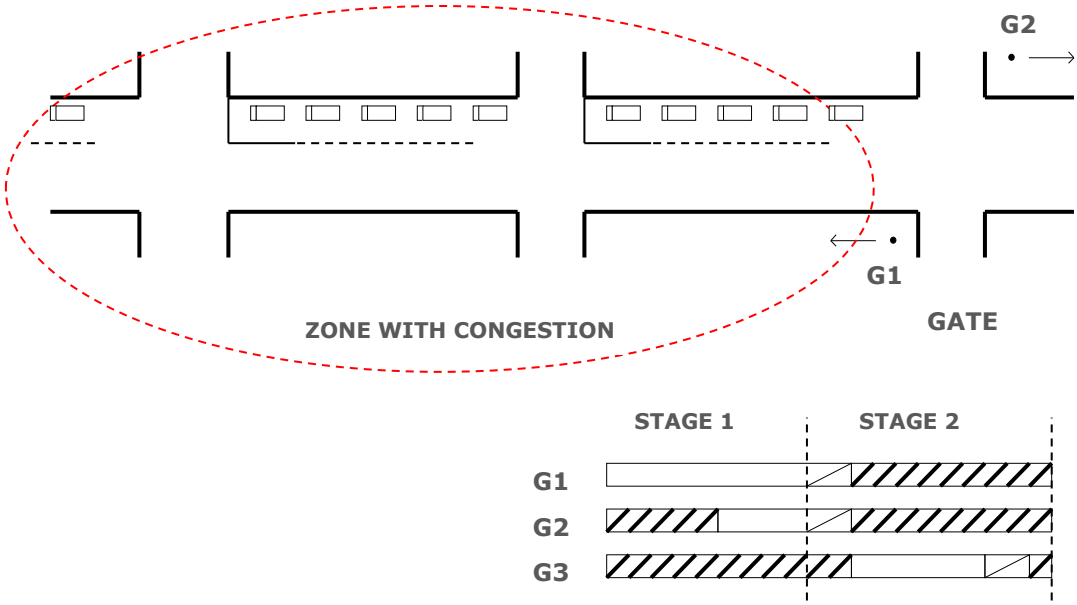

Figure 46 – Gating function

Control Strategies on Traffic Light Controllers

The Local traffic light controller can have a **queue and saturation flow estimation** algorithm that computes the information from detectors located in the stopping line; in that case, the calculations of Cycle, Split and Offset will be made considering saturation flows estimated by the Traffic Controller.

In order to be able to estimate the number of vehicles that are in queue located before the position of the detector, it is necessary to determine an characteristic instant of clearance of the queue that corresponds to the moment when the last vehicle in the queue goes through the stopping line once the green stage has started.

This is made by using artificial intelligence based techniques programmed directly in the Local Traffic Controller.

Also, the **micro-regulation function** installed in the Local Traffic light Controller allows switching the strategies that act by stages to use the Traffic Light Groups management in order to avoid blockage situations in the intersection. This micro-regulation function is basic for the deployment of priority strategies on public transport.

Therefore, the Traffic Controller has the possibility to act directly on the Traffic Light Groups with a determined degree of independency with respect to the stages.

The actions made on the traffic Light Groups depend on the real time measurement of the vehicle counting and occupancy of some detectors located in the area of the intersection.

The following actions are allowed on the Traffic Light groups:

- Bring forward the end of the green phase of a Traffic Light Group
- Extend the green time of the Traffic Light Group and thus postpone the starting of the green phase of its incompatible groups.

Traffic data acquisition and filtering

The acquisition of the traffic data (**Intensity and Occupancy**) measured by the detectors installed on each road lane and its integration in the **measurement points (PM)** is done every 1 minute and so they are made available for the system.

The reception in the Control Centre of the flow and occupancy time information from the detectors is made at intervals of **1 minute**.

A specific algorithm automatically filters the wrong data from detectors and substitutes them (in the case the detector never counts, or it always counts, or excessed counting, disarranged data, etc.)

The substitution of values is done, whenever possible, using the corresponding percentage value from the other detectors of the measurement point and when the right value measured by those detectors is equal to half plus one of the total number of detectors of the measurement point.

High occupancy alarms are generated, based on detectors measurements, and stored in the data base.

The Measurement points are defined in a general way according to the detectors (loops). The treatment of the loop failure is made by assigning to detector subassemblies a protected alarm that is programmed in the Traffic Controller.

Also, some information filtering actions are made in the measurement points. The value obtained from the measurement point can be substituted by the historical average value of the measurement point, averaged according the day and season of the year.

The **historical average is saved by type of day and type of season of the year**. The type of season will correspond to different periods of the year. The statistical processes of the data from the measurement points will be made on the values of flow, occupancy times, charges and saturation of intersection registered in the historical archives.

The updating of the historical archives of the system of the collected parameters is done by quarters of hour for the daily values, and by average for the type of day and for the season of the year.

The failure information from detectors and measurement points from the data acquisition subsystem are detected and stored in the historical data base. The detection of the general alarms is done at the level of the Traffic Controller, the Master Controller and the rest of monitoring equipment.

The Local traffic light controller can have a **queue and saturation flow estimation algorithm** starting from detectors located in the stopping line of the traffic light; in that case, the calculations of **Cycle, Split and Offset** will be made starting from the saturation flows estimated by the Traffic Controller.

Communication Network

Communication network is shown on figure below

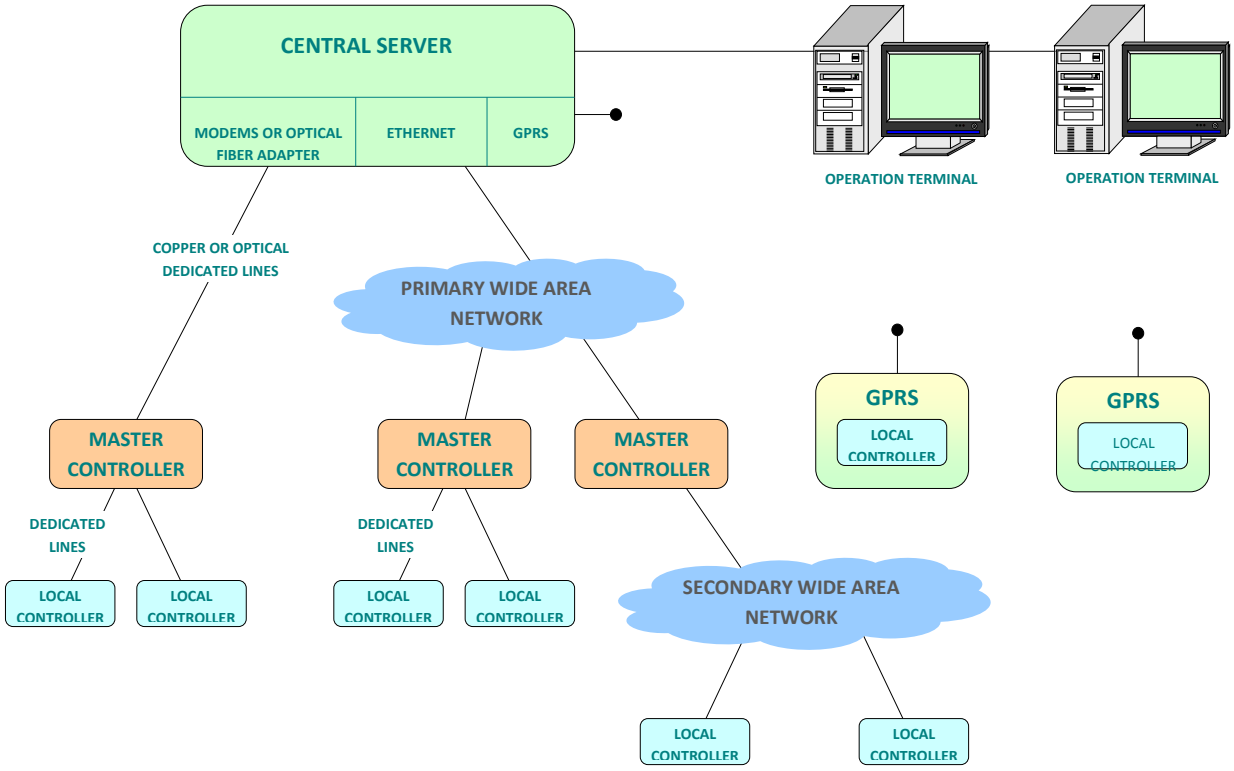

Figure 47 – Communication Network for ADIMOT

A2.2.1.2 Surveillance and Control Application (M30 SCA & T-SCA)

The **Surveillance and Control Application (SCA)** enables monitoring and control of tunnel and freeway systems for either newly-constructed or upgraded existing infrastructure (main highways).

SCA provides the ability to retrieve and manage data for the display and control of the road and tunnel environment, traffic and infrastructure assets.

The SCA freeway management solution consists of hardware and software that can implement precise tunnel or highway control system requirements which controls variable sign posting, vehicle detection system, ventilation, air-filtering, lighting, fire control equipment, etc.

This centralized management approach permits the optimization of facilities, and increases the overall level of security, while improving traffic flow and keeping users informed in real time (via Variable Message Signs –VMS- basically).

SCA is a multi-lingual management application that consists of remote equipment linked to a control centre running dedicated software that allows for Monitoring and Control of:

In a **M30 highway**:

- Traffic information (from loop detectors). Intensity, Occupancy, Speed, Vehicle Classification, Vehicle GAP
- VMS - Variable Message Signs
- CCTV cameras
- Road Weather Information equipment (RWIS). Not installed on M30

In a **Madrid City Tunnel highway**:

- Traffic information (from loop detectors)
- VMS - Variable Message Signs
- CCTV cameras
- RWIS
- Fire Detection System (fans, emergency exits, etc.)
- Vehicle Access Control sub-system (barriers, traffic lights)
- Pollution data (CO, NO, OP)
- Lightning

The system uses standard scripting languages to set operational rules that are required for the semiautomatic or automatic management of equipment and subsystems controlled by the SCA (for example to establish messages on VMSs in M30).

System Architecture and Communication Network

Architecture and Communication network is shown on figure below:

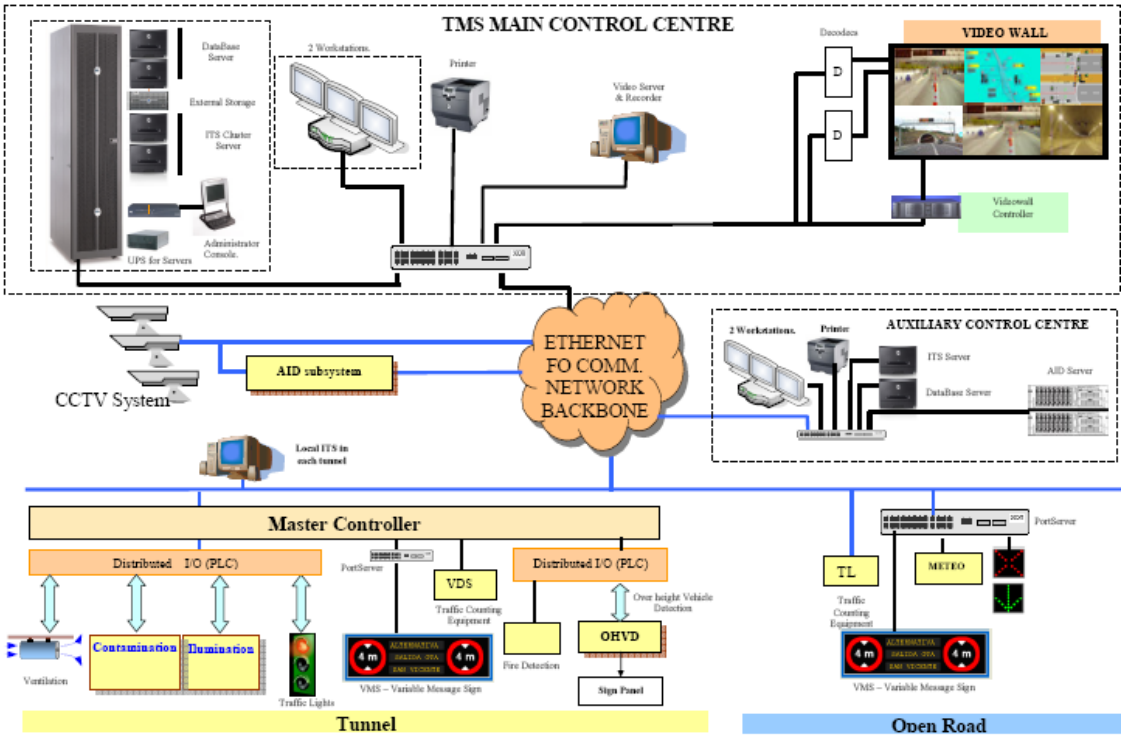

Figure 48 –SCA Architecture

In Madrid, M30 SCA and Tunnels-SCA are not integrated in a unique SCA application. They are controlled on different physical Traffic Control Centres of Madrid. Road infrastructure is supported by two different network communications; but basically, the conceptual architecture is the same.

A2.2.1.3 SICTRAM

SICTRAM is a powerful integrated application aimed at providing a city wide mobility management tool with a level 0 layer approach that integrates information from level 1 layer applications/systems (see Overall architecture on Madrid Mobility Control Centre figure).

Some of the characteristics of SICTRAM are listed hereafter:

- SICTRAM provides a single user interface for a city wide mobility tools and services
- SICTRAM follows a city ops plan for mobility management
- It systematically organizes and follows City Council action protocols
- Coordinates communications with other City Councils services (basically to support emergencies)
- Integrates with internal information sources
- SICTRAM is a flexible and open architecture for the use of open protocols such as "web services"

It is also possible to display the information to the public/citizen through the following methods:

- Web Portal (http://informo.munimadrid.es/informo/tmadrid/tmadrid.php)
- SMS messaging
- Radio

A2.2.1.4 MAD web site

The information that is provided to the citizens by different Madrid mobility management systems from main stakeholders is summarized in the following web site (see also Apps at the bottom) http://www.muevetepormadrid.es/

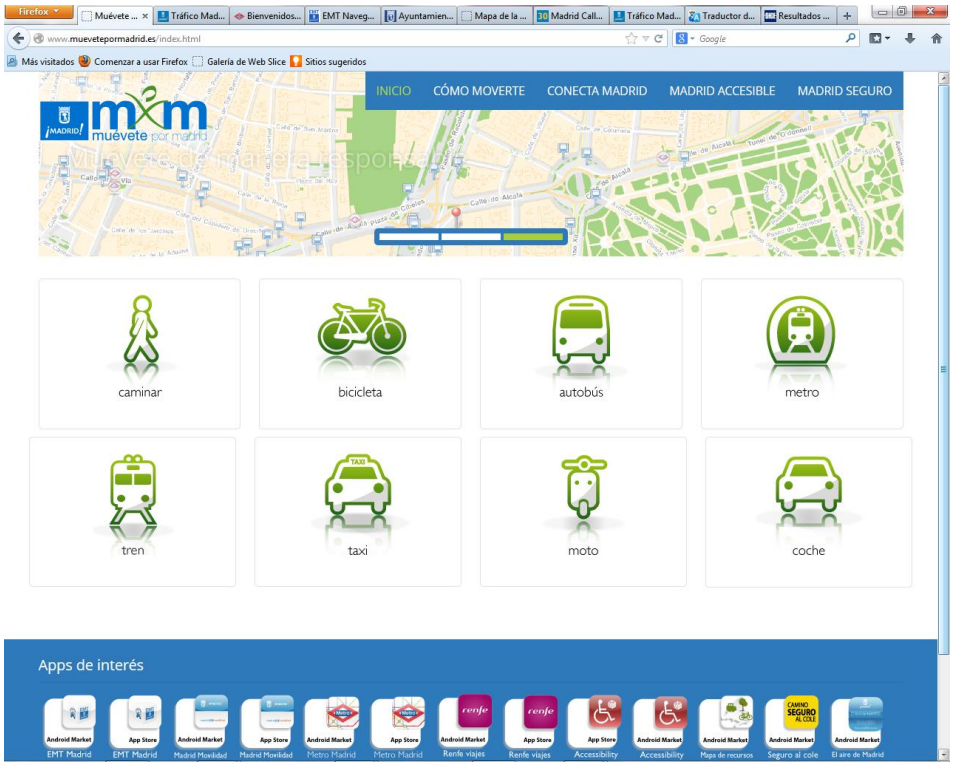

Figure 49 – Madrid Mobility Web Site

The detailed information about each transport mode is redirected to a specific link; for example, in Car Option, the information about traffic is provided in the following URL http://informo.munimadrid.es/informo/tmadrid/tmadrid.php

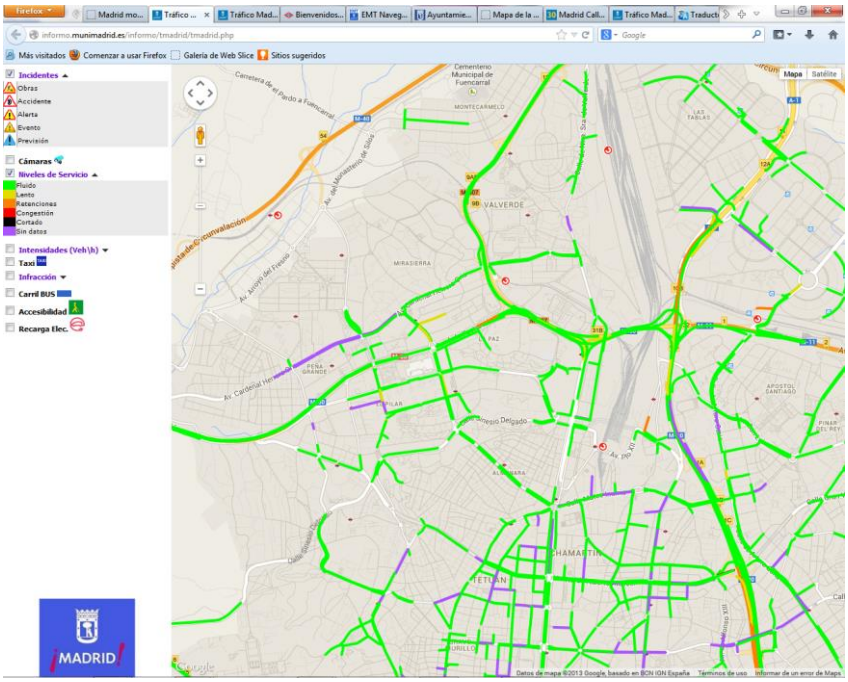

Figure 50 - Madrid Mobility Web Site

On the other hand, information about Public Bus Transport is provided in EMT web site: http://www.emtmadrid.es/mapaweb/emt.html) is shown in following figure:

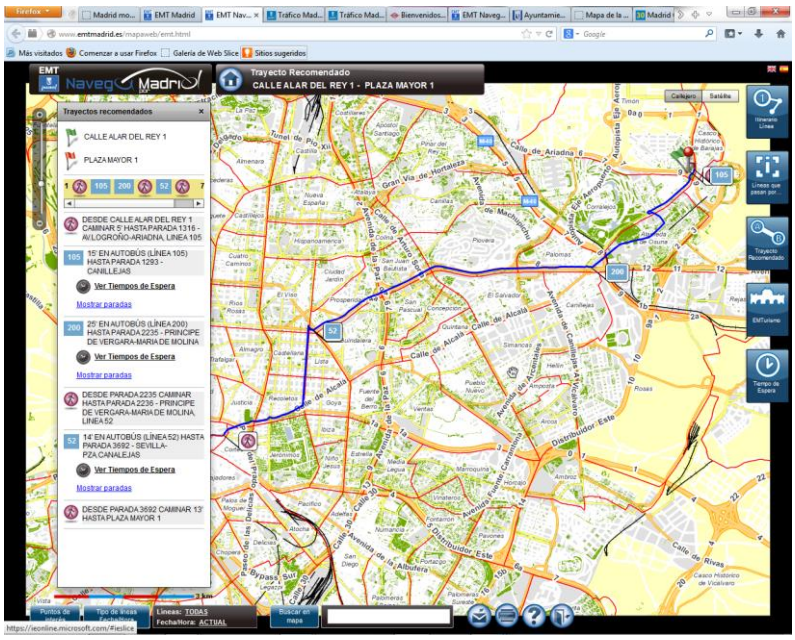

Figure 51 - EMT Mobility Web Site

All the aforementioned information could be accessible to MoveUs but it is necessary to transform it into an Open Data approach (in a similar way described on section 3.3.2.1.2 Open Data from EMT).

A2.2.1.5 Smart Crossing

SAFECROSS is a Smart Crossing System designed to improve safety at traffic-light-controlled pedestrian crossings for all pedestrians, especially those with reduced mobility

The system has the following basic features:

- Detection of pedestrians using the crossing by an artificial vision Camera.
- Green pedestrian phase-extension algorithm able to decide to extend the time for pedestrian crossing in the traffic light.

So, if the camera detects anyone still using the crossing when it is reaching the end of the pedestrians' green phase (minimum time), the time is extended by the traffic light controller until the pedestrian has crossed to the other side or until it reaches a pre-set value of time.

This feature is enabled when the pedestrian light turns green.

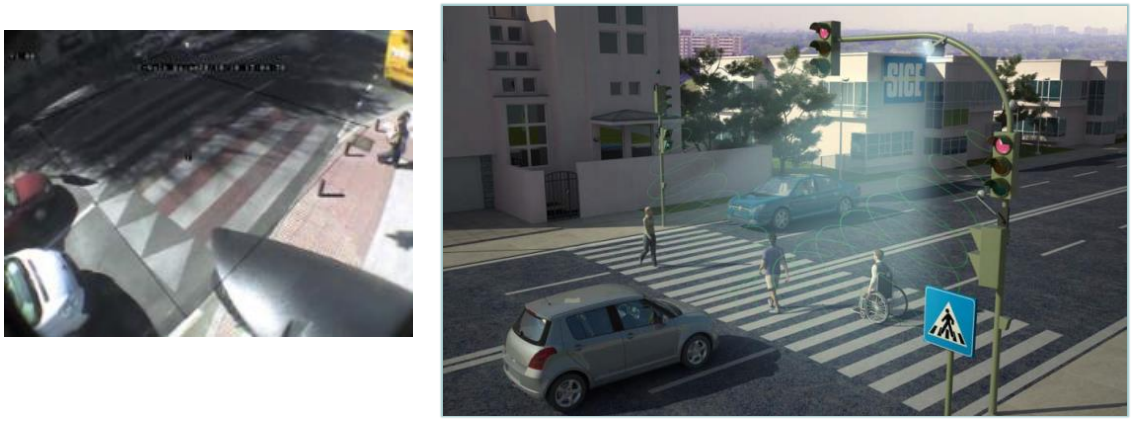

Figure 52 – Safecross System

A2.2.1.6 Bluetooth M2M network

A local Bluetooth sensor network has been installed to provide real travel time information (RTTI). The Bluetooth sensors have been installed along a road section of 2,4 km in Andalucia Avenue in Madrid.

Each Sensor is able to detect the Bluetooth devices on the passing vehicles; the sensor timestamps the Mac ID and communicates this information to the ITTS Backend over wireless.

The network uses the available private wireless data service provided by Telefonica operator (M2M network).

Data received from sensors must be cleaned and processed through RTTI algorithms (SICE is currently working on them), to calculate travel times with a high degree of accuracy and reliability.

A2.2.1.7 Bus fleet management system (EMT-SAE)

The EMT-SAE system is an Execution Support System, a fully functional solution that works in real time. There are several ways in which EMT-SAE meets its operational objectives about:

- **General Planning**: Network, Offer, Schedule, etc…
- **Operational Planning**: Resources, Buses, Drivers, etc…
- **Operational Management**: Bus fleet management optimization.
- **Improving Payment Systems**: Intelligent ticketing, contact-less solutions, etc…
- **Customer Information**: Before, during and after the service provision
- **Information Analyzing**: Improving General and Operational Planning.

The **General Planning Module** allows:

- to define routes, bus stops, information panels, and the whole network over a geographical projection system.
- to define the theoretical schedule (Offered Service) taking into account all the input data and restrictions.
- to define drivers and vehicles every day.

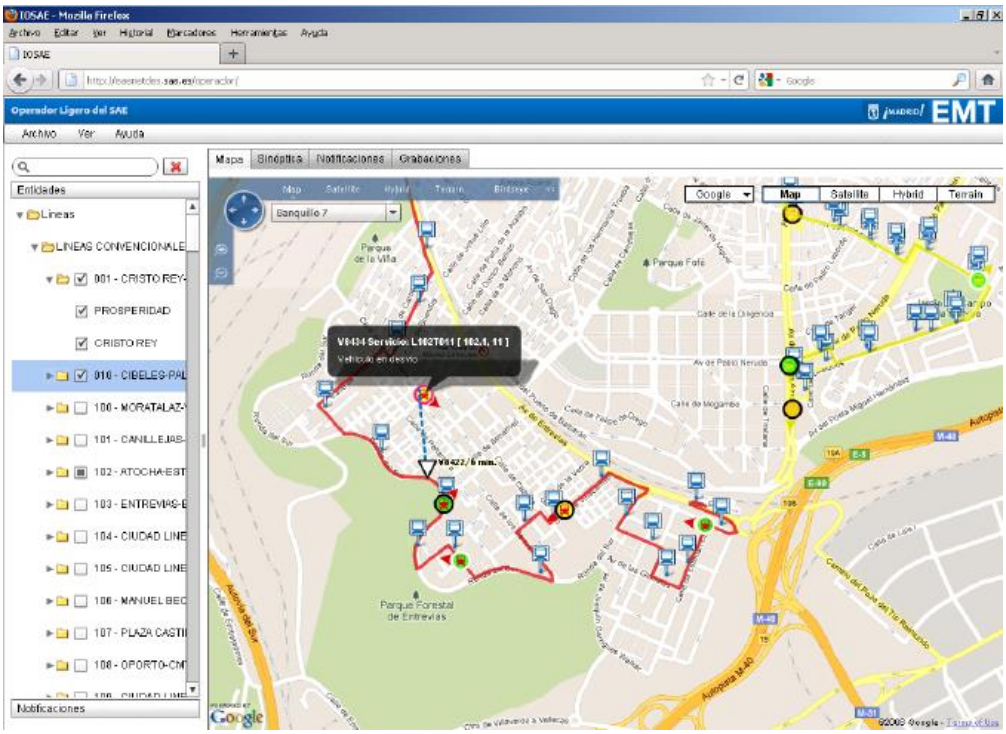

Figure 53 - Screen from General Planning module

The **Operational Management Module** functionalities allow:

- monitoring the situation of the fleet, in real time thanks to the on board units (OBUs) embedded in the buses.

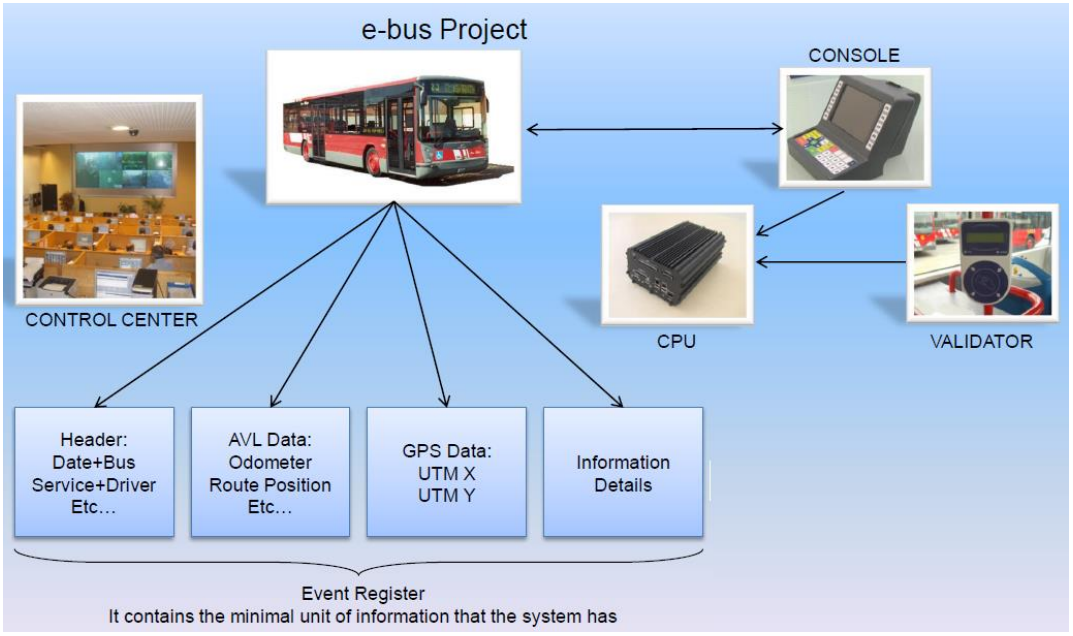

Figure 54 - Architecture of On-Board Unit (OBU)

The **Payment System Module** incorporates some payment devices as Magnetic Edmonson ticket and Contact Less Smart Card Tickets

The **Customer Information Module** provides different channels to support citizen information as Panels at bus stops, Panel inside the buses, Web Page, Acoustic Information and mobile systems (SMS messaging, App)

The **Information analysis Module** provides different internal and management reports on Quality of Service (QoS), Statistic Data and later knowledge of specific events like claims or sanctions.

A2.2.1.8 Open Data from EMT

EMT is providing an Open Data Platform on this URL http://www.emtmadrid.es/movilidad20/opendata.aspx ; therefore, some services are provided after the signature of an agreement of use.

Figure 55 - Access to EMT Open Data form.

An example of a service that is published is provided below:

GetNodesLines

Recupera todos los identificadores de parada, junto con su coordenada UTM, nombre y la relación de líneas/sentido que pasan por cada uno de ellos.

DECLARACIÓN DE LOS PARÁMETROS DE ENTRADA

```
POST /bus/servicebus.asmx HTTP/1.1
Host: servicios.emtmadrid.es
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://tempuri.org/GetNodesLines"

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <GetNodesLines xmlns="http://tempuri.org/">
      <idClient>string</idClient>
      <PassKey>string</PassKey>
      <Nodes>string</Nodes>
    </GetNodesLines>
  </soap:Body>
</soap:Envelope>
```

DESCRIPCIÓN DE LOS PARÁMETROS DE ENTRADA

idClient: Obligatorio. Código de cliente autorizado para la operación y suministrado por EMT

PassKey: Obligatorio. Código de clave asociado al cliente.

Nodes: (Opcional), El valor de una parada de EMT solicitada o de todas, en el caso de que el parámetro quede vacío

DECLARACIÓN DE LOS DATOS DE SALIDA

Devuelve una estructura XML con las paradas solicitadas, sus coordenadas UTM, nombre y líneas que paran en ella.

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <GetNodesLinesResponse xmlns="http://tempuri.org/">
      <GetNodesLinesResult>xml</GetNodesLinesResult>
    </GetNodesLinesResponse>
  </soap:Body>
</soap:Envelope>
```

DESCRIPCIÓN DE LOS PARÁMETROS DE SALIDA

Node: Número de parada EMT

PosxNode: Coordenada UTM X.

PosyNode: Coordenada UTM Y

Name: Nombre de la parada

Lines: Relación de las líneas que, en algún momento del día o tipo de día tienen parada allí. Se compone de grupos de valores separados por un slash (/). La primera parte es el número de línea EMT. La segunda parte es el sentido de viaje (1.- Ida 2.- Vuelta)

EJEMPLO DE RESULTADO DE DATOS:

```
<TABLA>
<RESULTADO>0</RESULTADO>
<DESCRIPCION>Resultado de la operacion Correcta</DESCRIPCION>
-
<REG>
<Node>500</Node>
<PosxNode>443486</PosxNode>
<PosyNode>4480695</PosyNode>
<Name>ARTURO SORIA-ELADIO LOPEZ VILCHES</Name>
<Lines>7/2 29/2 107/2 </Lines>
```

A2.2.2 Communication networks

Description	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Metropolitan fiber networks		Available	Metropolitan Area		ONO Telefónica	Available		Subscription	None
Urban fiber networks		Available	Urban area		ONO Telefónica	Available		Subscription	None
Mobile Operators		Available	Complete Coverage		Telefónica Vodafone, 3, Orange	Available		Subscription	None
WiFi networks	Various	Available	Various		EMT GOWEX	Available		Free	None
WiMax networks									
Tetra networks		Available			Emergency	Not Available			
Private radio networks (i.e. police networks)		Available	Various		Polizia/Carabinieri, Taxis, Emergency Serv. EMT	Available only EMT			

A2.2.3 Deployed software tools and information sources

Enumeration of the different software tools and information sources deployed on the different Systems ("an ITS Area is implemented by a System").

When the same element is used under exactly the same constraints and parameterization on several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Database containing information about buses		Stops Bus roads Time table Incidents Arrival time	Available	EMT	EMT	EMT	In Electronic format on request	EMT Citizens	Free	None

A2.2.4 Data collection. Inputs

Enumeration of the different inputs managed by the different Systems. When the same input is received under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

The inputs are split between:

- Systems / Devices/Sensors and
- Vehicle identification and position

A2.2.4.1 Systems / Devices / sensors

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints	Accuracy	Frequency (refresh and report)	Measure (units)	Coverage area
TVCC	VEA		Available	EMT	EMT	EMT	Web Service Real Time	EMT		LOPD		Real Time		Madrid City
Public Transportation management (AVL)	SAE		Available	EMT	EMT	EMT	Web Service Real Time	EMT		LOPD		20 Seconds		Madrid City

A2.2.4.2 Vehicle identification

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints	Frequency (refresh and report)
Fleets already equipped with OBUs	e-bus	Approx 2.000 Vehicles	available	Various		EMT	Available	EMT	Free		

A2.2.5 Outputs

Enumeration of the different output channels managed by the different systems. When the same output is used under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Centralized Control	PCC		Available	EMT	EMT	EMT	Free	EMT	Free	
Call centers	OAC		Available	EMT	EMT	EMT	Free	EMT	Free	
Info-mobility web sites	Navega X Madrid		Available	EMT	EMT	EMT	Free	EMT	Free	
Info-mobility apps	App Android, IOS		Available	EMT	EMT	EMT	Free	EMT	Free	
Info-mobility points	SAM PMV's		Available	EMT	EMT	EMT	Free	EMT	Free	

A2.2.6 Personal devices

Analysis of the diffusion of personal devices, which are interacting with the above described systems, subsystems and components.

Description	Diffusion (% of population)	Sales in the last year (units)	Sales in the last year (percentage of sales)
Smartphones			
Tablet			
PDA (do they still exist?)			
Mobile phones without data connection			
Lap Top			
In-car navigator (factory installed)			

A2.3 Tampere

A2.3.1 Communication networks

Description	Parameters	Current status	Physical Location	Server location IP Address	Owner	Technical Conditions	User	Economic Conditions	Constraints
Metropolitan fiber networks		Available in Parts of Tampere Region	Available in Tampere Area		City of Tampere and Operators (Sonera, Elisa)	Working		Subsciption and monthly payment	None
Urban fiber networks		Available in Parts of Tampere	Available in City Centrum		City of Tampere and Operators (Sonera, Elisa)	Working		Subsciption and monthly payment	None
Mobile Operators		Available	Everywhere		Operators (Sonera, Elisa)	Working		Monthly payment	None
WiFi networks		Available, not everywhere	Various in City Centrum		City of Tampere	Working		Free of charge	None
WiMax networks		Not in Public use							
Tetra		Not in Public use							

networks									
Private radio networks (i.e. police networks)		Available, not in Public Use							
Dedicated Short Range Communication (DSRC)		Some							
Other comms networks (specify)		None							

A2.3.2 Deployed software tools and information sources

Enumeration of the different software tools and information sources deployed on the different Systems ("an ITS Area is implemented by a System").

When the same element is used under exactly the same constraints and parameterization on several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Service offering real time and historical information and data about the	Digitraffic	data sources:Travel Time System, automatic measuring	Availability: 200X		http://www.infotripla.fi/digitraffic/english/ind	Digitraffic - service is produced by Infotripla Ltd and Gofore	Data format: XML Standard: tbd		Use is free of charge.	Access given by request. "

traffic on the Finnish main roads. The service is provided by the Finnish Transport Agency, and it is addressed for organisations developing information services or working with traffic management and planning.		devices (LAM) of the Finnish Transport Agency, road weather stations, road surface pictures.			ex.html	Ltd. Maintained by Finnish Road Administration "				
National database which contains precise and accurate data on the location of all roads and streets in Finland as well as their most important physical features (covering a total of 483,000 km or 300,000 miles).	Digiroad	Centre line geometry of the transport network: vehicle-accessible roads, ferry and cable ferry connections, railways, pedestrian routes and cycle routes. Traffic-related attribute data: traffic element attributes, traffic restrictions and other road and street network features.	Availability: 200X. Licence: tbd		Access request: http://www.digiroad.fi/hyodyntaminen/en_GB/ordering/	Maintenance: Finnish Transport Agency	Data formats: ESRI, XML Standard: tbd		Digiroad customers are charged extraction costs.	Access given by request

		Other transport system objects, e.g. services.								
Monitor Tampere bus traffic in real time and view predicted bus arrival times on stops.	Lissu Traffic Monitor		Available		http://lissu.tampere.fi				Free of charge	Logging enables saving own stops."
Routing services with turn-by-turn navigation, supporting cyclists and public transport passengers	City Navigator		Available		http://dev.itsfactory.fi/citynav			Any. Services provided: Trip planning Mobile version.	Free of charge	Data scope: Helsinki & Tampere regions.
Recommendations on the best public transport connection to your destination within city traffic	Repa Reittiopas		Available		http://reittiopas.tampere.fi			Any. Services provided: Bus trip planning Mobile version.	Free of charge	Data scope Tampere bus traffic, including some bus lines in Kangasala, Ylöjärvi, Pirkkala and Nokia
Seeking the best cycling route to user-defined points of interest in the Tampere Metropolitan area.	Journey Planner for Cycling		Available		http://kevytliikenne.tampere.fi/			Any. Services provided: Cycling and pedestrian routing Points of interest search Destinations added by users.	Free of charge	"Data scope Tampere and surroundings."

A2.3.3 Data collection. Inputs

Enumeration of the different inputs managed by the different Systems. When the same input is received under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

The inputs are split between:

- Systems / Devices/Sensors and
- Vehicle identification and position

A2.3.3.1 Systems / Devices / sensors

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints	Accuracy	Frequency (refresh and report)	Measure (units)	Coverage area
Monitoring vehicles travel times on certain road stretches.	Travel Time System		Available		http://www.infotripla.fi/digitraffic/english/index.html		Camera technology and automatic licence plate recognisation (ALPR) method.					real time		Coverage area map: http://www.infotripla.fi/digitraffic/images/map.jpg. 3300 km (divided to more than 300 links) of Finnish main road and congested road

														stretches around the biggest cities. Also the most important roads leading to Russian border in south-east Finland are covered.
Monitoring traffic amounts and speeds by the induction loops embedded in the road surface.	Automatic measuring devices (LAM)		Available		http://www.infotripla.fi/digitraffic/english/index.html	Finnish Transport Agency						real time		250 RT automatic measuring devices in Finland, all connected to Digitraffic.
Monitoring ordinary weather conditions	Road weather stations	temperature of air, relative moisture, dew point temperature, rain, wind etc	Available		http://www.infotripla.fi/digitraffic/english/index.html							The road weather information is usually updated 3-6 times in an hour, when temperature is near the zero, the information will be		350 road weather stations.

												updated more often.		
Monitoring the state of the road surface	Special sensors for the state of the road		Available		http://www.infotripla.fi/digitraffic/english/index.html									
Weather Picture delivery	Weather Camera		Available		http://www.infotripla.fi/digitraffic/english/index.html							real time		
Real-time status information of road weather cameras	Weather Camera		Available		http://www.infotripla.fi/digitraffic/english/index.html							real time		
Monitoring Tampere bus traffic.	Tampere bus traffic SIRI interface	RT machine to machine	Availability: Since P6/2013		https://siri.ij2010.tampere.fi/ws	Maintenance: Tampere City Public Transport Licence: Tampere City Open Data License	RT machine to machine. Data format: XML Standard: SIRI.		Access constraints Access given by request. Use is free of charge. Distribution and re-use of the data is allowed.	Only for server-to-server connections allowed.		real time		Available SIRI services: Vehicle Monitoring (VM), Stop Monitoring (SM), General Messaging (GM)
Monitoring Tampere bus traffic.	Tampere bus traffic SIRI interface		Availability: P9/2013		http://data.itsfactory.fi/siriacces	Maintainance: ITS Factory (dev-	Data formats: XML and		Access is open for anyone during beta			real time		Available SIRI services: Vehicle

	(RT JSON)				s/vm/json	support@itsfactory.fi) Licence: Tampere City Open Data License"	JSON Standard: SIRI.		phase, after beta phase access is given by request. Use is free of charge. Distribution and re-use of the data is allowed.					Monitoring (VM), Stop Monitoring (SM), General Messaging (GM). Remark: This API is a JSON modification of the SIRI 1.3 standard. Officially the JSON extension will be part of the SIRI 2.0 version of the standard, but that is not yet approved.
Monitoring Tampere bus traffic.	Tampere bus traffic SIRI interface (RT XML)		Availability: P9/2013		http://178.217.134.37:8080/siriaccess/vm/rest		Data formats: XML and JSON. Standard: SIRI.					real time		Please note that the url is still subject to change since the service is in beta (a domain name will be added

														later on).SIRI XML Access: http://178.217.134.37:8080/siriaccess/vm/siri (please note that this url accepts HTTP POST requests and therefore does not open up in the browser)
Tampere bus timetables	Tampere Public Transport SIRI Interface (Static)		Available			Maintainance: Tampere City Public Transport/ Infotripla Oy Licence: Tampere City Open Data License/ITS Factory	Data format: XML Standard: SIRI		Access given by all ITS Factory wiki users. Use is free of charge. Distribution and re-use of the data is allowed.	only server to server access is allowed				

Tampere Journey Planner	Tampere Reittiopas API	Bus stops geocoding Points of interest (POI) geocoding Reverse geocoding of bus stops and POIs Routing between two points Search for the bus stop's timetable	Availability: 9/2012		API access http://api.publictransport.tampere.fi/prod/ Access request http://developer.publictransport.tampere.fi/pages/en/account-request.php	Maintenance: Tampere City Public Transport Licence: Tampere City Open Data License	Data format: XML/JSON Standard: -		Access given by request. Use is free of charge. Distribution and re-use of the data is allowed.	Due to limited service capacity, queries of one account are limited to max. 5000 weighted query in one hour.				

A2.3.3.2 Vehicle identification

Not available

A2.3.4 Outputs

Enumeration of the different output channels managed by the different systems. When the same output is used under exactly the same constraints and parameterization by several systems, the attribute "System" will register their names separated by "/"; otherwise, different rows will be reported.

Description	System	Parameters	Current status	Physical Location	Server location	Owner	Technical Conditions	User	Economic Conditions	Constraints
Centralized Control	Digitraffic									
Call centers										
Info-mobility web sites	Lissu Traffic monitor / City Navigator / Repa Reittiopas / Journey Planner Cycling									
Info-mobility apps	Lissu Traffic monitor / City Navigator / Repa Reittiopas / Journey Planner Cycling									
Info-mobility points										

A2.3.5 Personal devices

Analysis of the diffusion of personal devices, which are interacting with the above described systems, subsystems and components.

Description	Diffusion (% of HOUSEHOLDS)[18]	Sales in the last year (units)	Sales in the last year (percentage of sales)
Smartphones	46		
Tablet	10		
PDA (do they still exist?)			
Mobile phones without data connection			
Lap Top	73		
In-car navigator (factory installed)	32		

[18] Data available at: http://www.stat.fi/tup/suoluk/suoluk_tiede_en.html (2012 data - % of households, not population)

A3. Annex 3: Detailed inventory of the existing Datasets in the pilot cities

A3.1 Madrid

Traffic Management	DATAset #1 TMIS and SCADA (source: SICTRAM system)	DATAset #2 Urban Traffic Control System (source: ADIMOT system)
Brand name	SICTRAM	ADIMOT: ADaptIve Multialgorithmic Optimisation Technique
Content	Data obtained: Cycle, Split, Offset on each local controller; Intensity and Occupancy from detectors Intensity and Occupancy calculated for PMs. Traffic level service is calculated Incident information on GIS. CCTV monitoring Data published: Level of service Incident information on GIS CCTV images	ADIMOT is a centralized control system for city traffic, based on the Multi-Algorithmic concept that supports the Self-adaptive strategy. Data obtained: Cycle, Split, Offset on each local controller; Intensity and Occupancy from detectors Intensity and Occupancy calculated for PMs. Time to red (in case of fixed plans) Queue estimation (the queue length), saturation flow, cyclic profiles, levels of service (of traffic flow) Data published: Level of service
Physical location	DGM-Municipal Control Centre	Local and Master controllers, located at the road network; DGM-Municipal Control Centre
Physical DATA format	XML	XML
Server location	DGM-Municipal Control Centre	DGM-Municipal Control Centre
DATA Owner	Madrid City Council - Area of Mobility (MAD partner)	Madrid City Council - Area of Mobility (MAD partner)
DATA Provider	Madrid City Council - Area of Mobility (MAD partner)	Madrid City Council - Area of Mobility (MAD partner)

Standards	Proprietary protocols	Proprietary protocols
DATA Users	Both; Private - MAD for traffic operation; Public - citizen through Madrid Mobility web site (see Traveler Journey Assist. table)	Both; Private - MAD/SICE for traffic operation; Public - citizen through Madrid Mobility web site (see Traveler Journey Assist. table)
DATA export	web services	web services
Geographic coverage	Urban street network and M30 highway in Madrid	Urban street network in Madrid
Update cycle	Minutes	Minutes
Other relevant DATA attributes	Location of measurement equipment along the urban traffic network and M30 highway	Location of traffic lights and traffic controllers at each regulated crossing
Types of communication channels	Web site (http://informo.munimadrid.es/informo/tmadrid/tmadrid.php) where data are displayed on google maps; Traffic light state: red-orange-green (both for pedestrians and for drivers); Variable Message Signs that inform of the times necessary to reach the nearest exit and publish traffic warnigns (congestion, accidents, road works, closed roads, other events, etc.).	Web site (http://informo.munimadrid.es/informo/tmadrid/tmadrid.php) where data are displayed on google maps Traffic light state: red-orange-green (both for pedestrians and for drivers)
End user device/Media	laptop	laptop
Type of output	Maps on Google Maps, Text and graphics on VMS panels, animations in traffic lights.	Colored animation (red-green state of traffic light) for both pedestrians and drivers
Pricing Model	The information published is free	The information published is free
Usage restrictions	The information published don't have any constraints to the use	The information published don't have any constraints to the use

Traffic Management	**DATAset #3 Highway SCADA (source: M30 SCA)**	**DATAset #4 CCTV data sets**
Brand name	M30 Accesses Surveillance and Control System (SCA)	CCTV
Content	Data obtained: Traffic data from urban highway:	Data obtained: video streaming; Data published: images (snapshots)

	Intensity (veh/h), Occupancy (%), Velocity (km/h), vehicle counting, Distance between vehicles (m), type of vehicle (light, heavy); data measured from the main carriageway of the highway (data per lane and per carriageway) and from specific secondary lanes, main on- ramps and main off-ramps. Data published: Traffic conditions - Service level, Speed, Traffic jam alarm; Weather conditions - Rain, Fog, Snow; Other - Road works, Closed roads. Information is provided through the dynamic signaling equipment in variable message panels installed in the street.	
Physical location	Data acquisition station, where data are available for a limited period of time; data stations communicate data to the Traffic control centre (DGM-Municipal Control Centre) servers for processing and permanent storing	Cameras are located at specific points of interest along the urban street network and M30 highway and communicate data to the control centre (DGM-Municipal Control Centre)
Physical DATA format	XML	XML
Server location	DGM-Municipal Control Centre	DGM-Municipal Control Centre
DATA Owner	Madrid City Council - Area of Mobility (MAD partner)	Madrid City Council - Area of Mobility (MAD partner)
DATA Provider	Madrid City Council - Area of Mobility (MAD partner)	Madrid City Council - Area of Mobility (MAD partner)
Standards	Proprietary protocols	Proprietary protocols
DATA Users	Both; Private - MAD/SICE for traffic operation; Public - citizen through Madrid Mobility web site (see Traveler Journey Assist. table)	Both; Private - MAD/SICE for traffic operation; Public - citizen through Madrid Mobility web site (see Traveler Journey Assist. table)
DATA export	web services	web services
Geographic coverage	M30 Urban Highway surrounding the centre of Madrid City, specific service lanes and main on-ramps and off-ramps	M30 Urban Highway surrounding the centre of Madrid City, specific service lanes and main on-ramps and off-ramps
Update cycle	Minutes	Minutes

Other relevant DATA attributes	Location of data measured at the highway is identified by alpha-numeric code indicating km and direction of flow.	Description of location of cameras (street, zone or place of reference)
Types of communication channels	Web site (http://informo.munimadrid.es/informo/tmadrid/tmadrid.php) where data are displayed on google maps. Variable Message Signs that inform of the times necessary to reach the nearest exit and publish traffic warnigns (congestion, accidents, road works, closed roads, other events, etc.).	Web site (http://informo.munimadrid.es/informo/tmadrid/tmadrid.php) where snapshots are displayed with information about the location of the image, time and date of snapshot taken.
End user device/Media	laptop	laptop
Type of output	Maps; text on VMS panels supported by icons representing the incidents	Snapshots
Pricing Model	The information published is free	The information published is free
Usage restrictions	The information published don't have any constraints to the use	The information published don't have any constraints to the use

Emergency Notification & Response	**DATAset #1**
Brand name	NR / NA

Public Transport Management	**DATAset #1**	**DATAset #2**	**DATAset #3**
Brand name	Stops	Bus Routes	Bus Lines
Content	Set of bus stops of EMT public buses network	Set of bus routes of EMT public buses network; general description.	Detailed description of each bus line
Physical location	EMT Madrid Server	EMT Madrid Server	EMT Madrid Server
Physical DATA format	XML	XML	XML
Server location	https://servicios.emtma	https://servicios.emtmadrid.es:8443/geo/servi	https://servicios.emtmadrid.es:8443/geo/ser

	drid.es:8443/geo/servicegeo.asmx	cegeo.asmx	vicegeo.asmx
DATA Owner	EMT Madrid. Avalaible	EMT Madrid. Avalaible	EMT Madrid. Avalaible
DATA Provider	EMT Madrid	EMT Madrid	EMT Madrid
Standards	None	None	None
DATA Users	Both	Both	Both
DATA export	Web service	Web service	Web service
Geographic coverage	Madrid City	Madrid City	Madrid City
Update cycle	daily	daily	daily
Other relevant DATA attributes	point, UTM		point, UTM
Types of communication channels	network	network	network
End user device/Media	smartphone, laptop, etc.	smartphone, laptop, etc.	smartphone, laptop, etc.
Type of output	XML	XML	XML
Pricing Model	free	free	free
Usage restrictions	free	free	free

Traveler Journey Assistant	**DATAset #1 Madrid Mobility web site**
Brand name	2. Muevete por Madrid http://www.muevetepormadrid.es/
Content	Information about different transport modes in Madrid: - links to different Web sites including walking, biking, metro, public bus, train, taxi, motorcycle and car modes of transport. Walking: routes, maps, points of interest including urban parks, calories

	consumption calculator; Biking: recommended routes, routes maps with altitude profiles, bike parking zones, biking lanes, public bike hiring service information; Public bus: routing, bus lines information and maps and navigator (EMT information provider), routing and interurban public buses lines information in Madrid Region and airport bus line and maps, traveler tickets and price, information about transporting bikes on the bus; Metro: routing, lines information and maps, traveler tickets and price, information about transporting bikes on metro; Train: routing, lines information and maps, traveler tickets and price, information about transporting bikes on train; Taxi: taxi stops information and maps, fares and zones, taxi services, lost objects service, etc. Motorcycle: motorcycle web site (http://www.infobicimadrid.es/motos/gis_motos.htm) with information on google maps about parking reservation spaces, touristic information and places of interest to visit on motorcycle, residential priority zones, places where motorcycles are placed in first line before a traffic light, etc. Vehicle: maps with information of traffic: levels of service, intensity levels, accidents, works, closed roads, location of cameras and snapshots, location of taxi stops, only-bus lanes, electric vehicles charging points, etc., parking facilities information on location and services, both on-street and off-street, including car-sharing, etc.
Physical location	Madrid Mobility Area servers;
Physical DATA format	XML
Server location	DGM-Municipal Control Centre
DATA Owner	Madrid City Council Mobility Area; free use.
DATA Provider	Madrid Mobility Area; conditions of use are restricted by the Municipality
Standards	Proprietary protocols
DATA Users	Public and Private
DATA export	Web services
Geographic coverage	The city of Madrid
Update cycle	Minutes
Other relevant DATA attributes	Information displayed on Google Maps
Types of communication	on-line web site

channels	
End user device/Media	Laptop
Type of output	Maps, text, graphics, video, audio…
Pricing Model	Free
Usage restrictions	None

Traveler Journey Assistant	**DATAset #2 TRAFICO app**
Brand name	TRAFICO app
Content	It is an application for smartphone (Android); - Real time state of the traffic; the state of the traffic is represented by levels of service and displayed in different colors over a Google map. - Images of traffic taken from CCTV traffic surveillance cameras: a list of cameras is displayed in the screen and the user can select the camera from which he wants to see the image of the traffic. - Incidents in traffic: different kinds of incidents can be displayed to the user, represented over google maps, like works, accidents, alerts, events, etc. - Mobility information of relevance: access to information about different modes of transport in the city is provided, like taxi, bike hiring, loading-unloading zones, electric vehicle charging zones, radars, bus lanes, mobility for impaired people, etc. - Visualization of routes and zones in the city: a list of pre-configured set of routes and main zones of the city is displayed to the user that can visualize the route or zone selected through the images taken by the CCTV system. The user is able to see the whole route in images and get information about it and the effect of possible incidents in it.
Physical location	Google Maps servers, Madrid Mobility servers;
Physical DATA format	XML
Server location	DGM-Municipality Control Centre
DATA Owner	Madrid Mobility Area; free use.
DATA Provider	Madrid Mobility Area; conditions of use are restricted by the Municipality
Standards	Proprietary protocols
DATA Users	Public and Private

DATA export	Web services
Geographic coverage	The city of Madrid
Update cycle	Minutes
Other relevant DATA attributes	Information displayed on Google Maps
Types of communication channels	on-line web site
End user device/Media	Laptop
Type of output	Maps, text, graphics, video, audio…
Pricing Model	Free
Usage restrictions	None

Traveler Journey Assistant	**DATAset #3 Air quality network in Madrid web site**
Brand name	The quality of air in Madrid city
Content	The air of Madrid wweb site and smartphone application allows users to know, in real time, the air quality of the City of Madrid. Information is disseminated through the quality indexes that let the user know, in a clearly, directly and quickly way, the quality of the air breathed. For each pollutant, information is also spread through the numerical data recorded at each measuring point. This tool is updated hourly, with data provided by the monitoring system of air quality of the City of Madrid.
Physical location	Madrid City Council servers
Physical DATA format	Unknown
Server location	Madrid City Council Environment Area
DATA Owner	Madrid City Council; free use.
DATA Provider	Madrid City Council; conditions of use are restricted by the Municipality
Standards	Proprietary protocols
DATA Users	Public and Private
DATA export	Excel files (tables of data)
Geographic coverage	The city of Madrid
Update cycle	Hourly updated

Other relevant DATA attributes	The information can be displayed on google maps.
Types of communication channels	Mobile (smartphone application for Android) and on-line on web site
End user device/Media	Smartphone (Android), laptop
Type of output	Maps, files
Pricing Model	Free
Usage restrictions	None

Traveler Journey Assistant	**DATAset #4 Traveler Journey Assistant from EMT**	**DATAset #5 Traveler Journey Assistant from EMT**
Brand name	Route calculation	Bus stops nearby
Content	Algorithm that plans traveller journey based on origin and destiny points.	Considering an UTM coordinated point as a base (central point), the tool offers the user information about the bus stops included in a surrounding limited area
Physical location	EMT Madrid Server	EMT Madrid Server
Physical DATA format	XML	XML
Server location	https://servicios.emtmadrid.es:8443/GetGeoRutaCalleDMZ/servicegeo.asmx	https://servicios.emtmadrid.es:8443/geo/servicegeo.asmx
DATA Owner	EMT Madrid. Avalaible	EMT Madrid. Avalaible
DATA Provider	EMT Madrid	EMT Madrid
Standards	None	None
DATA Users	Both	Both
DATA export	Web service	Web service
Geographic coverage	Madrid City	Madrid City
Update cycle	daily	daily
Other relevant DATA attributes	point, UTM	point, UTM

Types of communication channels	network	network
End user device/Media	smartphone, laptop, etc.	smartphone, laptop, etc.
Type of output	XML	XML
Pricing Model	free	free
Usage restrictions	free	free

Electronic Fee Collection	**DATAset #1**
Brand name	NR / NA

In Vehicle System	**DATAset #1**
Brand name	Time to bus arrival
Content	It estimates the time to arrival of the bus in a bus station
Physical location	EMT Madrid Server
Physical DATA format	XML
Server location	https://servicios.emtmadrid.es:8443/geo/servicegeo.asmx
DATA Owner	EMT Madrid. Available
DATA Provider	EMT Madrid
Standards	None
DATA Users	Both
DATA export	Web service
Geographic coverage	Madrid City
Update cycle	daily
Other relevant DATA attributes	point, UTM
Types of communication	network

channels	
End user device/Media	smartphone, laptop, etc.
Type of output	XML
Pricing Model	free
Usage restrictions	free

Law Enforcement	**DATAset #1**
Brand name	NR / NA

Communications	**DATAset #1**
Brand name	NR / NA

Demography & Economics	**DATAset #1**
Brand name	NR / NA

Tourism	**DATAset #1**
Brand name	NA

Business	**DATAset #1**
Brand name	NA

Crowd Sourced Data	**DATAset #1**
Brand name	NA

A3.2 Genoa

Traffic Mgmt	DATAset #1	DATAset #2	DATAset #3
Brand name	Traffic Alerts and Events	Webcam	Traffic level sensors
Content	Traffic message (real time and scheduled) including measures and travel times	Geo Position (Lat, Long) of 40 Traffic Webcams (with resolution 352 × 288).	More than 2000 field sensors to measure the traffic level
Physical location			
Physical DATA format	JSON - Webservice REST emiXer build on Windows Communication Foundation	JSON - Webservice REST emiXer build on Windows Communication Foundation	JSON - Webservice REST emiXer build on Windows Communication Foundation
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
DATA Provider	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
Standards			
DATA Users	Public	Public	Public
DATA export	/	/	/
Geographic coverage	city	city	city
Update cycle	5 minutes	5 minutes	5 minutes
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	land networks	land networks, GPRS, EDGE	land networks, GPRS, EDGE
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	image	Text
Pricing Model	free	free	Free
Usage restrictions			

Traffic Mgmt	DATAset #4	DATAset #5	DATAset #6
Brand name	Dynamic Park Information (Infopark)	Road Works (Monica)	Video Message System (VMS)
Content	Infopark is dedicated software to the supervision of occupancy of parking lots. The system manages 16 parking spaces and 16 poles indicator of the state where parking on each pole shows the status of one or more parking spaces, with special panels dedicated information.	Monica reports when part of the roads has to be occupied for work relating to the road, most often in the case of road surface repairs.	Variable message panels managenment system.
Physical location			
Physical DATA format	JSON - Webservice REST emiXer build on Windows Communication Foundation	GEOJSON - Webservice REST build on Geoserver	JSON - Webservice REST emiXer build on Windows Communication Foundation
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
DATA Provider	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
Standards			
DATA Users	Public	Public	Public

DATA export	/	/	/
Geographic coverage	city	city	city
Update cycle	5 minutes	5 minutes	5 minutes
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	land networks, GPRS, EDGE	land networks	land networks, GPRS, EDGE
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text	text	text
Pricing Model	free	free	free
Usage restrictions			

Emergency N&R	DATAset #1	DATAset #2	DATAset #3
Brand name	Pollution Sensors	Road Wheater Information	FloodAlert Sensor
Content	The acquisition of data about pollutant emissions is achieved with monitoring stations. SO2, CO, O3, NO2, C6H6, PM10.	The Wheater Station System developed in collaboration with Civil protection can export a series of detailed informations about the temperature, the humidity level, and weather in general, for more than twenty areas of the Municipality.	The sensors are based on ultra-sound principles. This monitoring allows to prevent any floodings.
Physical location			
Physical DATA format	JSON - Webservice REST emiXer build on Windows Communication Foundation	GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Province of Genoa	Civil Protection	Civil Protection
DATA Provider	Province of Genoa	Civil Protection	Civil Protection
Standards			
DATA Users	Public	Public	Public
DATA export	/	/	/
Geographic coverage	city	city	city
Update cycle	1 day	5 minutes	5 minutes

Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	GPRS, EDGE	GPRS, EDGE, LAN	GPRS, EDGE
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text,map	text,map
Pricing Model	free	free	free
Usage restrictions			

Emergency N&R	DATAset #4	DATAset #5
Brand name	Mapdata	Hospital Locations
Content	GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. Being a community-driven project, GeoServer is developed, tested, and supported by a diverse group of individuals and organizations from around the world. GeoServer can create maps in a variety of output formats. OpenLayers, a free mapping library, is integrated into GeoServer, making map generation quick and easy. GeoServer is built on Geotools, an open source Java GIS toolkit. The municipality of Genoa has implemented a Geoserver solution to handle some geo-data related to safety (Civil Protection, Industrial Areas, Public Works, Safety).	Geo Position (Lat, Long) of Hospital
Physical location		
Physical DATA format	GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS). GeoServer forms a core component of the Geospatial Web. GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa	Municipality of Genoa
DATA Provider	Municipality of Genoa	Municipality of Genoa
Standards		

DATA Users	Public	Public
DATA export	/	/
Geographic coverage	city	city
Update cycle	5 minutes	/
Other relevant DATA attributes	point, 2D, 3D,lines, polygon, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	Mobile and Land networks	GPRS, EDGE, land networks
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text,map
Pricing Model	free	free
Usage restrictions		

Public Transport Mgmt	DATAset #1
Brand name	SIMON
Content	SIMON (integrated monitoring system) is the system for monitoring the Fleet provided by AMT SpA, Public Transport operator of the city of Genoa. In detail, SIMON includes: • 750 on-board systems • 1 control and monitoring system comprising 11 stations operator • 102 points of information to users on the ground • 15 computerized kiosks • 5 deposits equipped with short-range communication network for loading and unloading data • 80 intersections with traffic signal priority system functionality.
Physical location	
Physical DATA format	JSON - Webservice REST emiXer build on Windows Communication Foundation
Server location	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	AMT
DATA Provider	AMT

Standards	
DATA Users	Public
DATA export	/
Geographic coverage	city
Update cycle	5 minutes
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	GPRS, EDGE, information kiosks, information screens
End user device/Media	desktop,notebook,tablet,smartphone
Type of output	text,map
Pricing Model	free
Usage restrictions	

Traveller Journey Assistant	DATAset #1	DATAset #2	DATAset #3
Brand name	Bus Station	Train Station	Public Transport Ticket Retails
Content	Geo Position (Lat, Long) of the Bus Station	Geo Position (Lat, Long) of the Train Stations	Geo Position (Lat, Long) of Ticket Retails
Physical location			
Physical DATA format	JSON - Webservice REST emiXer build on Windows Communication Foundation	JSON - Webservice REST emiXer build on Windows Communication Foundation	JSON - Webservice REST emiXer build on Windows Communication Foundation
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	AMT	Municipality of Genoa	AMT
DATA Provider	AMT	Municipality of Genoa	AMT
Standards			
DATA Users	Public	Public	Public
DATA export	/	/	/
Geographic coverage	city	city	city
Update cycle	/	/	/
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)

Types of communication channels	GPRS, EDGE, land networks	GPRS, EDGE, land networks	GPRS, EDGE, land networks
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text,map	text,map
Pricing Model	free	free	free
Usage restrictions			

Traveller Journey Assistant	**DATAset #4**	**DATAset #5**	**DATAset #6**
Brand name	Park and Rest Area	Car & Bike Sharing	Limited Traffic Area
Content	Geo Position (Lat, Long) of Park and Rest Area	Geo Position (Lat, Long) of Car & Bike Sharing	Geo Position (Lat, Long) of Limited Traffic Area
Physical location			
Physical DATA format	GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
DATA Provider	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa

Standards			
DATA Users	Public	Public	Public
DATA export	/	/	/
Geographic coverage	city	city	city
Update cycle	/	/	/
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	GPRS, EDGE, land networks	GPRS, EDGE, land networks	GPRS, EDGE, land networks
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text,map	text,map
Pricing Model	free	free	free
Usage restrictions			

In Vehicle Systems	DATAset #1
Brand name	Floating Car Data
Content	Interface with the Project SI.MO.NE (Vehicles Services Center)
Physical location	
Physical DATA format	DDBB " Traffic - Environment " build on MS SQL Server
Server location	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa
DATA Provider	Municipality of Genoa
Standards	
DATA Users	Public
DATA export	/
Geographic coverage	city
Update cycle	5 minutes (?)
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)
Types of communication channels	GPRS, EDGE

End user device/Media	desktop,notebook,tablet,smartphone
Type of output	text
Pricing Model	free
Usage restrictions	

Communications	DATAset #1	DATAset #2	DATAset #3	DATAset #4
Brand name	FreeWiFiGenova Hotspot	FreeWiFiGenova Registered Users Connector	FreeWiFiGenova Daily Access Connector	FreeWiFiGenova Bandwitdh Connector
Content	Geo Position (Lat, Long) of FreeWiFiGenova Hotspot	Registered Users at milliseconds	Total daily Access and Unique daily access at milliseconds	Total Traffic in Byte at milliseconds
Physical location				
Physical DATA format	GEOJSON - Webservice REST build on Geoserver	JSON	JSON	JSON
Server location	Datasiel (GEN Webfarm), Genoa, Italy	CINECA, ROME, ITALY	CINECA, ROME, ITALY	CINECA, ROME, ITALY
DATA Owner	Municipality of Genoa	CINECA	CINECA	CINECA
DATA Provider	Municipality of Genoa	CINECA	CINECA	CINECA
Standards				
DATA Users	Public	Public	Public	Public
DATA export	/	/	/	/
Geographic coverage	city	city	city	city
Update cycle	/	/	/	/

Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)			
Types of communication channels	GPRS, EDGE, land networks	GPRS, EDGE, land networks	GPRS, EDGE, land networks	GPRS, EDGE, land networks
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text	text	text
Pricing Model	free	free	free	free
Usage restrictions				

Demography & Economics	DATAset #1	DATAset #2	DATAset #3	DATAset #4
Brand name	Schools	Markets	NewsAgents	City Help Desk
Content	Geo Position (Lat, Long) of the Schools	Geo Position (Lat, Long) of the Markets	Geo Position (Lat, Long) of the Markets	Information
Physical location				
Physical DATA format	GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver	GEOJSON - Webservice REST build on Geoserver	WebService SOAP
Server location	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
DATA Provider	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa	Municipality of Genoa
Standards				
DATA Users	Public	Public	Public	Public
DATA export	/	/	/	/
Geographic coverage	city	city	city	city
Update cycle	/	/	/	/
Other relevant DATA attributes	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)	point, 2D, WGS 84 (aka WGS 1984, EPSG:432)

Types of communication channels	GPRS, EDGE, land networks	GPRS, EDGE, land networks	GPRS, EDGE, land networks	land networks
End user device/Media	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone	desktop,notebook,tablet,smartphone
Type of output	text,map	text,map	text,map	text
Pricing Model	free	free	free	free
Usage restrictions				

Tourism	DATAset #1
Brand name	Events' Agenda
Content	Calender of events in the city
Physical location	
Physical DATA format	DDBB MS SQL Server
Server location	Datasiel (GEN Webfarm), Genoa, Italy
DATA Owner	Municipality of Genoa
DATA Provider	Municipality of Genoa
Standards	
DATA Users	Public
DATA export	/
Geographic coverage	city
Update cycle	/
Other relevant DATA attributes	
Types of communication channels	GPRS, EDGE, land networks

End user device/Media	desktop,notebook,tablet,smartphone
Type of output	text
Pricing Model	free
Usage restrictions	

A3.3 Tampere

Traffic Mgmt	DATAset #1	DATAset #2
Brand name		
Content	**Traffic Flow Real time fluency and travel time data** (Fluency classes Travel times Fluency class data from yesterday Average daily fluency class data from the 12 previous weekdays starting from yesterday Current free flow speeds)	**Real time data from automatic measuring devices (point)** (Current free flow speeds)
Physical location		
Physical DATA format	XML. Web Service interfaces. WSDL described at: http://www.infotripla.fi/digitraffic/docs/Digitraffic%20web%20services.pdf	XML. Web Service interfaces. WSDL described at: http://www.infotripla.fi/digitraffic/docs/Digitraffic%20web%20services.pdf http://www.infotripla.fi/digitraffic/english/index.html
Server location	http://www.infotripla.fi/digitraffic/english/index.html	http://www.infotripla.fi/digitraffic/english/index.html
DATA Owner	Infotripla Ltd and Gofore Ltd.	Infotripla Ltd and Gofore Ltd.
DATA Provider	Finnish Transport Agency (FTA)	Finnish Transport Agency (FTA)
Standards		
DATA Users	Private	
DATA export		
Geographic coverage	Coverage area map: http://www.infotripla.fi/digitraffic/images/map.jpg. 3300 km (divided to more than 300 links) of Finnish main road and congested road stretches around the biggest cities. Also the most important roads leading to Russian border in south-east Finland are	250 RT automatic measuring devices in Finland, all connected to Digitraffic.

	covered.	
Update cycle	real time	real time
Other relevant DATA attributes	Travel time XSD available at: http://www.infotripla.fi/digitraffic/docs/staticinformation.xsd. Travel time XML (static) info at: http://www.infotripla.fi/digitraffic/docs/LocationData.XML	More precise description of the interfaces available at: http://www.infotripla.fi/digitraffic/english/utilise.html
Types of communication channels		
End user device/Media	any	
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf

Traffic Mgmt	DATAset #3	DATAset #4
Brand name		
Content	Incident and roadwork information	Traffic Lights static data Locations and metadata
Physical location		
Physical DATA format	At the moment available only by FTP interface. More info available at: http://www.infotripla.fi/digitraffic/docs/FTA_ftp-server_guide.pdf	JSON, GML2, GML32, SHAPE-ZIP, CSV, WFS
Server location	http://www.infotripla.fi/digitraffic/english/index.html	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=52&alasivu=1&vapaasana=
DATA Owner	Infotripla Ltd and Gofore Ltd.	Maintained by Tampere City Location Services
DATA Provider	Finnish Transport Agency (FTA)	
Standards	InfoXML. Datex 2, schema available at: http://www.infotripla.fi/digitraffic/docs/DATEXIISchema_1_0_1_0_FI.xsd. Also avalaible as web service interface. Contact to service center for more information.	
DATA Users		
DATA export		
Geographic coverage		Tampere
Update cycle		static data
Other relevant DATA attributes		
Types of communication channels		

End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf	Tampere Open Data License

Traffic Mgmt	**DATAset #5**	**DATAset #6**
Brand name		
Content	Crossings with traffic lights static data	**Traffic Devices static data**
Physical location		
Physical DATA format	JSON, GML2, GML32, SHAPE-ZIP, CSV, WFS	JSON, GML2, GML32, SHAPE-ZIP, CSV, WFS
Server location	3. re.fi/tietovaranto/tietovaranto.php?id=50&alasivu=1&vapaasana=	4. http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=51&alasivu=1&vapaasana=
DATA Owner	Maintained by Tampere City Location Services	Maintained by Tampere City Location Services
DATA Provider		
Standards		
DATA Users		
DATA export		
Geographic coverage	Tampere	Tampere
Update cycle	static data	static data
Other relevant DATA attributes		

Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	Tampere Open Data Licence	Tampere Open Data Licence

Traffic Mgmt	**DATAset #7**	**DATAset #8**
Brand name	DigiRoad	
Content	Traffic-related attribute data: traffic element attributes, traffic restrictions and other road and street network features. Other transport system objects, e.g. services. Official name and number of road Position of road Width and pavement type of road Number of lanes Speed restriction Bridges and tunnels Parking buildings and areas Prohibited maneuvers and vehicles Width, height and weight restrictions Bus stops Cargo and passenger terminals Addresses of houses	Tampere street info (name, direction, road class, speed info)
Physical location		
Physical DATA format	ESRI, XML. Data objects described at: http://www.digiroad.fi/dokumentit/en_GB/documents/_files/84853526732145072/default/Description_of_Digiroad_Data_Objects_35.pdf	JSON, GML2, GML32, SHAPE-ZIP, CSV
Server location	Access request: http://www.digiroad.fi/hyodyntaminen/en_GB/ordering/	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=56&alasivu=4&vapaasana=

DATA Owner	Maintained by Finnish Transport Agency	
DATA Provider	Finnish Transport Agency / Digiroad	
Standards		
DATA Users		
DATA export		
Geographic coverage	National 483,000 km.	
Update cycle		Real time
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Users are charged extraction costs.	
Usage restrictions	License: TBD. Access given by request.	

Traffic Mgmt	**DATAset #9**	**DATAset #10**
Brand name	DigiRoad	
Content	Dynamic parking information	Map data
Physical location		
Physical DATA format	Datex2. Not ready yet.	http://www.paikkatietoikkuna.fi/web/en/frontpage
Server location	Finnpark	http://www.paikkatietoikkuna.fi/web/en/frontpage
DATA Owner	Finnpark	National Land Survey of Finland
DATA Provider	Finnpark	National Land Survey of Finland
Standards	DATEX2	?

DATA Users	private	both
DATA export	standard format	standard format
Geographic coverage	Parking garages in Tampere. On-street parking places is coming.	National
Update cycle	real time	static data
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	Licence with Finnpark	The criteria of openness have not yet been firmly defined, although the premises of what follows are based on spatial data sets which are widely available free of charge in a digital format and whose terms of use permit at least the publication of the data as a part of an application, service or other product; either as is, modified or combined with other data sets.

Emergency Not. & Response	**DATAset #1**	**DATAset #2**
Brand name		
Content	**Current road weather station data** (Status of road stations)	**Weather Camera Picture delivery** (Available real-time weather camera pictures , Real-time status information of road weather cameras)
Physical location		
Physical DATA format	XML. Web Service interfaces. WSDL described at: http://www.infotripla.fi/digitraffic/docs/Digit	XML. Web Service interfaces. WSDL described at: http://www.infotripla.fi/digitraffic/docs/Digitraff

	raffic%20web%20services.pdf	ic%20web%20services.pdf
Server location	http://www.infotripla.fi/digitraffic/english/index.html	http://www.infotripla.fi/digitraffic/english/index.html
DATA Owner	Infotripla Ltd and Gofore Ltd.	Infotripla Ltd and Gofore Ltd.
DATA Provider	Finnish Transport Agency (FTA)	Finnish Transport Agency (FTA)
Standards		
DATA Users		
DATA export		
Geographic coverage	350 road weather stations.	350 road weather stations.
Update cycle	The road weather information are usually updated 3-6 times in an hour, when temperature is near zero, the information will be updated more often.	real time
Other relevant DATA attributes	More precise description of teh interfaces available at: http://www.infotripla.fi/digitraffic/english/utilise.html	More precise description of teh interfaces available at: http://www.infotripla.fi/digitraffic/english/utilise.html
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf

Emergency Not.	**DATAset #3**	**DATAset #4**

& Response		
Brand name		
Content	**Road weather forecasts (winter time)**	**Frostheave information**
Physical location		
Physical DATA format	XML. Web Service interfaces. WSDL described at: http://www.infotripla.fi/digitraffic/docs/Digitraffic%20web%20services.pdf	At the moment available only by FTP interface.More info available at: http://www.infotripla.fi/digitraffic/docs/FTA_ftp-server_guide.pdf
Server location	http://www.infotripla.fi/digitraffic/english/index.html	http://www.infotripla.fi/digitraffic/english/index.html
DATA Owner	Infotripla Ltd and Gofore Ltd.	Infotripla Ltd and Gofore Ltd.
DATA Provider	Finnish Transport Agency (FTA)	Finnish Transport Agency (FTA)
Standards	Links to road weather forecasts sections, vector and symbols at: http://www.infotripla.fi/digitraffic/english/utilise.html	
DATA Users		
DATA export		
Geographic coverage	350 road weather stations.	350 road weather stations.
Update cycle	The road weather information are usually updated 3-6 times in an hour, when temperature is near zero, the information will be updated more often.	The road weather information are usually updated 3-6 times in an hour, when temperature is near zero, the information will be updated more often.
Other relevant DATA attributes	More precise description of teh interfaces available at: http://www.infotripla.fi/digitraffic/english/utilise.html	
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge

Usage restrictions	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf	can start using Digitraffic web service interfaces after making an agreement with Finnish Transport Agency (FTA), contract available at: http://www.infotripla.fi/digitraffic/docs/Digitraffic-contract.pdf

Emergency Not. & Response	**DATAset #5**
Brand name	
Content	Map data
Physical location	
Physical DATA format	http://www.paikkatietoikkuna.fi/web/en/frontpage
Server location	http://www.paikkatietoikkuna.fi/web/en/frontpage
DATA Owner	National Land Survey of Finland
DATA Provider	National Land Survey of Finland
Standards	?
DATA Users	both
DATA export	standard format
Geographic coverage	National
Update cycle	static data
Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	Free of charge
Usage restrictions	The criteria of openness have not yet been firmly defined, although the premises of what follows are based on spatial data sets which are widely available free of charge in a digital format and whose terms of use permit at least the publication of the data as a part of an application, service or other product; either as is, modified or combined with other data sets.

Public Transport Mgmt	DATAset #1	DATAset #2
Brand name	Lissu Traffic Monitor	Tampere bus traffic SIRI interface (RT machine to machine)
Content	Public transport network data: RT Tampere bus traffic, including predicted arrival times on stops	Tampere bus traffic
Physical location		
Physical DATA format	SIRI	XML
Server location	http://lissu.tampere.fi	https://siri.ij2010.tampere.fi/ws
DATA Owner	public	public
DATA Provider	CGI	Maintenance: Tampere City Public Transport.
Standards		SIRI. RT machine to machine
DATA Users		
DATA export		
Geographic coverage	Tampere	Tampere
Update cycle	real time	real time
Other relevant DATA attributes		
Types of communication channels		
End user device/Media	All	All
Type of output	map	
Pricing Model	Free of charge.	Free of charge.

Usage restrictions	Logging to the service enables saving own stops.	Only for machine to machine connections. Access given by request. Distribution and re-use of the data is allowed. License: Tampere City Open Data License.

Public Transport Mgmt	**DATAset #3**	**DATAset #4**
Brand name	Tampere bus traffic SIRI interface (RT XML)	Tampere bus traffic SIRI interface (RT JSON)
Content	Tampere bus traffic	Tampere bus traffic
Physical location		
Physical DATA format	XML	JSON
Server location	http://178.217.134.37:8080/siriaccess/vm/rest	http://data.itsfactory.fi/siriaccess/vm/json
DATA Owner	public	public
DATA Provider	Maintenance: Tampere City Public Transport.	CGI
Standards	SIRI	
DATA Users		
DATA export		
Geographic coverage	Tampere	Tampere
Update cycle	real time	real time
Other relevant DATA attributes		
Types of communication channels		
End user device/Media	All	All
Type of output		

Pricing Model	Free of charge.	Free of charge.
Usage restrictions	Please note that the url is still subject to change since the service is in beta (a domain name will be added later on).SIRI XML Access: http://178.217.134.37:8080/siriaccess/vm/siri (please note that this url accepts HTTP POST requests and therefore does not open up in the browser)	Access is open for anyone during beta phase, after beta phase access is given by request. Distribution and re-use of the data is allowed.

Public Transport Mgmt	**DATAset #5**
Brand name	**Tampere Public Transport SIRI Interface (Static)**
Content	**Public transport time table: Tampere bus**
Physical location	
Physical DATA format	XML
Server location	http://wiki.itsfactory.fi/index.php/Tampere_Public_Transport_SIRI_Interface_(Static)
DATA Owner	Tampere City Open Data License/ITS Factory
DATA Provider	Maintained by: Tampere City Public Transport/Infotripla Oy
Standards	SIRI
DATA Users	
DATA export	
Geographic coverage	Tampere
Update cycle	static data
Other relevant DATA attributes	http://www.infotripla.fi/siri_tampere/Infotripla_SIRI_Tampere_documentation.pdf
Types of communication channels	
End user device/Media	All

Type of output	
Pricing Model	Free of charge.
Usage restrictions	Access given by all ITS Factory wiki users (registration needed). Distribution and re-use of the data is allowed. Only server to server access is allowed

Traveller Journey Assist.	**DATAset #1**	**DATAset #2**
Brand name		Journey Planner API (Repository)
Content	Parking meters on Tampere city streets	Bus stops geocoding Points of interest (POI) geocoding Reverse geocoding of bus stops and POIs Routing between two points Search for the bus stop's timetable
Physical location		
Physical DATA format		XML/JSON
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=55&alasivu=1&vapaasana=	Access request at: http://developer.publictransport.tampere.fi/pages/en/account-request.php
DATA Owner	Maintained by Tampere City Location Services	Maintained by Tampere City Public Transport.
DATA Provider	Public	Public
Standards	MID, MIF	
DATA Users		
DATA export		
Geographic coverage	Tampere	Tampere bus traffic, including some bus lines in Kangasala, Ylöjärvi, Pirkkala and Nokia
Update cycle	Static data from 2011, not fully up-to-date; to be updated.	static

Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge.	Free of charge.
Usage restrictions	Tampere Open Data License	Access given by request. Distribution and re-use of the data is allowed. Due limited service capacity, queries of one account is limited to max. 5000 weighted query in one hour.

Traveller Journey Assist.	**DATAset #3**
Brand name	
Content	Bike Parking
Physical location	
Physical DATA format	JSON, GML2, GML32, SHAPE-ZIP, CSV
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=69&alasivu=3&vapaasana=
DATA Owner	Maintained by Tampere City Location Services
DATA Provider	Public
Standards	
DATA Users	
DATA export	
Geographic coverage	Tampere
Update cycle	static

Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	Free of charge
Usage restrictions	Tampere Open Data License

Electronic Fee Coll.	**DATAset #1**
Brand name	Public transportation fees
Content	
Physical location	
Physical DATA format	
Server location	http://joukkoliikenne.tampere.fi/en/travelling/fares.html
DATA Owner	
DATA Provider	
Standards	
DATA Users	
DATA export	
Geographic coverage	
Update cycle	
Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	

Usage restrictions	

Communications	**DATAset #1**
Brand name	Free WiFi Cafe spots in Tampere
Content	
Physical location	http://www.wificafespots.com/wifi/city/FI--Tampere
Physical DATA format	
Server location	
DATA Owner	
DATA Provider	
Standards	
DATA Users	
DATA export	
Geographic coverage	
Update cycle	
Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	
Usage restrictions	

Demography & Economics	**DATAset #1**	**DATAset #2**
Brand name	Demographics: Statistics Finland's official demographics statistics by	Education

	region and age group.	
Content		Adult education, Vocational education, Employment and studies, Polytehnic education, etc.
Physical location		
Physical DATA format	XSLX	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=72&alasivu=3&vapaasana=	http://www.stat.fi/til/aiheet_en.html#kou
DATA Owner	http://www.paikkatietoikkuna.fi/web/en/open-spatial-data	Statistics Finland
DATA Provider	Public	Public
Standards		
DATA Users	both	
DATA export		
Geographic coverage		
Update cycle	Static	Static
Other relevant DATA attributes	Population, regions, age, age groups, the average age, gender, nationality, foreigners, native language, foreign-language	
Types of communication channels		
End user device/Media	all	
Type of output		
Pricing Model	free of charge	
Usage restrictions	http://www.paikkatietoikkuna.fi/web/en/terms-and-conditions	

Demography & DATAset #3	**DATAset #4**

Economics		
Brand name	Economic trends	Prices and costs
Content		
Physical location		
Physical DATA format	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html
Server location	http://www.stat.fi/til/suhd_en.html	http://www.stat.fi/til/aiheet_en.html#hin
DATA Owner	Statistics Finland	Statistics Finland
DATA Provider		
Standards		
DATA Users		
DATA export		
Geographic coverage		
Update cycle		
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model		
Usage restrictions		

Demography & Economics	DATAset #5	DATAset #6
Brand name	Income and consumption	Consumption, general
Content		

Physical location		
Physical DATA format	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html
Server location	http://tilastokeskus.fi/til/aiheet_en.html#tul	http://www.stat.fi/til/asan_en.html?k=C#consumption
DATA Owner	Statistics Finland	Statistics Finland
DATA Provider		
Standards		
DATA Users		
DATA export		
Geographic coverage		
Update cycle		
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model		
Usage restrictions		

Tourism	**DATAset #1**	**DATAset #2**
Brand name	Tampere rowing beaches	Tampere garbage bins
Content		Type of garbage & Emptying intervals
Physical location		
Physical DATA format	JSON, GML2, GML32, SHAPE-ZIP, CSV.	JSON, GML2, GML32, SHAPE-ZIP, CSV.
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=65&alasivu=4&vapaasana=	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=64&alasivu=4&vapaasana=

DATA Owner	City of Tampere	City of Tampere
DATA Provider	City of Tampere	City of Tampere
Standards		
DATA Users	Both	Both
DATA export		
Geographic coverage	Tampere	Tampere
Update cycle	periodically, small changes every year	real time
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions	works with GeoServer, http://docs.geoserver.org/latest/en/user/services/wfs/index.html	works with GeoServer, http://docs.geoserver.org/latest/en/user/services/wfs/index.html

Tourism	**DATAset #3**	**DATAset #4**
Brand name	Tampere winter slides	Tampere sports fields
Content		
Physical location		
Physical DATA format	JSON, GML2, GML32, SHAPE-ZIP, CSV	JSON, GML2, SHAPE-ZIP
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=43&alasivu=6&vapaasana=	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=42&alasivu=6&vapaasana=
DATA Owner	City of Tampere	City of Tampere
DATA Provider	City of Tampere	City of Tampere
Standards		

DATA Users		
DATA export		
Geographic coverage	Tampere	Tampere
Update cycle	real time	real time, except the data concerning the fields administered by schools (here data from a few years ago)
Other relevant DATA attributes		
Types of communication channels		
End user device/Media		
Type of output		
Pricing Model	Free of charge	Free of charge
Usage restrictions		

Tourism	**DATAset #5**
Brand name	Tampere nature trails
Content	
Physical location	
Physical DATA format	JSON, GML2, GML32, SHAPE-ZIP, CSV
Server location	http://palvelut2.tampere.fi/tietovaranto/tietovaranto.php?id=15&alasivu=10&vapaasana=
DATA Owner	City of Tampere
DATA Provider	City of Tampere
Standards	
DATA Users	
DATA export	
Geographic coverage	Tampere
Update cycle	daily

Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	
Usage restrictions	

Business	**DATAset #1**
Brand name	Business enterprises
Content	Bankruptcies, business restructuring, financial statement statistics, use of IT in enterprises, etc.
Physical location	
Physical DATA format	http://tilastokeskus.fi/org/lainsaadanto/avoin_data_en.html
Server location	http://www.stat.fi/til/asan_en.html?k=B#business_enterprises
DATA Owner	Statistics Finland
DATA Provider	
Standards	
DATA Users	
DATA export	
Geographic coverage	
Update cycle	
Other relevant DATA attributes	
Types of communication channels	
End user device/Media	
Type of output	
Pricing Model	

Usage restrictions	

A4. Annex 4: Information sources and datasets, users and stakeholders involved in the services at each pilot site

A4.1 Madrid pilot site

A4.1.1 Description of the service 1: Smart prioritization of vehicles

A4.1.1.1 Datasets and information source

The service will use datasets from different information providers, which are listed hereafter:

- Traffic management data from the Traffic Light Controllers: location of controllers, Cycle, Split, Offset, Traffic control plans from the local controller in the crossing zone; Intensity and Occupancy (level of service) from detectors. Those data are available within MoveUs consortium.

- Public transport management system from EMT (Exploitation Support System - ESS + OBU), for the priority of public buses, from the ESS system of the public buses operator: location of bus stops, location of buses in their route, Identification code of the bus, trajectory, location of control points along the buses trajectories, travel times historic data, level of priority. Those data are available within MoveUs consortium.

- It will be possible to obtain the location and trajectory of a car-sharing vehicle through an App running on the Smartphone of the user.

A.4.1.1.2 Users and stakeholders

Users

There are not users. It is a Machine to Machine Service (M2M), except on stage 4 in which bus driver is informed with an ACK or NACK message to the priority request.

Stakeholders

- Urban Traffic Operator - Public Administration - Mobility Department
- Public Bus Transport Operator – EMT in Madrid

A.4.1.2 Description of the service 2a: Smart routing for pedestrian

A.4.1.2.1 Datasets and information source

The service will use datasets from different information providers, which are listed hereafter:

- GPS position system. This data is available in each personal device which connects to the service provider.
- Public information on points of interest in the city (tourism and leisure, etc.). Links to the suppliers of such information (like concerts, exhibitions, museums and galleries, performances and shows, workshops, sport competitions, etc.) will be provided to the user as far as they are available on the internet.
- Users' information: Preferences and likes for transport modes of each user. Those data will be available within the service application developer once the users sign up for the service.
- Smartest route plan will be provided through a GPS based application according to the smart option selected and available within MoveUs.
- Smart mobility option list: public transport, car-sharing, bike hiring, safest crossings, flat sidewalks… Information from these mobility options will be available in the MoveUs platform, other might be added during service operation:
- Public transport information: bus lines, schedules and delays, stations, routes and travel times of the routes, etc. (source: Exploitation Support System from EMT)
- Shared-mobility options: Car-sharing, bike hiring access points, parkings and link to the on-line facility to use it (source: Mobility Department of Madrid City Council MAD)
- Information about levels of service, traffic incidents and congestions etc. (source: SICTRAM from MAD).

A.4.1.2.2 Users and stakeholders

Users

All citizens may benefit from this smart routing service:

- Pedestrians and regular walkers

- Daily commuters

- Tourists and city visitors

- Mobility impaired people,

- Etc.

Stakeholders

- GIS maps providers
- Car sharing operators
- Bike sharing operatorsUrban Traffic Operator
- Public Administration - Mobility Department

- Public Bus transport operator
- Tourist, leisure and sport events operators / organizers / information providers
- Mobility impaired associations
- Business Associations

A.4.1.3 Description of the service 2b: Smart crossing for pedestrian.

A.4.1.3.1 Datasets and information source

The service will use datasets from different information providers and equipment that are listed hereafter:

- GPS position system. This data is available in each personal device which joins the service.
- A list of smart crossings in the city and their GPS location as well as the coordinates of the areas of detection of the Bluetooth readers, are available within the consortium.
- Camera images, coming from SafeCross System. These data could be available within de consortium.
- Bluetooth connections. Personal device data could be available within de consortium, likewise the LTC Bluetooth data, in those LTC that have a reader installed and connected with the ADIMOT network.
- Traffic management data from the UTC (ADIMOT system + Local Traffic Controller). Those data are available within MoveUs consortium.

A.4.1.3.2 Users and stakeholders

Users

Pedestrians and regular walkers will obtain benefits from those services.

Stakeholders

- GIS maps providers
- Urban Traffic Operator
- Public Administration - Mobility Department
- Mobility impaired associations

A.4.1.4 Description of the service 3: Eco-efficient Route Planning and Traffic prediction

A.4.1.4.1 Datasets and information source

The service will use datasets from different information providers, which are listed hereafter:

- Traffic management data from the UTC (ADIMOT system + Traffic Light Controllers): Cycle, Split, Offset on the local controller in the crossing zone; Intensity and Occupancy (level of service) from detectors. Those data are available within MoveUs consortium.

- Identification of personal devices MACs and time of detection, obtained by Bluetooth readers to be deployed in the street network; the MAC codes are unique in every personal device; the MACs detected will be filtered and processed before validation of the data. The validated data will be uploaded to MoveUs.

- Traffic management data and information obtained by the Bluetooth readers will serve as basis for the calculation of travel times in urban street routes.

- Otherwise it would be possible to obtain location of drivers and travelers through an App running on a Smartphone.

- The traffic information and route planning functionality will be GIS based using Google Maps.

A.4.1.4.2 Users and stakeholders

Users

- Drivers subscribed to premium services

- Drivers with eco-friendly mobility patterns, according to the incentives model defined.

- Other drivers to be considered: visitors to the city that use MoveUs and follow the mobility options provided by the system, etc.

Stakeholders

- GIS maps providers
- Urban Traffic Operator
- Public Administration - Mobility Department
- Professional Transport Associations (taxi, logistic fleets, etc.)
- Automobile clubs and drivers associations
- Environmental Bodies

A4.2 Genoa pilot site

A4.2.1 Description of the service 1: Personal multi-modal journey planner with energy calculator, incentives & rewards management and electronic wallet functionalities

A4.2.1.1 Datasets and information source

The effectiveness of the service is based on the amount of data available; this means that all datasets mapped in Task 2.3 in principle could be used for the development of the sub-services. Additional and essential datasets, as described in the following table, may be also required:

Sub-services	Datasets
• Multimodal journey planner with feedback from users **REMARK**: The Region of Liguria developed a multimodal journey planner service. The possibility of using this service will be investigated together with the Regional Administration.	• Traffic Management. • Emergency Notification and Response. • Public Transport Management. • Traveller Journey Assistance. • Electronic Fee Collection. • In-Vehicle Systems. • Law Enforcement.
• Car sharing management	• Car Sharing information
• Bike sharing management	• Bike Sharing information
• Carbon footprint calculator	• KPI defined in WP4
• Energy consumption calculator	• KPI defined in WP4
• Car Pooling information	• The Datasets will be populated by the users themselves at the moment of registration
• Incentives management	• RULES and INCENTIVES databases that will be built in Task 6.2 and that will serve as basis for local customization of the MoveUs platform.
• Coupons/Vouchers/Deals management	• Demography & Economics • Tourism • Businesses
• Electronic wallet management	• Businesses • Communications
• Identity Services	• The Datasets will be populated by the users themselves at the moment of registration
• Social Services	• Crowd Sourced Data and Identity dataset

Table 15 Subservices and datasets of the multi-modal journey planner in Genoa

NOTE: All the data concerning the car/bike sharing service are collected in a dedicated server, physically located in Genova Parcheggi Spa (Municipality Subsidiaries), company located in Genoa and totally controlled by the Municipality.

All the information are available for processing and statistic analysis, according to user's privacy regulations.

A4.2.1.2 Users and stakeholders

Users

The service addresses the needs of a wide typology of users, including:

- **Citizens and Tourists**, better defined in the following table excerpt from CO-CITIES19:

User group	Typical age	Examples/kind of travels	Frequency of travels	Expected frequency of service usage per year	Service platform used
Urban commuters	10 - 65	Employees, scholars / students to go to work / school / university	Working days (++)	Medium (++) Focus on real-time information	Smartphone, navigation device
Sub-urban commuters	10 - 65	Employees, scholars / students to go to work / school / university	Working days (++)	Medium (++) Focus on real-time information	Smartphone, navigation device
Urban ad-hoc travellers	14 - 75	Shoppers, going out, get-together. Going to doctor, bank	Less than daily (++)	High (+++) Routing and real-time information	Web, Smartphone, navigation device
Sub-urban ad hoc travellers	14 – 75	Shoppers, going out, get-together. Going to doctor, bank	Less than daily (++)	High (+++) Routing and real-time information	Web, Smartphone, navigation device

[19] www.co-cities.eu

Tourist / leisure travellers	18 – 75	Individuals, families, groups of people for sightseeing and sports	Less than monthly (+)	Low (+) Focus on routing information	Web, Smartphone, navigation device
Business travellers	20 – 65	Business people arranging meetings, int'l business trips	Less than daily (++)	High (+++) Routing and real-time information	Web, Smartphone, navigation device
Travellers with limited mobility	14 - 65	Temporary handicapped (pram, carrier bag) and disabled people	Daily (+++)	Medium (++) Special routing and real-time information	Web, Smartphone, navigation device

Table 16 Typology of users of the multi-modal journey planner in Genoa

- **Public and private transit organizations and transport/fleet operators** [e.g., urban traffic managers, public transport operators (bus, tram, metro), emergency fleets, car-sharing operators, parking services and mobility planners].

They not only are data providers (smart mobility information, recommended routing and traffic prioritization services) to end-users but **shall be considered users since can adapt the transport offer according to the transport demand** through the MoveUs platform.

- **Cities Authorities** [e.g. Transport, Mobility, Energy, and Economic Development Departments of City Councils].

City and regional transport authorities can use the MoveUs platform in order to **rapidly integrate and deploy a variety of user-aware and sensor-based services to their citizens**.

- **Local Business** [e.g. 'green' companies, tourism, leisure, entertainment and content providers].

They will use the MoveUs platform and real-time data for **providing added-value services to end-users such as emissions of coupons/vouchers and deals**

- **Energy operators**: MoveUs will let them be **aware of energy consumption patterns** (interesting for planning charging points) and also, in advance, of occasional changes in energy consumption needs.

- **ICT solutions providers** [e.g. particularly SMEs operating as system integrators and ICT solutions developers in different fields].

The MoveUs platform and APIT toolkit will facilitate chiefly SMEs to **have access to scattered mobility data and to services and the develop and deploy their own sustainable ICT solutions across multiple cities** at an affordable cost, thereby increasing their competitiveness.

Stakeholders

The main stakeholders identified are:

- Consumers Associations
- Business Associations
- Energy Operators Associations
- Environmental Bodies
- Professional Transport Associations
- Automobile clubs
- Public Administration (in a broad sense)
- Research Centers and Academies
- Social networks (Linkedin, Twitter, Facebook, FourSquare, Waze, etc.)
- Public Transport Operators (like Genova Parcheggi S.p.a., the public company managing the parking areas; AMT - Azienda Mobilità e Trasporti S.p.a., the local public transport company).
- ICT solution providers.

A4.2.2 Description of the service 2: Integration of crowd sourced data into the Genoa traffic supervisor

A4.2.2.1 Datasets and information source

The Mobility Department will open to the MoveUs consortium a very flexible environment enabling integration, processing and delivery of Multimodal Real Time Traffic and Travel Information services. This environment called E-Mixer, is deeply connected with the RoadVisor system. It was developed using Windows Communication Foundation (WCF), a set of runtime and API build with Microsoft .NET technology, hosted in IIS (Microsoft Internet Information Services), and it used with HTTP (REST).

This is a ready-to-use solution for MoveUs consortium.

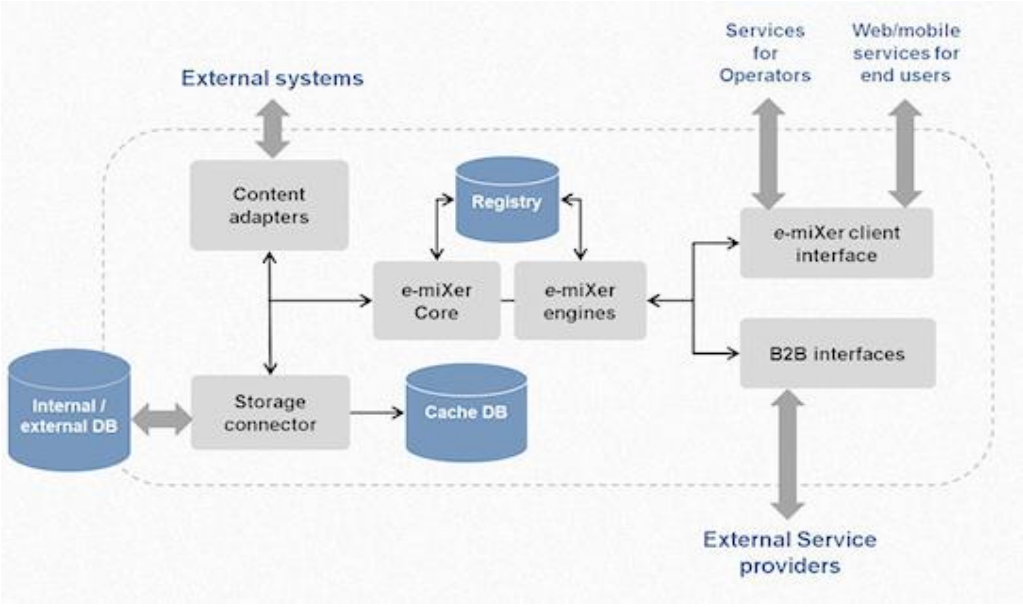

Figure 56 emiXer Logical Architecture

In particular the following sub-systems of the Supervisor will be open to consortium:

- **Sigma+ system**: Traffic lights management system.
- **MMS-VMSS system**: Variable message panels management system.
- **Infopark:** This system is a dedicated software to the supervision of parking lots occupancy. The system manages 8 parking spaces where information panels show the status of one or more parking spaces.

Figure 57 Infopark System

- **TCT System:** Traffic webcam management system (TVCC - images of 40 Traffic Webcams in real time with resolution 352 × 288).
- **Simon System:** This is the buses monitoring system provided by AMT SpA, the Public Transport operator in Genoa. In detail, SIMON includes: 750 on-board systems, 1 control and monitoring system comprising 11 stations operator, 102 points of information to users on the ground, 15 computerized kiosks, 5 deposits equipped with short-range communication network for

loading and unloading data and 80 intersections with traffic signal priority system functionality.

- **MobiGIS Database:** This database contains the road network of public and private transport , socio-economic data , data for urban planning and so on.
- **ZTL system:** Access control system in the Limited Traffic Zones of the historical center in Genoa.
- **CMI system:** Road accidents management system
- **Traffic – Environment Database:** Database that manages environmental data linking to traffic data. The acquisition of data about pollutant emissions is achieved with monitoring stations (SO2, CO, O3, NO2, C6H6, PM10).
- **CELERITAS system:** Speed control system for the elevated highway in Genoa (called "Strada Aldo Moro").

Figure 58 Celeritas System

- **ACITRAFF system:** Traffic measures provided by ACI (Italian Automobile Club) through infrared sensors system.
- **FCD:** Floating car data management system.

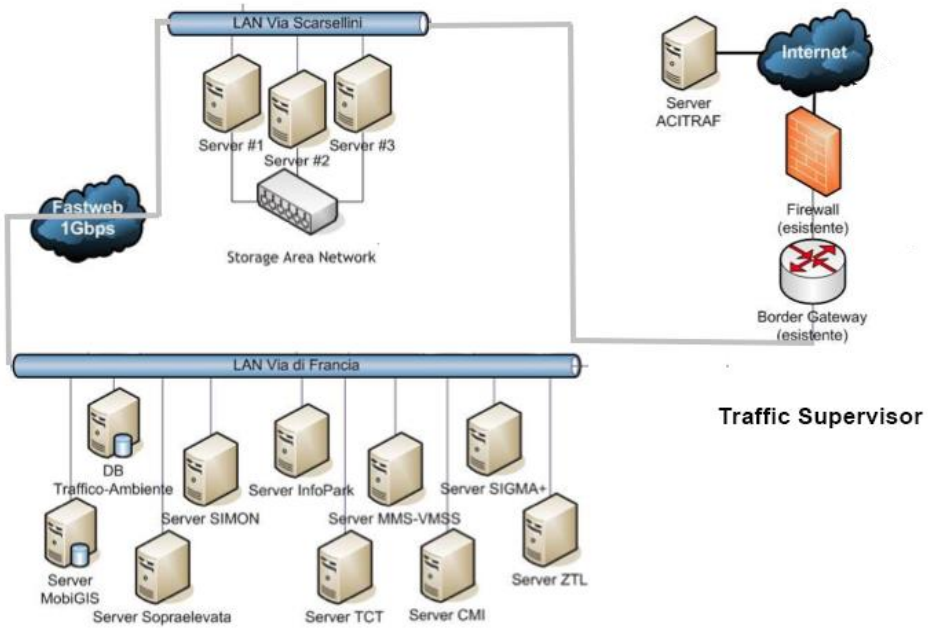

Figure 59 Traffic Supervisor Subsystems Logical Architecture

Regarding Floating Car Data, within a national project just concluded, has been developed the S.I.MO.NE adapter (called "Aggregatore"). This adapter is capable to:

- Manage FCD producers;
- Manage TDP (Travel Time);
- Viewing Application Event, statistics on events application.

S.I.MO.NE. is based on JBoss Application Server. Thanks to his built-in technology is possible to integrate dataset from different sources such as:

- **Floating cellular (CDMA, GSM, UMTS, GPRS) data-based.** No special devices/hardware are necessary: every switched-on mobile phone becomes a traffic probe and is as such an anonymous source of information.
- **Electronic toll collection** device data using particular transponders.
- **GPS-based:** vehicle equipped with a box that contains a GPS receiver.

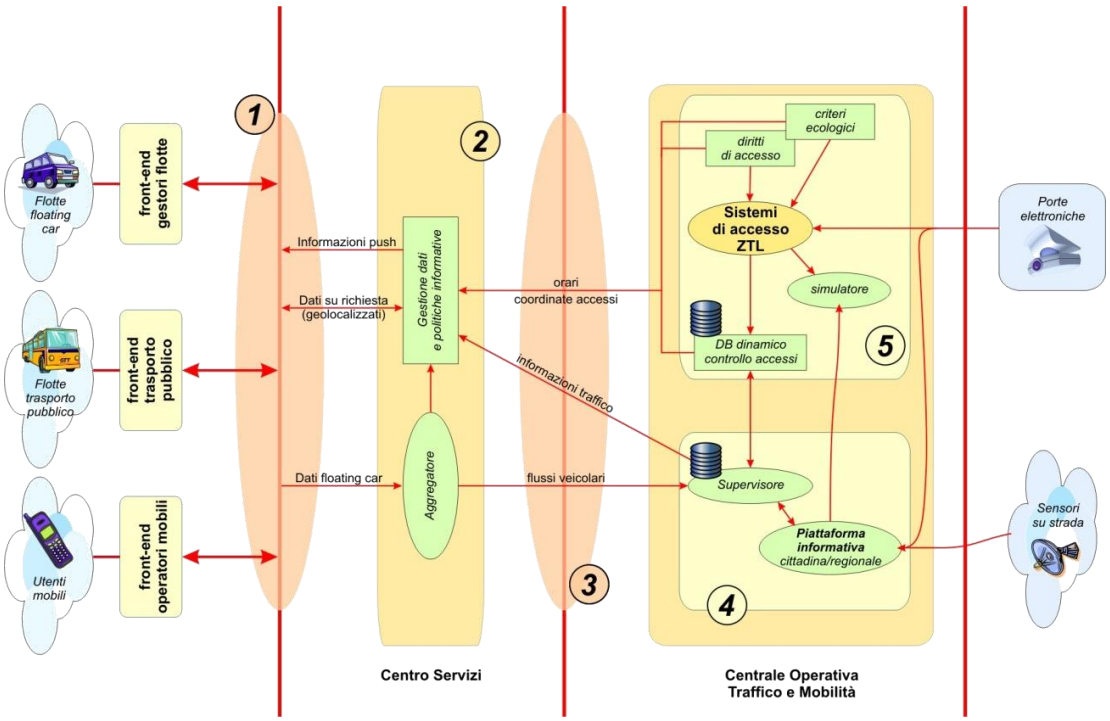

Figure 60 Traffic Supervisor Subsystems – S.I.MO.NE. Logical Architecture

In particular The Mobility Department has the following FCD dataset:

- **FCD by AMT**: Buses are equipped with dedicated hardware such as transponders, which are uniquely identifiable, may be read not only at bus stops collection points. This is used as a method to collect traffic flow data. The dataset contains the travel time for each bus stop.
- **FCD** by private company (for example, Infoblu or 5T).

A.4.2.2.2 Users and stakeholders

Users

Users of the service are:

- Citizens and, Tourists
- Public and private transport organizations and transport/fleet
- Cities Authorities
- Local Business

Stakeholders

The main stakeholders identified are:

- Consumers Associations
- Business Associations

- Energy Operators Associations
- Environmental Bodies
- Professional Transport Associations
- Automobile clubs
- Public Administration (in a broad sense)
- Research Centers and Academies
- Social networks (Linkedin, Twitter, Facebook, FourSquare, Waze, etc.)
- Public Transport Operators (like Genova Parcheggi S.p.a., the public company managing the parking areas; AMT - Azienda Mobilità e Trasporti S.p.a., the local public transport company).
- ICT solution providers.

A4.2.3 Bike & Car Sharing Annex

The actual position of the car sharing vehicles parking area, cover all the city centre (in term of park area) as illustrated in the pictures. All the parking area are 52 across all the city area (Levante, Val Polcevera, Centro, Val Bisagno, Levante).

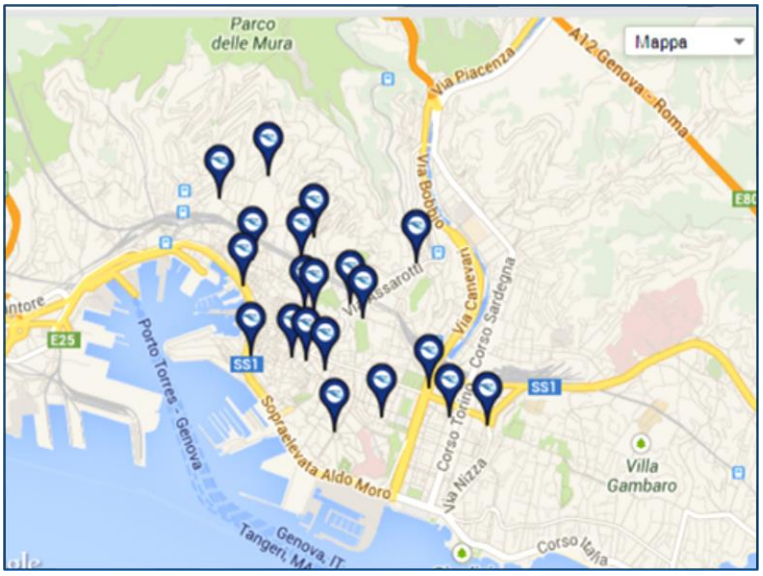

Figure 61 Car sharing service - City centre localization # 1

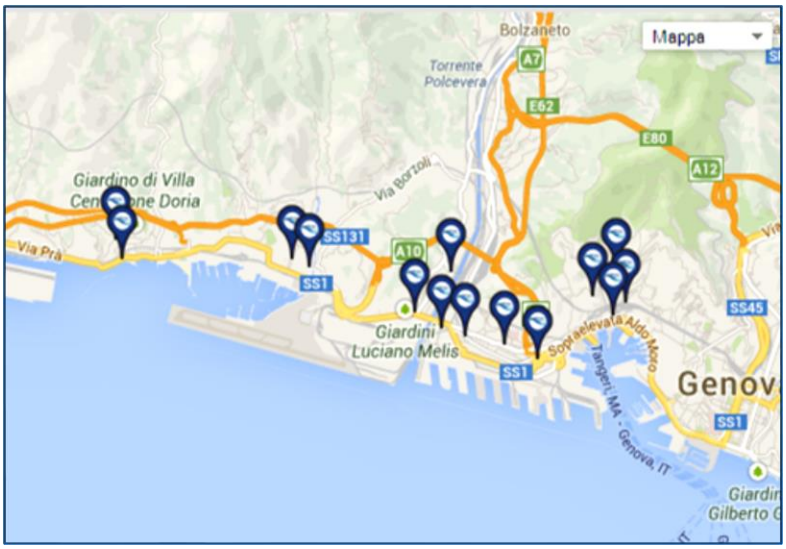

Figure 62 Car sharing service - City centre localization #2

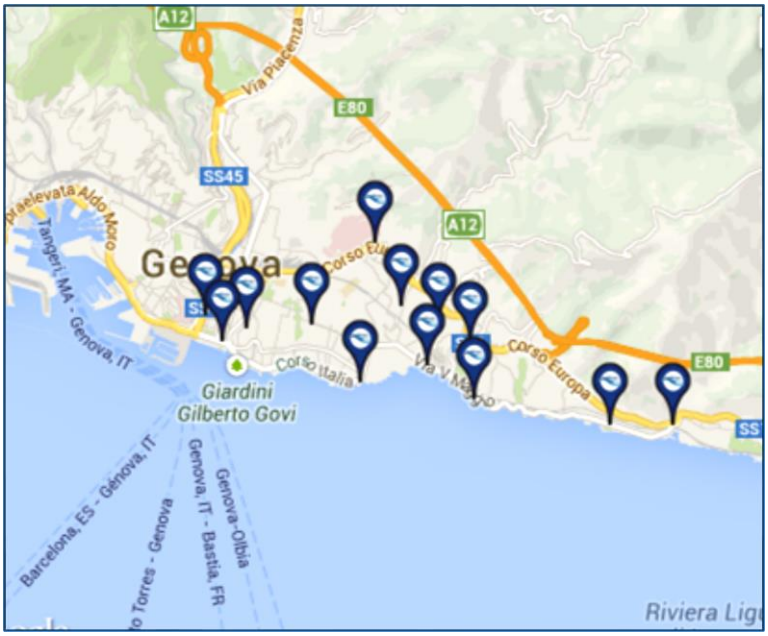

Figure 63 Car sharing service - City centre localization #3

The bike sharing system, is composed from 60 available bike located in 6 different parking areas (as illustrated in the picture below), located inside the city centre area, the system will be implemented during the 2014 with new bikes and dedicated parking areas.

The ELEKTRA project is an E.U. funded project that aims to promote the use of electric scooters in urban areas through the development of electric motorcycle sharing.

Figure 64 Bike sharing service - City centre localization

A4.3 Tampere pilot site

A4.3.1 Description of the service 1: Multimodal Journey Planner

A4.3.1.1 Datasets and information source

Must-include datasets and apps

- Journey Planner API (Reittiopas) – for buses
- Tampere bus traffic (Lissu traffic monitor)
- Journey Planner for Cycling

Could-include datasets and apps

- Incident and roadwork information.
- Traffic Devices static data
- Bike Parking
- Road and weather conditions
- RT Winter maintenance data from maintenance vehicles equipped with On Board Units (OBUs). Data of interest enables slipperiness (road surface friction obtained through optical measurements), humidity, heat and other road condition data.
- Public transport timetable
- Datasets the Tampere smart prioritization service relies on, i.e.:
    - Traffic Flow Real time fluency and travel time data. Traffic flow is obtainable through the trafic light system, as number of vehicles passing a traffic light.
    - Traffic light group status information - available in future. All traffic light data is open to MoveUs.

Traffic flow and disturbances from automated traffic monitoring points (ATMP), traffic light sensors data, and FCD-data from taxi vehicles.

A.4.3.1.2 Users and stakeholders

Users

Users: Public transport customers (end users). All data is also available for third-party developers such as mobile application developers.

The service offered to include approx. 200 busses, 100 traffic lights and 20 real time monitors.

Stakeholders

Stakeholders: Tampere Municipality (Tampereen kaupunki)

A4.3.2 Description of the service 2: Energy efficiency/CO2 assessment of journey options

A4.3.2.1 Datasets and information source

- Input journey option(s) (i.e. mobility and routing choices available between the start and end points of the trip) for which the EE/CO2 assessment is desired
- Road weather forecasts
- Frostheave information
- RT Winter maintenance information from maintenance vehicles

A.4.3.2.2 Users and stakeholders

Users

Users: Public transport customers (end users). All data is also available for third-party developers such as mobile application developers.

The service offered to include approx. 200 busses, 100 traffic lights and 20 real time monitors.

Stakeholders

Stakeholders: Tampere Municipality (Tampereen kaupunki).

A4.3.3 Description of the service 3: User-tailored incentive-based visualization

A4.3.3.1 Datasets and information source

- Input energy/CO2 consumption values
- User profile information, if available.

A.4.3.3.2 Users and stakeholders

Users

Users: Public transport customers (end users).

Stakeholders

Stakeholders: Tampere Municipality (Tampereen kaupunki).