A.T.2.2

IDENTIFICATION AND DETAILED DESIGN OF VALUE-ADDED SERVICES FOR LEZ

Deliverable D.T 2.2.3 –*ICT-based tools supporting Value-Added services implementation*	Final Version 01/2018

Author: **Vicenza**	
Version: Final version	**Date of version:** **01/2018**
Project: SOLEZ	
Duration of the project: 36 Months	
Project coordination: Comune di Vicenza	
The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the European Union	

TABLE OF CONTENS

1 Introduction

This document provides overall description of the ICT-based tools for the implementation and operation of effective and innovative Value-Added mobility services (for passenger mobility and for freight transport), as defined and described in the deliverable D.T2.2.2 – Supporting tool (toolbox) for overall design of low-carbon Value-Added services for freight and people.

Based on an effective combination of top-down and bottom-up approaches implemented in the project, low-carbon passenger and freight mobility services finally selected for the target FUAs are as follows: Mobility as a Service (MaaS) schemes for passenger transport, multi-users lines (multimodal transport corridors) for freight transport, B2B and B2C last-mile delivery by cargo bikes for freight.

Turin is planning to design and implement two different low-carbon Value-Added mobility services: a MaaS scheme as well as multi-users lanes (freight transport).

Graz is planning to promote soft mobility modes (mostly walking) by integrating into tim (a multimodal transport and mobility hub) that offers, inter alia, car-sharing, for example, by including the digital maps for a green network. **Sárvár** is planning to develop the MaaS concept to aggregate the different transport solutions by one app, enabling to provide multimodal passenger mobility solutions. On the other hand, the remaining two SOLEZ pilot sites involved in Added-Value mobility service development in the target FUAs are planning to address freight transport "pull" measures.

Vicenza is planning to develop a Business to Consumer (B2C) last-mile delivery by cargo bikes for LTZ shoppers, including residents, city users as well as tourists. **Gdansk** is planning to develop a Business to Business (B2B) last-mile delivery by cargo bikes for the pedestrian areas of the city.

B2B and B2C last-mile delivery by cargo bikes, as Added-Value freight services, are not focused on technological-driven and ICT-based solutions, being mostly business case-oriented initiatives as well as organisational-based measures. IT solutions to operate last-mile delivery service using cargo bikes are quite market-based tools and applications including, for example, web-based vehicle (bikes) tracking system, routing systems, automatic proof of delivery using smartphones and tables, etc.

Therefore, these two freight transport services are not focus on ICT-based tools, where information and communication technologies are an "accessory" part of the service as a whole, reason why they are out of scope of this report which is aimed at guiding PAs and businesses in the development and implementation of the MaaS concept and multi-users lines through interoperable ICT/ITS solutions.

Value-Added mobility services are aimed at reducing disadvantages produced by traffic restriction policies (e.g. LEZ, LTZ, pedestrian areas, etc.) to people living, working or visiting the concerned Functional Urban Areas (FUAs) and to increase business opportunities of mobility services suppliers.

Value-Added mobility services must be considered as pull measures being organizational interventions to encourage alternative mobility solution to common fossil-fuelled transport service.

This document describes ICT-based solutions supporting the development and implementation of the two-selected low-carbon Value-Added mobility services as follows: MaaS and multi-users lanes.

The final reason behind the selection of these two Value-Added services is twofold: from the one hand, the two Value-Added mobility services have been finally selected by the SOLEZ pilot sites being most relevant, promising and well-fitting local-based conditions and strategic objectives for the target FUAs; from the other hand, the two aforementioned Value-Added mobility service are strongly based on ICT/ITS solutions in terms of software applications, ICT platforms as well as IT systems (e.g. ICT road side), considering the possibility of exploiting existing systems, software and mobile apps.

This report has been elaborated combining top-down and bottom-up approaches to provide an effective and transferable ICT-based tools description for stakeholders (including both public sector and businesses) to develop and implement the two **technological-driven Value-Added services**:

- **MaaS**, enabling to offer seamless door-to-door services across passenger transport modes,
- **Multi-users lanes**, enabling to share public transport reserved lines for freight transport.

MaaS is a new concept aiming to provide consumers with flexible, efficient, user-oriented and ecological mobility services covering multiple modes of transport on a one-stop-shop principle. MaaS is a paradigm change in transportation towards offering personalized and smart mobility services reflecting users' different needs. The aim of MaaS is to be the best value proposition for its users, providing an alternative to the private use of car that may be as convenient and more sustainable.

The aim of MaaS is to be the best value proposition for its users, providing an alternative to the private use of the car that may be as convenient, more sustainable and even cheaper. MaaS is a paradigm change in transportation towards offering personalized and smart mobility services reflecting users' different needs such as seamless, well-functioning transport services (transport as an "experience") as well as easy access to mobility at urban and FUA level. Expected benefits of MaaS are not only related to transport users' (citizens) but also to both the public sector and businesses.

Multi-users lanes concerns the possibility of sharing dedicated bus lanes by logistics operators without affecting public transport system, reducing pollution and congestion for all categories of users. The usability of preferred lanes by specific recognised commercial vehicles (mostly by light commercial less polluting vehicles) needs to be monitored by dedicated ITS and recognition schemes.

This pull measure can be considered an added-value freight mobility services enabling of sharing dedicated bus lanes by logistics operators without affecting public transport system (maintaining acceptable level of service) and reducing congestion for all categories of users in the road network. Multi-users lanes include effective access management of recognized freight vehicles in bus lanes while maintaining an acceptable level of service (LoS) for the whole public transport system.

2 SOLEZ supporting tool: Value-Added services / pull measures

2.1 Passenger & Freight Value-Added Services

Value-Added services are all about pull measures covering both passenger and freight transport as follows: car sharing services, carpooling system, traditional and free floating bike-sharing services, promoting the use of public transport interchanges by offering innovative services, green last-mile logistics by electric vehicles and Urban Consolidation Centre (UCC), last-mile logistics services by cargo bikes, multi-user lines (multimodal transport corridors), Mobility as a Service (MaaS), etc.

SOLEZ Value-Added (VA) services will be **organizational measures** enabling to incentive and promote low-carbon mobility services in target FUAs as an effective alternative mobility solution to conventional fossil-fueled transport modes such as private cars, more polluting heavy commercial vehicles (HCV) and light commercial vehicles (LCV), more polluting urban and peri-urban buses, etc.

Based on an effective combination of top-down and bottom-up approaches - by local stakeholders' consultation meetings within the Action Plans elaboration in the FUAs, by the results of Steering Committee meetings in Graz (22nd-24 th of February 2017) and in Turin (18nd-20th of October 2017) - low-carbon passenger and freight mobility services finally selected for the target FUAs are as follows:

- **Mobility as a Service (MaaS)** schemes for passenger transport,
- **Multi-users lines** (multimodal transport corridors) for freight transport,
- **B2B and B2C last-mile delivery by cargo bikes** for freight transport.

This document is aimed at guiding Public Administrations and businesses in the development and implementation of the identified Added-Value services through interoperable and/or existing ICT/ITS solutions in terms of software applications, ICT platforms as well as IT systems (e.g. road side units).

In this respect, most ICT-based solutions enabling to implement low-carbon Added-Value services in target FUAs are presented by the introduction of innovative and technological-driven **MaaS concept**, enabling to offer seamless door-to-door mobility services across passenger transport modes.

On the other hand, ICT-based solutions supporting the implementation of more sustainable freight transport services are mostly related to **multi-users lanes concept**, enabling recognised freight vehicles to use and share public transport reserved lines for freight delivery services provision.

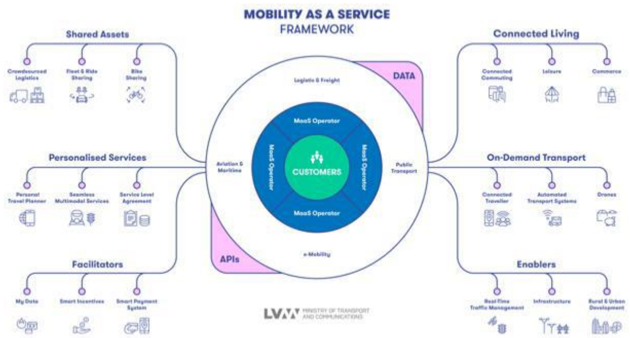


Figure 1: ICT-based solutions for the implementation of Value-Added mobility services: passenger and freight transport

2.2 Mobility as a Service (MaaS) concept

Mobility as a Service (MaaS) is a mobility distribution model in which customer's major transportation needs are met through one single integrated service provider. MaaS provides a new way of thinking in terms of how the delivery and consumption of mobility is organized and managed.

MaaS is a new concept aiming to provide consumers with flexible, efficient, user-oriented and ecological mobility services covering multiple modes of transport on a one-stop-shop principle.

New technologies enable to address users' needs and expectations which are becoming more demanding and fragmented, while the resources for developing transport systems are decreasing.

MaaS is a paradigm change in transportation towards offering personalized and smart mobility services reflecting users' different needs such as seamless, well-functioning transport services (transport as an "experience") as well as easy access to mobility at urban and suburban level. MaaS is all about multimodal passenger transport, shared mobility, multimodal traveler information, integrated booking/ticketing/payment, etc. MaaS is fed by scheduled public transport services, public/private parking, private sharing mobility services, on-demand public transport services, etc.

MaaS can be designed in different ways and with different types of actors as the lead. On a European level, the MaaS Alliance, supported by European network for ITS deployment (ERTICO, www.ertico.com), was formed during 2015 with the aim to stimulate the implementation of MaaS in Europe. Established at the ITS World Congress in Bordeaux in 2015, following the launch of the MaaS concept at the ITS European Congress in Helsinki in 2014, the MaaS Alliance is a public-private partnership working to establish foundations for a common approach to MaaS and to unlock the economies of scale needed for successful implementation and uptake of MaaS in Europe. The MaaS Alliance facilitates stakeholder cooperation through a shared work programme engaging all relevant stakeholders: i) Transport service providers and public transport operators; ii) MaaS operators and integrators; iii) IT system providers; iv) Customers; v) Cities, local, regional and national authorities.

Expected benefits of MaaS implementation are not only related to transport users' but also to both the public sector and businesses. For the public sector, MaaS development means improving the effectiveness of the whole transport system, efficient allocation of resources based on users' needs, reaching a more reliable and accessible transport system through advanced data deployment, etc. On the other hand, public transport operators can benefit making easier to use public transport as part of the value chain and becoming the operators of new, seamless and user-oriented mobility.

The public sector should act as an enabler building a regulative framework aimed at ensuring transparent market conditions, ensuring fair market performance and securing the legal position of users (as consumers) instead of technically-focused regulation of individual transport modes.

For businesses, MaaS development means generating new business by profitable markets for new transport services, renewing opportunities for the traditional transport business sectors as part of innovative services concepts, providing smarter transport connections for all sectors, etc.

MaaS comprises the following main components that enable integrated mobility services:

- **registration (including selection of potential MaaS mobility package)**
- **multimodal traveller information**

- **ticketing/booking**
- **shared mobility**
- **payment**

To enter in the "Customer Travel Experience" within the MaaS concept, users need to make a one-time **registration**. By creating an account, users should provide personal which includes: age, gender, family status, health conditions and disabilities, vehicle license availability, car ownership, mobility preference information, etc. Within the registration process, users might be recommended to upload driving license information necessary for using car sharing service(s) offered by the MaaS platform.

The step ahead through a one-time registration process is represented by the selection of potential **MaaS mobility package** where users might pay a one-time registration fee by purchasing the package (e.g. standard/core MaaS mobility package, customized/personalized MaaS mobility package, etc.).

In this respect, it is quite important to timely define which types of mobility package might be offered thought the definition and agreement of the different services/functionalities of the Maas mobility package (e.g. real-time transport information, multimodal journey planner, smart ticketing, booking system, sharing mobility resources and/or services, pay-as-you-go payment for all modes).

Individualized **multimodal traveller information** provided by integrated traveller information services via web-based and app-based solutions is a key factor for seamless door-to-door multimodal mobility. European Directive 2010/40/EU on the framework for the deployment of ITS provides priority actions on the setup of EU-wide multimodal travel information services (Directive 2010/40/EU). To provide seamless and connected transport network, multimodal traveller information is a key feature in the integration of different transport modes on a digital level as well as on an organizational level. Multimodal traveller information provides a basis for the deployment of MaaS service concepts. Some services incorporate for instance real-time information on public transport schedules, routing information for different transport modes, journey planning, etc. Once users entered pre-trip essential information (e.g. destination, times, preferred duration, etc.), the system should be able to provide different (ranked) multimodal route options accordingly and match the most suitable route for the user based on the journey information they provided pre-trip.

Ticketing/booking is an integral part of MaaS. With more sophisticated ticketing, the customer experience can better meet customer expectations, which can foster co-modality and intermodality. In this respect, **ticketing** could contribute to the overall improvement of the transport network level of services and accessibility, with the main aim to facilitate and increase the use of alternative transport and contribute to the overall sustainable transport goals. Existing obstacles need to be removed and common data and information interfaces need to be created. Ticketing as a MaaS component especially requires integration with other MaaS service components to be effective.

Ticketing is just one step in the "Customer Travel Experience" within the MaaS concept. A smart card can serve for instance as the sole ticket to access mobility services such as public transport or release a shared car. On the other hand, more technology advanced solutions based on smartphones can be used as the sole ticket for accessing multimodal mobility services instead of a common smart card. In this case, smartphone would be scanned in the same way as a smart card would be to access modes. To book vehicles (e.g. taxi, car sharing, etc.), user should be transferred to the MaaS **booking system** which is a centralized platform that brings users and transport operators all into one place. MaaS booking system should be able to integrate the booking systems of all transport providers.

When user chooses to take a transport mode that requires booking (taxi, car sharing) the MaaS booking system should enable to book it for its journey. Company and price should be all presented to the user enabling to book and then receive complete message with the information of the vehicle (taxi, car). In case of vehicles equipped with GPS devises, user could be possible to view when the taxi is approaching or where is located the nearest vehicle of station-based or free-floating car sharing.

Shared mobility is needed to intensify the transport system by reducing the number of private cars commuting daily on the road network, and promoting alternative options like carpooling, ridesharing or bike sharing as first/last-mile options. The aim is to reduce the number of 'second car'-households (or ideally even some 'first car'-households) and enable a seamless transition from individual to multimodal public transport without needing to own a private car. ICT technology and especially the provision of smartphone or web-based applications can facilitate an easier access to available, shared mobility resources and services. In this respect, ICT technology and smartphone/web-based applications can facilitate an easier access to available, shared mobility resources and services. ICT-development can also enable a more transparent presentation of available supply and hence improve general situational awareness about available mobilty services.

Different sharing mobility concepts can be considered and implemented including:

- station-based mobility service (users are able to use mobility services in which vehicles/bikes need to be returned at predefined stations),
- mostly station-based mobility service (users are able to use mobility services in which vehicles/bikes need to be returned at predefined stations as well as in which vehicles/bikes can be left everywhere within a delimited area),
- free-floating mobility service (users are able to use mobility services in which vehicles/bikes can be left everywhere within a delimited area)
- private mobility sharing service (Peer-2-Peer) in which vehicles/rides are shared among private persons (e.g. carpooling) without a company providing the equipment (e.g. car, bike).

Payment represents the final step of the "Customer Travel Experience" within the MaaS concept. In addition to the traditional pay-per-use model, fixed or customized monthly packages can be offered as well. User might purchase a MaaS pre-paid mobility package in which direct debit and automatic renewal are available. On the other hand, the amount might be deducted at each time of use though the pay-as-you-go service provided by the system as well. For instance, if users purchase a monthly MaaS mobility package, smart card or smartphone/tablet will record the amount of use for each corresponding mode taken and recalculate the balance of monthly package. In case of exceeding the total monthly amount, users might have options to either pay separately by receiving a monthly bill or proceed with direct debit to pay their monthly package plus the exceeding part altogether.

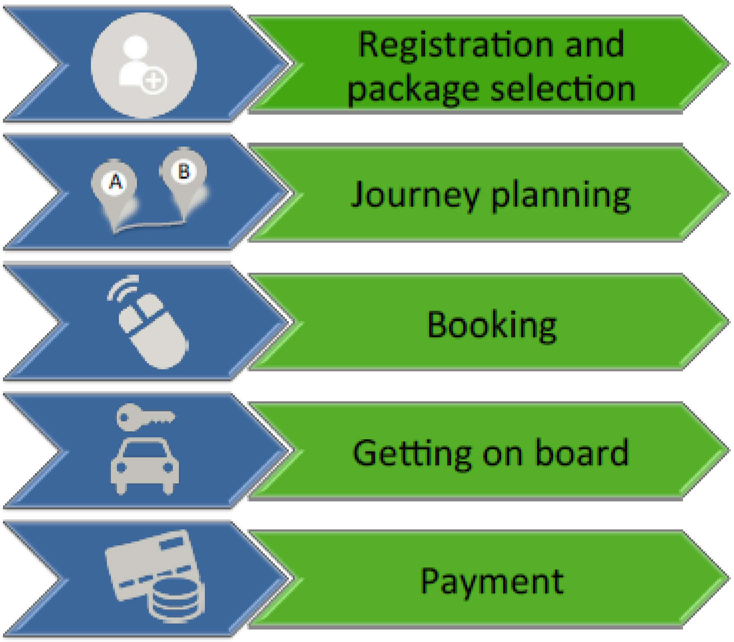


Figure 2: MaaS potential services *(Source: UCL, Feasibility Study for "Mobility as a Service" concept in London, 2015)*

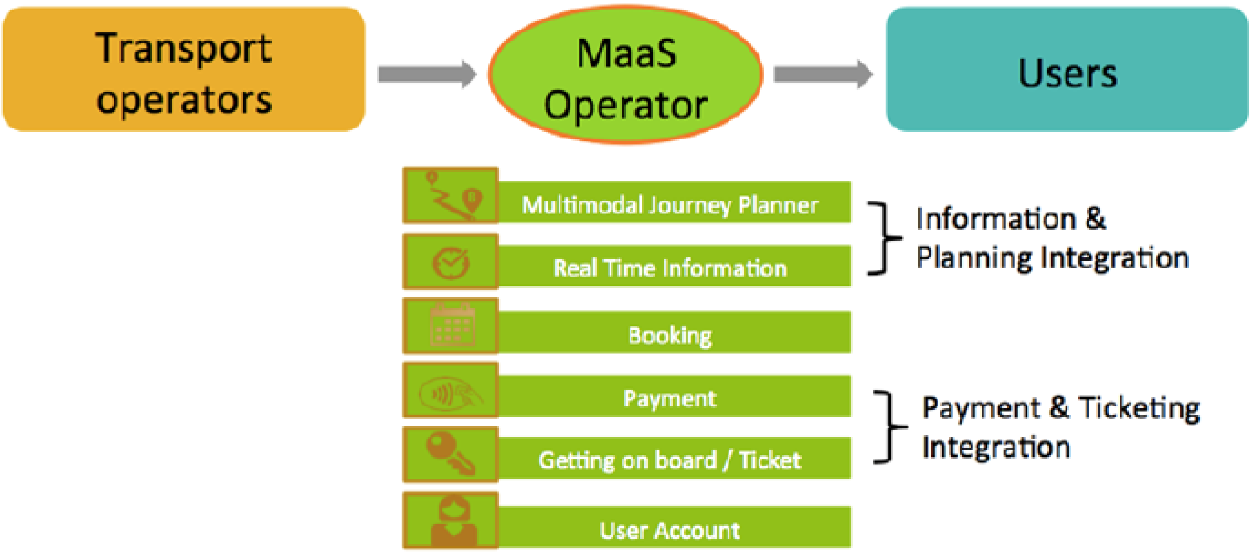


Figure 3: Functions of a MaaS operator *(Source: UCL MaaSlab, 2015)*

Figure 4: Main processes in MaaS offering *(Source: MaaS Alliance, White Paper – Guidelines & Recommendations to create the foundations for a thriving MaaS Ecosystem, 2017)*

As the deployment of MaaS strongly relies on the provision of ICT technologies, the focus within this document is on the related requirements. In this respect, already employed technologies within MaaS and related services have been identified and described for effective MaaS development.

Preliminary self-assessment (readiness level)

Before the design and implementation of ICT-based solution for MaaS offering, it is recommended to undertake a preliminary self-assessment of its applicability and readiness in the target FUAs.

The **MaaS Readiness Level Indicators Framework** was developed within the CIVITAS ECCENTRIC project (2016-2020) where Madrid, Stockholm, Munich, Turku and Ruse are working together to tackle the challenges of mobility in suburban districts and clean, silent and CO2-free city logistics.

- **MaaS readiness level indicators** highlight the different aspects of MaaS development that are identified to showcase the local authorities' current situation for establishing MaaS in the local context;
- **Readiness level indicators** are aimed as a starting point for local authorities;
- MaaS readiness level indicators give a cross-sectoral view on how prepared each local authority is for the change and what sort of decisions it has already made regarding transportation and how these supports the implementation of the new transport services.

MaaS indicators consist of eight different components:

- **Strategic readiness**
  - Strategic focus
  - Parking policies
- **Internal use**
  - Travelling guidelines
  - Use of shared mobility
- **Shared use**
  - Shared economy
  - Public transport
- **Shared understanding**
  - Integration platform
  - Visibility

STRATEGIC READINESS
Strategic focus
Parking policy
INTERNAL USE
Travelling guidelines for the staff and politicians
Use of shared mobility within local administration
SHARED USE
Shared economy – availability and market penetration of shared and combined travel options
Public transport (PT)
SHARED UNDERSTANDING
Integration Platform
Visibility – how obvious and easy to get are the shared mobility offers to the citizens

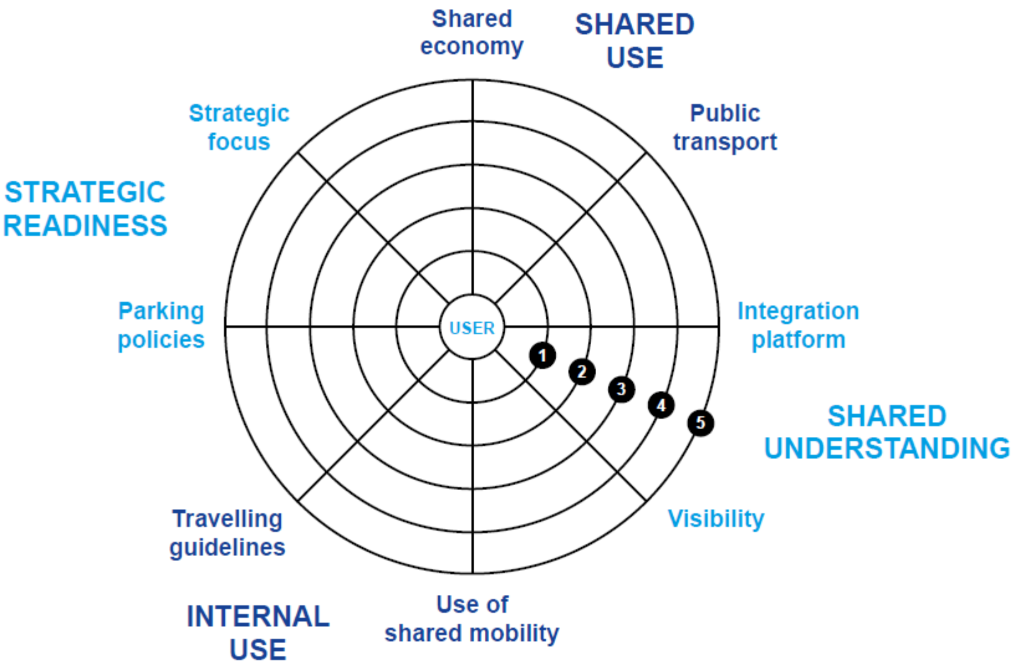


Figure 5: MaaS readiness level diagram (Source: CIVITAS ECCENTRIC)

The results of preliminary **self-assessment performed in the SOLEZ pilot sites** which are planning to address the MaaS concept in the respective target FUA (Turin, Graz, Sárvár) is provided below.

Turin is planning to design and implement two different low-carbon Value-Added mobility services: a MaaS scheme (passenger transport) as well as multi-users lanes (freight transport).

Based on consultation process with the local stakeholders, **Graz** is planning to promote soft mobility modes (mostly walking) by integrating into tim (a multimodal transport and mobility hub) that offers, inter alia, car-sharing, for example, by including the digital maps for a green network.

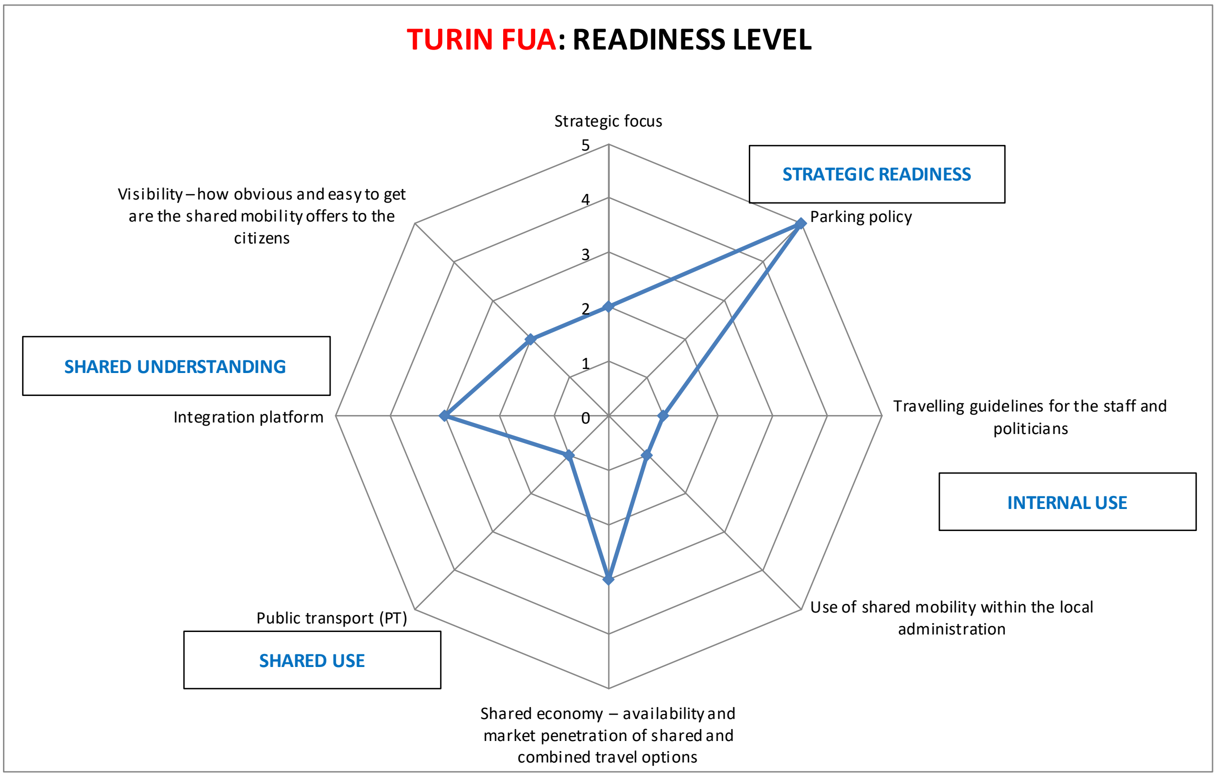
Sárvár is planning to develop the MaaS concept to aggregate the different transport solutions by one app, enabling to provide multimodal passenger mobility solutions.

On the other hand, the remaining two SOLEZ pilot sites (Vicenza, Gdansk) involved in Added-Value service development in the target FUAs are planning to address freight transport as follows:

- B2C last-mile delivery by cargo bikes (**Vicenza**) for LTZ shoppers, including residents, city users as well as tourists
- B2B last-mile delivery by cargo bikes (**Gdansk**) for the pedestrian areas of the city.

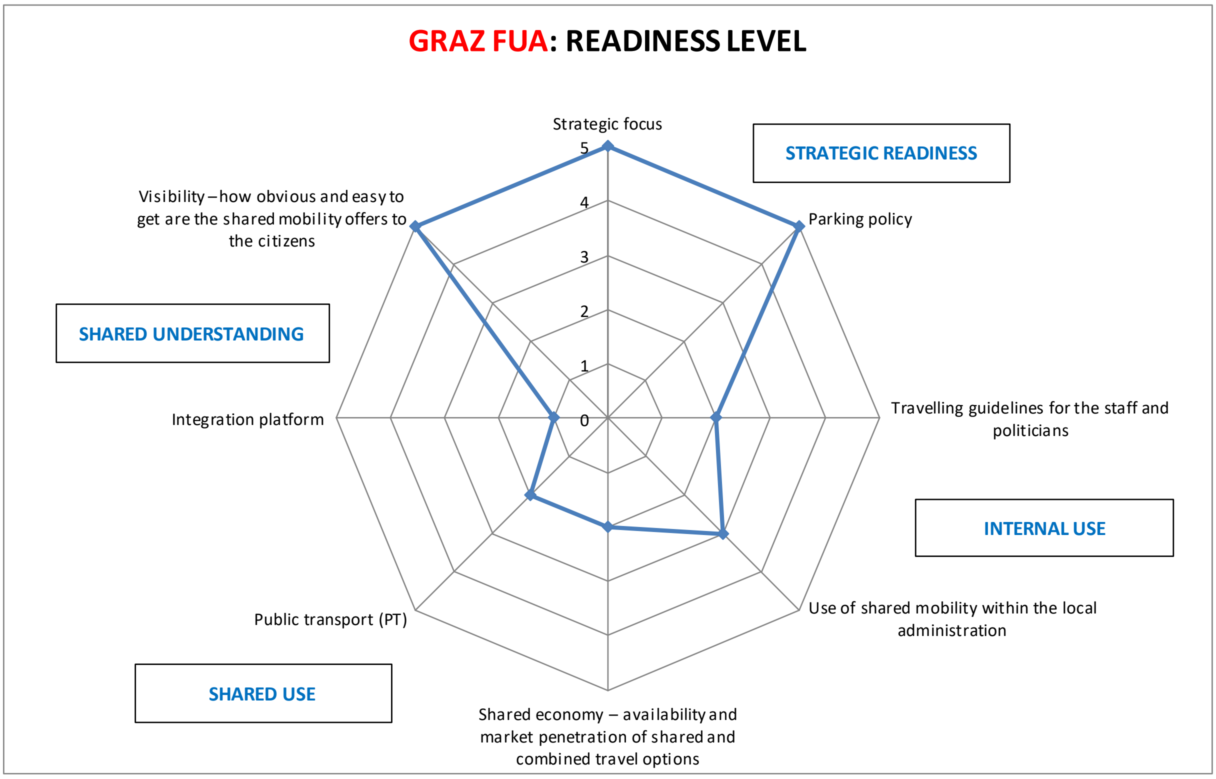
The two above Added-Value freight services are not focused on technological-driven and ICT-based solutions, being mostly business case-oriented initiatives as well as organisational-based measures.

Therefore, these two services are not focus on ICT-based tools, where information and communication technologies are an “accessory” part of the service as a whole, reason why they are out of scope of this report aimed at guiding PAs and businesses in the development and implementation of the identified Added-Value services through interoperable ICT/ITS solutions.



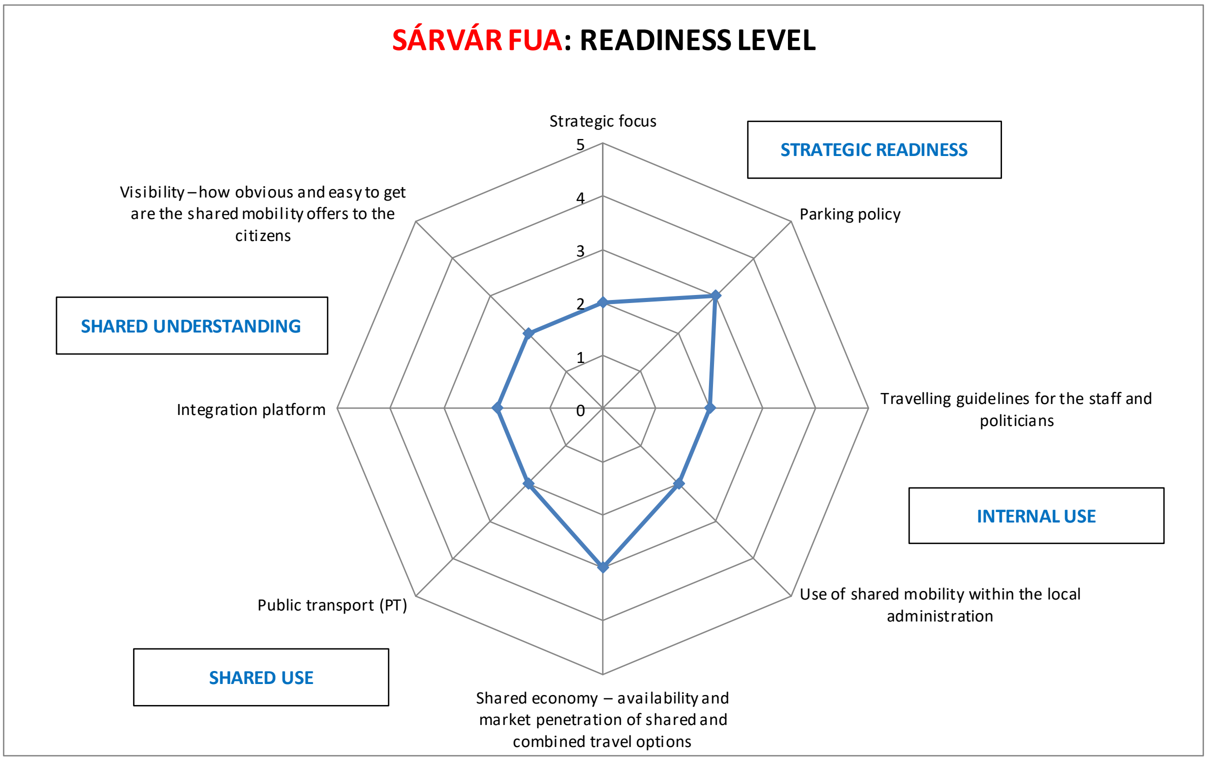
STRATEGIC READINESS	3,5
Strategic focus	2
Parking policy	5
INTERNAL USE	1
Travelling guidelines for the staff and politicians	1
Use of shared mobility within the local administration	1
SHARED USE	2
Shared economy – availability and market penetration of shared and combined travel options	3
Public transport (PT)	1
SHARED UNDERSTANDING	2,5
Integration platform	3
Visibility – how obvious and easy to get are the shared mobility offers to the citizens	2

Figure 6: MaaS readiness level diagram and indicators for Turin FUA



STRATEGIC READINESS	5
Strategic focus	5
Parking policy	5
INTERNAL USE	2,5
Travelling guidelines for the staff and politicians	2
Use of shared mobility within the local administration	3
SHARED USE	2
Shared economy – availability and market penetration of shared and combined travel options	2
Public transport (PT)	2
SHARED UNDERSTANDING	3
Integration platform	1
Visibility – how obvious and easy to get are the shared mobility offers to the citizens	5

Figure 7: MaaS readiness level diagram and indicators for Graz FUA



STRATEGIC READINESS	2,5
Strategic focus	2
Parking policy	3
INTERNAL USE	2
Travelling guidelines for the staff and politicians	2
Use of shared mobility within the local administration	2
SHARED USE	2,5
Shared economy – availability and market penetration of shared and combined travel options	3
Public transport (PT)	2
SHARED UNDERSTANDING	2
Integration platform	2
Visibility – how obvious and easy to get are the shared mobility offers to the citizens	2

Figure 8: MaaS readiness level diagram and indicators for Sárvár FUA

2.3 Multi-users lanes concept

Freight vehicles picking up and distributing goods at urban level are allowed free access to public transport priority lanes (*free access to public transport lanes*). Vehicles need to meet certain criteria set by the city administration to qualify for access, offering an incentive towards cleaner vehicles.

To optimise the use of available street space, multi-functional lanes are introduced. Using VMS (Variable Message Sign) technology, lanes can be designated for varying types of traffic and/or parking at various times of the day, including a "slot" for goods deliveries (*multi-user lanes*).

Free access to public transport lanes starting from less polluting and heavy freight vehicles might encourage promotion and usage of Environmentally Friendly Vehicles (EFV) in urban freight - encouraged by several urban authorities and national governments across Europe - since important developments on low emission vehicles (e.g. hybrid vehicles, etc.) have already been achieved. Many municipal and national activities started to encourage the use of EFV in urban freight transport.

Within Barcelona, three lanes are used as "multi-use lanes" installed with VMS technology which clarifies who is allowed to use the street (residents, deliveries) according to the time of the day.

The city of Turin is implementing the **multi-users lanes** concept, including effective access management of recognized freight vehicles in public transport bus lanes while maintaining an acceptable level of service for the whole PT system. The goal is to reduce emissions for freight traffic.

Multi-users lanes concerns the possibility of sharing dedicated bus lanes by logistics operators without affecting public transport system (maintaining acceptable level of service) and reducing congestion for all categories of users in the city road network.

For what concerns the multi-users lanes, the sharing of such high-speed lanes between PT and logistics operators was envisaged in the Freight Quality Partnership (FQP) signed in 2013. Then it followed a real-life pilot involving initially a fleet of 20 vehicles that took advantage from the use of the so-called Olympic lanes (high-speed lanes developed for fast movement of referees and athletes during Winter Games 2006). The pilot involved key express courier companies that deliver in LTZ[1].

The results collected from on board units of recognised freight vehicles have been very promising so that the City Administration decided to test the possibility to extend the use of reserved lanes to the PT lanes. This cannot be tested in real life immediately and that is the reason for the development and implementation of a pilot based on model simulation. If the inclusion of freight vehicles in PT lanes network will not affect the level of service of buses (e.g. commercial speeds, etc.), it will be implemented at full scale in real environment. In the SOLEZ project, City of Turin will continue and enlarge the NOVELOG experience[2], including electric and Natural Gas-Powered (CNG) vans.

Preliminary self-assessment (readiness level)

Multi-user lanes

- **Category of the measure:** Organizational
- **Policy design of the measure:** Initiated/supported by public administrations.

[1] TNT, DHL, UPS, FEDEX, SDA, GLS, BARTOLINI
[2] NOVELOG project pilot involves about 50 freight vehicles

- **Involved stakeholders:** Administrations, Freight carriers, Shippers, Residents.
- **Possible barriers:** Possible financial obstacles: Need for investment in VMS systems to regulate the multi-user lanes, plus necessary enforcement staff. Possible technical obstacles: Important to ensure that all users respect and obey the designated timeslots. Failure to effectively enforce the system will result in it being abused and ignored.
- **Innovativeness:** Although priority lanes are widely used, we are not aware of any other cities which operate timed multi-user lanes of this kind.
- **Driver for success:** Availability of necessary infrastructure. A legal basis must exist or can be adopted for designation of multi-user lanes. Effective enforcement is critical so that the measures are respected by all users, especially at the beginning.
- **Transferability:** The measure is replicable, but requires investment in VMS systems, signage and sufficient enforcement staff.

Common strengths are herewith presented for free access to public transport lanes/multi-user lanes.

- bus lanes are an efficient use of road space, because less vehicles circulates for them;
- a study of existing bus lanes in Norwich (UK) was undertaken to determine the most suitable lanes for heavy goods vehicles to use. It might be decided to allow only heavy goods vehicles (HGVs) associated with specific Freight Consolidation Centre / Urban Distribution Centre to use most appropriate (priority) bus lanes for their goods pickup/delivery service provision;
- allow the use of bus lanes by consolidation centre vehicles was considered a means to promote use of the consolidation centre;
- opinion of freight companies, logistic organisations, bus companies, cyclists' organisations and public authorities should be considered to define the viability of bus lanes usage;
- increase of the average speed of freight vehicles to access the city centre;
- consumption fuel reduction due to there is less congestion along priority bus lanes;
- CO2 and NOX emissions reduction due to less congestion along priority bus lanes;
- reduce journey times per freight transport and delivery trip;
- training for drivers who drive consolidation centre vehicles to aware them about the presence of the cyclists (i.e. freight vehicle drivers trained for economy/ecology driving, etc.);
- freight vehicles are fitted with blind spot lenses to see the cyclists.

Common weaknesses are presented for free access to public transport lanes/multi-user lanes.

- the width of existing bus lanes (generally 3.0m wide) might be a barrier to implement measure; it might be decided that only consolidation centre vehicles could use the bus lanes;
- some stakeholder opposition to the measure might be encountered, particularly from cycling organisations who believe that it is unsafe to mix HGV's with cyclists along bus lanes;
- the length of bus lane that can be used is small (3,2 km) when compared to the overall journey length from the consolidation centre to the city centre;
- the main benefits from using an inbound bus lane only occur during peak periods;
- there is only little benefit from this measure in off-peak periods;
- an increase of freight vehicles circulating in narrow bus lanes could be dangerous for cyclists;
- reduction of journey time savings due to more freight vehicles use the bus lanes.

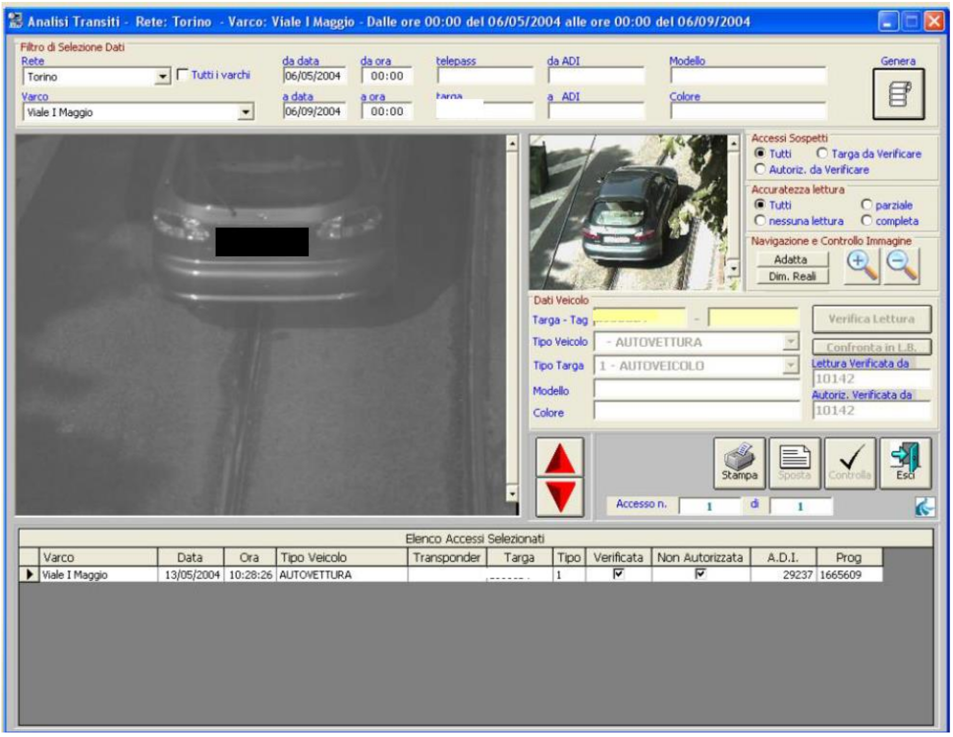


Figure 9: Example of multi-users lanes concept (*Source: 5T srl*)

3 Passenger ICT-based supporting tool: MaaS development

3.1 Passenger Value-Added Services: MaaS

Setting the scene

MaaS constitutes the integration of various forms of transport services into a single mobility service accessible on demand. The aim of MaaS is to be the best value proposition for its users, providing an alternative to the private use of the car that may be as convenient, more sustainable and even cheaper. As infrastructural measures mostly entail high investment costs to be covered by the public sector, planning measures delivering more efficient and sustainable resource utilization are of high relevance including digital networks, new ICT technologies, shared mobility as well as new types of mobility offers. MaaS aims at establishing integrated and more personalised mobility services.

End users are the focus of the MaaS services: current travel behaviour and mobility patterns can provide insight for MaaS product and system design. When designing and developing the MaaS ecosystem, the principle of openness and inclusivity should be fully respected, enabling to offer a MaaS system open to all service providers and inclusive for all different kind of users.

The MaaS ecosystem and different actor roles are introduced, showing that there are business opportunities for MaaS operators, platform providers, mobility service providers as well as for public transport if the MaaS service is designed in a right way. To build attractiveness and public acceptance for MaaS services, the whole value chain should be carefully and inclusively designed to meet the high expectations related to ecological and financial sustainability.

From **the supply side** viewpoint, it is recommended to set-up and implement a collaborative partnership between potential MaaS offering provider and transport services suppliers at urban and peri-urban (FUA) level. The MaaS service might include public transport, rail, taxi, car sharing, bike sharing, etc. In this respect, each individual transport and mobility service supplier should agree to the terms (obligations) which should be set. **Obligations** might be to provide timetable information (public transport and rail), price information (public transport, rail, car sharing, bike sharing, taxi), booking information (rail, car sharing, taxi), station locations (public transport and rail), locations of parking bays (car sharing and bike sharing), information of special services (car sharing and taxi) as well as drivers' information (carpooling). Operators of different services should indicate the price they charge on a unit basis (e.g. cost for each km/mile, cost for each hour, etc.).

On the other hand, operators should also supply several basic information such as real-time information (e.g. instantaneous timetable for public transport and rail, availability for bike sharing and car sharing vehicles, etc.), location information, booking information, etc. Operators (car sharing and taxi) might finally provide sustainability information based on vehicle characteristics (e.g. full electric, CNG, hybrid, etc.), enabling users to be environmental friendly.

Main roles and responsibilities of stakeholders within MaaS is provided in Table 1.

Level	Stakeholder	Roles, responsibilities and obligations
National road authorities and ministries	Ministry of Transportation	Legislator, responsible for transport policy and strategies, financing infrastructure investments
	Transport Agency/ Road Administration	Implementation of transport policy, strategy and investments, (long-term) plans and guides for the national development of (new) transport services
	Transport safety agency/ authority	Issues permits, regulations, approvals and decisions, prepares legal rules regarding the transport sector
Local authorities	Regional/local transport agency	Plans, organizes and manages public transport in the region, provides locations of stations and stops
	The city and city planning department	Strategic urban and city planning, responsible for transportation, traffic planning, local infrastructure
MaaS operator	MaaS company, public transport operator, PPP etc.	Combines the existing transport services into a single mobile application on the "one-stop-shop" principle and provides personalized transport plans tailored to customer needs; responsible for customer service
Transport service providers	Public transport	Provide schedules, fares as covered by ticketing and real-time information
	Rail	Provide schedules, fares covered by ticketing and real-time information and booking information
	Bike sharing	Offer fares, locations (bikes and docking stations)
	Car clubs (e.g. sharing, rental)	Provide fares, vehicle information, booking information, availability, locations
	Ride sharing	Provide drivers and rides database
	Taxi	Provide fares, vehicle information, booking information
Mobile service provider (MSP)	3^{rd} party technology, ICT and service providers	Provides key enabling technology and services (e.g., mobile ticketing and payment) to MaaS operator and transport service providers

Table 1: Roles and responsibilities of stakeholders within the MaaS ecosystem (*Source: MAASiFiE, Business and operator models for MaaS, 2016)*

The central element of MaaS requires a mobility platform that offers mobility services across modes.

A mobility platform could be considered a virtual market place for transport services. It is necessary to **make use of existing technology to achieve better usage of already existing infrastructure and**

services in the first place. In fact, one should focus the application of MaaS on areas where good physical connections are already in place. In principle, MaaS is about integrating transport modes through the internet. This can be seen in the context of connected infrastructure and the concept of smart cities, which leads to the question of how to guarantee the necessary availability and capacity of internet connections. Development of the MaaS offering will rely on access and openness data, open **APIs (Application Programming Interface**), more flexible transport and mobility regulations.

ICT-based supporting tool: MaaS value chain and feasibility

Even though MaaS has a strong orientation towards the implementation of new business models and requires new organisational concepts, technology is an important enabler to provide citizens with access to public and private real-time mobility services. Working ICT infrastructure as well as intelligent and connected infrastructure are vital elements in MaaS deployment.

Using existing mobile networks, MaaS can be deployed cost-effectively.

Open interfaces further accelerate the emergence of new and innovative mobility services. Open **APIs (Application-Programming-Interfaces)** provide simplified linking of different digital web-based services. By enabling Open API standards, even third-party developers can be provided with the programmatic access to proprietary mobility service solutions. APIs basically represent, in this context, a set of requirements that govern the interaction and communication among different web-based services. Depending on the use of APIs (whether end-user oriented; publisher-client communication; operator-to-operator oriented services; or publisher to another publisher communication), different requirements on different technical levels arise.

Within the **MaaS value chain** the following modular levels/functions can be defined:

- **Data Level**: One basic function is data collection. This encompasses the collection of all transport data (such as timetables and departure times) as well as dynamic raw data (e.g. traffic or weather data measured using sensors). This is done in strict compliance with data protection laws. Processing of these data is done at this stage as well. For instance, updating and validating data is done at this stage together with gathering data on pricing schemes.
- **Information Level**: Based on the processed data, information can be gathered which is further required for the MaaS service implementation. At this stage for instance information generation and maintenance such as storage/update of dynamic information is done.
- **MaaS Service Creation**: The information is analysed, pooled and interpreted to generate a wide range of MaaS service features. For instance, analysis of information, routing capability, and forecasting processes are performed in this stage.
- **MaaS Service Provision**: Each MaaS service has to be provided and accessed in a suitable form by respective end-user groups. Appropriate HMI/MMI (Human-Machine/Machine-Machine) interfaces have to be available. In most cases, smartphone-based apps are established on this level. Ticketing and payment procedures are defined at this level.
- **Mobility Market**: Describes the whole set of different available transport and mobility services being provided to respective end-users/travellers/user groups.

Different service combinations in different geographical areas can be defined as well. Potential geographical areas to be considered for MaaS offering are cities (urban area), suburban and rural.

FUA might include for sure the three categories of geographical areas as above.

MaaS service combinations can be analysed through three elements:

- **value proposition,**
- **value creation system,**
- **revenue model.**

These elements form a company's business model framework. Maas should be the best value proposition for users, helping them meet their basic access needs and solving the inconveniences of the journey (e.g. congestion, safety and security risks, inconsistent costs, etc.).

The best value proposition is not limited to what is the quickest or most cost-efficient solution. Depending on the user´s priorities it can be the safest, most environmentally-friendly, most aesthetically appealing or providing the best working-while-commuting facilities. In a mobility context, a service promise means that users get a door-to-door solution from A to B or at least the best solution from A to B. The attractiveness of MaaS is based on the freedom and variety it offers.

Cities are the first places where MaaS is going to be implemented due to the high population and fruitful environment for testing and piloting. Cities have most of the transport modes and hence different service combinations already exist. The main objective of MaaS in **urban areas** is to reduce the ownership and use of private cars and by that reduce the traffic congestion, emissions and parking problems. The most effective way to reach this objective is to include all the available transport modes in the service coverage. MaaS services can be offered to both private consumers and company employees. Potential service combinations are presented in Figure 10.

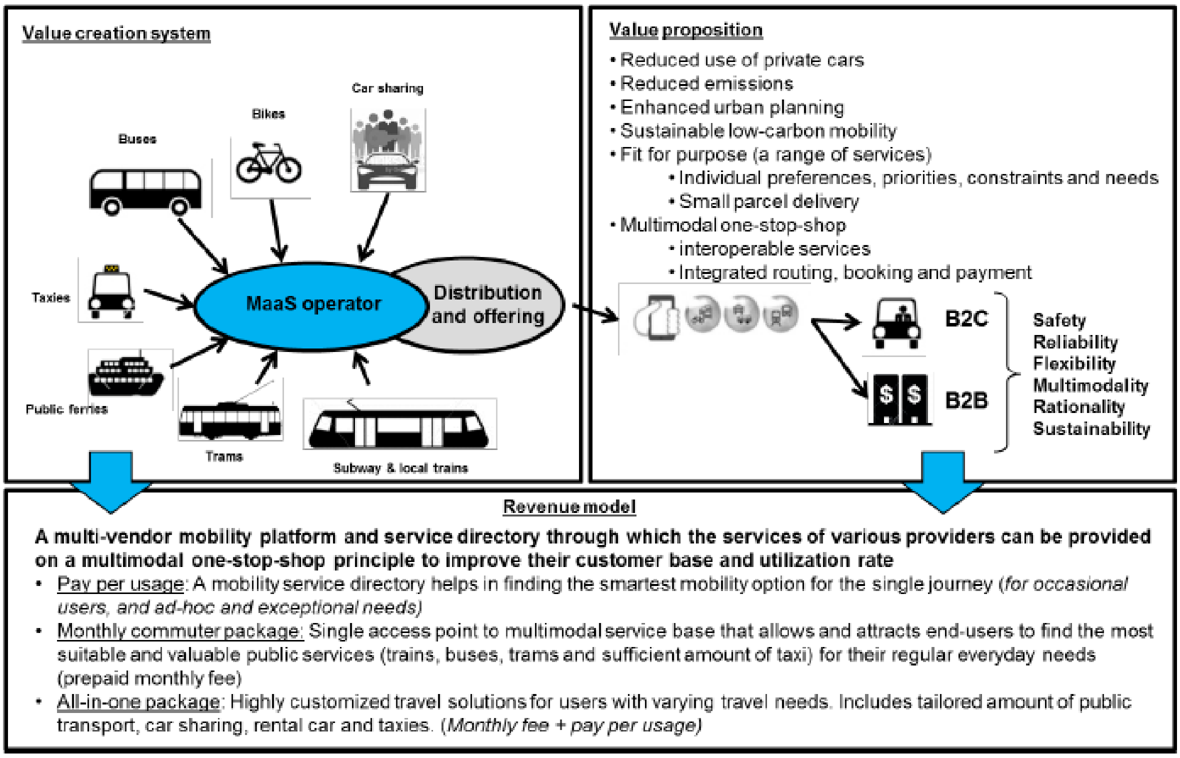


Figure 10: MaaS services in urban areas (*Copyright Aapaoja, A. & Eckhardt, J. 2016)*

MaaS in **suburban areas** is mostly focused to improve service levels (i.e., trams, buses, subway) by integrating taxis and other modes of demand-responsive transport with public transport. Suburban areas are potential locations for carpooling and ride-sharing if effective tools and platforms for managing those are available. Potential service combinations in suburban is presented in Figure 11.

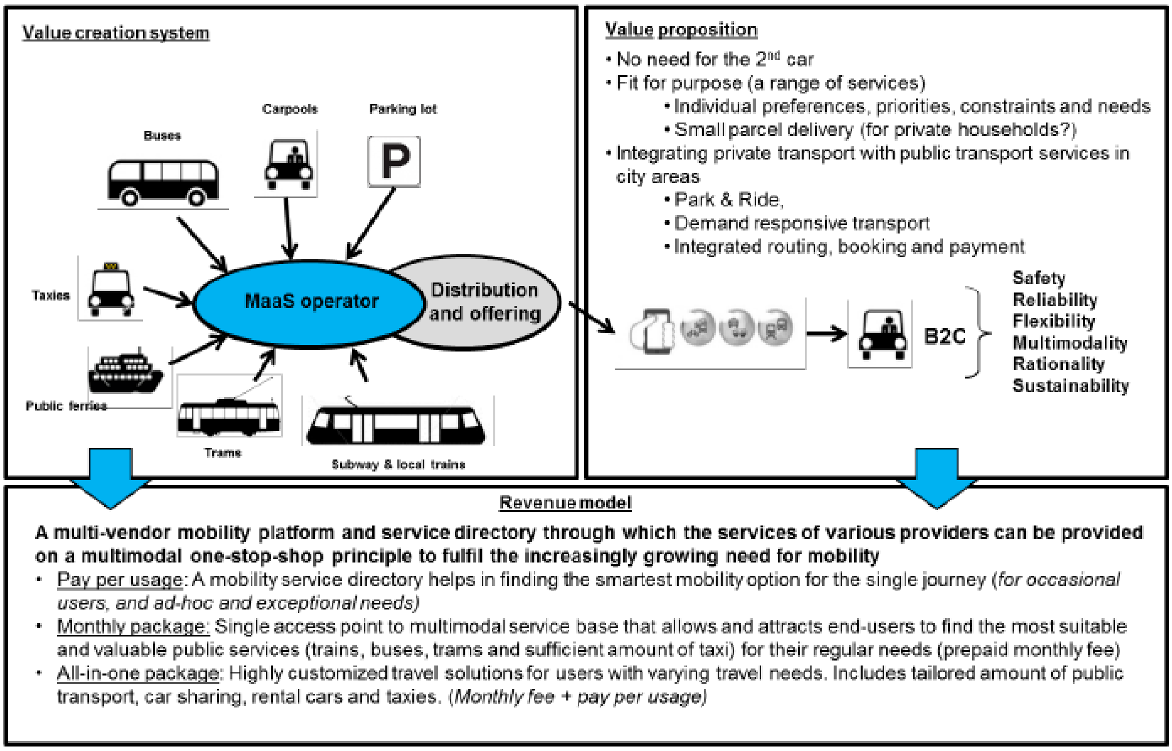


Figure 11: MaaS services in suburban areas *(Copyright Aapaoja, A. & Eckhardt, J. 2016)*

To some extent, MaaS services in **rural areas** are equivalent to the desired services in suburban areas. Rural areas are suffering from a lack of connections to long-haul and scheduled services. Potential service combinations in rural is presented in Figure 12.

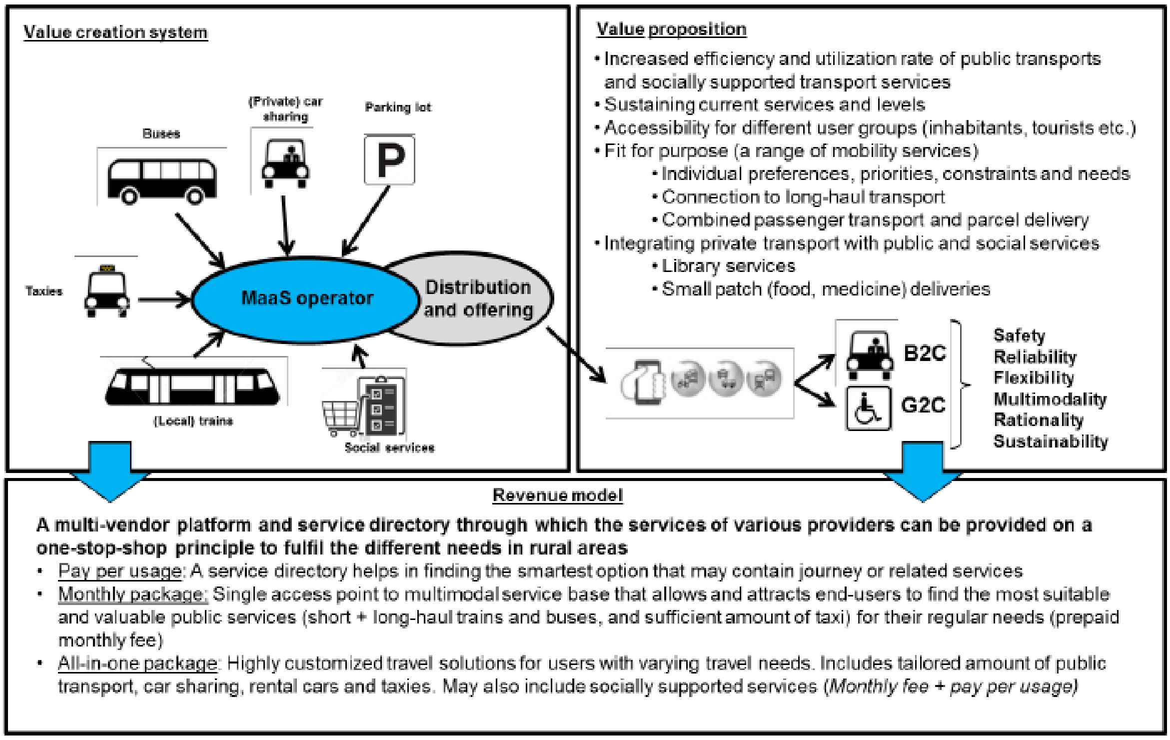


Figure 12: MaaS services in rural areas (*Copyright Aapaoja, A. & Eckhardt, J. 2016)*

Before starting with the MaaS development, it is important to consider potential of MaaS in different geographical scope, considering respectively urban, suburban and rural areas as well.

Cities	• **Objectives**: reduce the use of private cars (causing problems related to congestion, parking and emissions and air quality) • **Based on**: existing public transport, extended with rental and shared cars and bikes etc
Suburban areas	• **Objectives:** No need for a second car, first mile & last mile accessibility • **Based on:** park & ride services, on-demand transport and other services connecting suburban to city transport services
Rural areas	• **Objectives:** increase efficiency, maintain sufficient service level, improve accessibility • **Based on:** demand-reposonsive transport, taxis, buses and connections to long-haul transport, car-pooling: parcel deliveries, library services, grocery & medicine distribution as add-on services

Figure 13: Potential of MaaS in different geographical scope (*Source: MaaSiFie presentation, 2017)*

On the other hand, it is strongly recommended to **preliminary evaluate operational, technical and economic feasibility of implementing the MaaS concept** in cities, suburban areas or rural areas.

For the **operational feasibility** viewpoint, parties involved in transport and mobility service provision are expected to be influenced by MaaS development. It is recommended to evaluate acceptability level distinguishing between two different categories of stakeholders as follows: 1) internal stakeholders (parties within the organisation which is planning to implement MaaS); 2) external stakeholders (parities outside the organisation which can cooperate in MaaS implementation).

The most promising and suggested organisation to implement MaaS should be the organisation responsible for the transport system in city and/or region. The MaaS development could contribute to the implementation of the overall sustainable transport and mobility strategy of city/region, according with the transport and mobility planning framework (including SUMPs, Mobility Master Plans, Air Quality Plans, Urban Mobility Plans, Urban Traffic Plans, Freight Development Plans, etc.).

Being MaaS a very technology-intensive transport solution, it will need skilled manpower able to successfully operate and maintain the MaaS platform, integrating different transport modes and data. On the other hand, both the supply (transport operators) and the demand side (users/customers) must be willing to join and use the MaaS platform as well.

From the **supply side**, it should be verified potential acceptability to join MaaS for the different transport and mobility service suppliers for each category of service (e.g. public transport, rail, bike sharing, car sharing, carpooling, taxi, etc.). Moreover, existing ride sharing ICT-based platforms which operate in city/region might benefit from joining MaaS, by enjoying a larger potential market.

From the **demand side**, MaaS offering should enable users/customers to enjoy savings in travel expenses and journey time, enhancing transport's accessibility, encouraging sustainable modes, etc.

In this respect, technology penetration though a wide spread of smartphone and tablet adoption represents a fundamental enabler to MaaS-based services deployment across Europe and beyond. Nevertheless, common smart cards can be also considered to achieve wider promotion and usage by the group of population that are less familiar with new technologies such as the elderly, etc.

For the **technical feasibility** viewpoint, the design, operation and maintenance of MaaS system are the most important elements of the MaaS concept real-life implementation. Maas system needs to be setup and complemented by the necessary integration of infrastructure and equipment as well.

Main technical elements to be considered for the successful development of MaaS are as follows:

- **information technology integration**,
- **infrastructure and equipment integration**.

The MaaS concept should be focused to the **integration of already existing mobility tools and technologies** into one easy-to-use platform. The integration is based on overall concept that MaaS will not designed to replace any of the existing businesses, but it will only offer an innovative way to bring a larger market to each individual transport operator and mobility service provider.

In this respect, possible technical scenarios for MaaS developing are represented as follows:

- *Scenario A*: expanding current web-based traveller information system and/or journey planner of public transport operator/mobility agency/transport authority in city or region;

- *Scenario B*: bringing on one of the existing traveller information system and/or journey planner in city or region as a contracting partner within the MaaS concept;
- *Scenario C*: creating a completely new multimodal traveller information system and/or intermodal journey planner, designed according with MaaS architectural framework.

Developing a complete new intermodal journey planner could be made very specific to the MaaS concept without needing integration among existing sharing mobility and journey planning platforms. On the other hand, creating a new ICT-based mobility service platform would need of much more time, resources and efforts compared with simply information technology integration.

Creating an ex-novo ICT-based platform would have no existing customer basis that could easily be exposed to the new platform. The above two technical scenarios (namely *Scenario A and Scenario B*) enable to have access to current customer basis of existing ICT-based mobility service platforms.

Another important technical element to be considered for the successful development of MaaS is represented by **infrastructure and equipment integration**. A key driver for MaaS developing is to start from a baseline scenario characterised by a high level of ticketing and payment integration in public transport system. Already existing smart cards enabling to access intermodal public transport services can be considered as an important enabler for successful MaaS implementation.

This technical aspect might be addressed within different timeframes: initially, a smart card could be provided at MaaS registration phase enabling to access public transport, car and bike-sharing, etc. Then, when technology becomes more mature smartphones and tablets could replace smart cards.

For the **economic feasibility** viewpoint, transport operators and mobility service providers have complex fare structures which should be analysed to define and implement a potential one payment system within the MaaS concept. On the other hand, mature information technology, infrastructure and equipment needed for MaaS implementation might be already developed in cities and regions, enabling to concentrate efforts and financial resources for MaaS development mostly in the integration of these existing hardware and software infrastructures. It is necessary to also consider other types of costs that Maas development may incur, such as costs of promotional campaigns addressed to citizens, the marketing costs to penetrate user market, the lobbying costs to persuade and recruit transport operators to join MaaS. Finally, MaaS operation and maintenance costs as well as local-based taxes should be considered as well within the overall costs for MaaS implementation.

On the other hand, potential MaaS revenue might include monthly package sales, pay-as-you-go fares, smart card sales, app downloads revenue, commission fees from transport operators, etc.

In terms of user requirements, the MaaS app should address the following key objectives:

- offering added value compared to existing information services such as the local public transport operator’s travel planner and Google maps,
- offering information on all modes of transport,
- offering information on journeys to be undertaken “now” and journeys planned for later,
- offering information in real time,
- offering customize information.

ICT-based supporting tool: MaaS technical description

In terms of technology, main critical points for MaaS development are interoperability, roaming and harmonised standards. An essential prerequisite for a successful MaaS implementation is to design and set up an open middle-layer platform to connect transport and mobility service providers with a potential MaaS operator (integrator). This business-to-business (B2B) platform should be managed or operated by an entity (B2B integrator) distinct from both transport service operators and MaaS operators. The platform manages the business processes related to the collection of data from the various service providers, including trip information, routing, transactions, takes care of the various B2B clearing processes, and makes relevant data available to MaaS operators in the form of APIs.

From the technical viewpoint, a potential MaaS operator should be responsible of implementing an ICT-based system to set up services, publish data, interface with third party modules and to integrate different public and private transport service providers. Service requirements mainly deal with the provision of common and open interface concepts, allowing service providers to contribute to a jointly operated MaaS system. While data requirements focus on the provision of a common basis for embedding different data and information sources, service requirements concentrate on the provision of harmonized and agreed-upon information exchange and interface procedures, including usability requirements. MaaS operator should also promote interoperable interfaces in the MaaS ecosystem (for transport service providers and other service providers) and share anonymized data with the city/suburban/rural areas, other mobility stakeholders as well as with other integrators.

Accessibility to end-user devices is required for consuming final MaaS services and allows the provision of real-time interaction between end-users (travellers) and producers (e.g. transport operators and/or service providers). Wireless networks, especially, provide a key enabling technology fulfilling the physical requirements. For instance, the evolvement of 5G and 4G/3G mobile network technologies together with the integration and expansion of local wireless communication networks (e.g. WLAN and Bluetooth) pave the way towards a seamless access environment to MaaS systems.

MaaS can be presented to end-users in different ways with different technologies and in different formats: in this respect, **web-based technologies represent a key driving technology for the provision of MaaS services.** MaaS system architecture is based on the use of web technologies.

The suggested architecture provides an overview of the technical MaaS system and related operations, but for sure it might be other technical solutions available and used that fulfil the same requirements. Nevertheless, there is a strong focus on using internet-based technologies, the use of mobile web-based devices like smartphones or tablets, as they already have a high penetration rate and enable cross-linking of different services, including common payments.

The MaaS system architecture analysis systematically links to the organisational background of the corresponding MaaS system. In other words, processes and technologies required for final MaaS service provision are highlighted in the MaaS system architecture, as indicated in Figure 14.

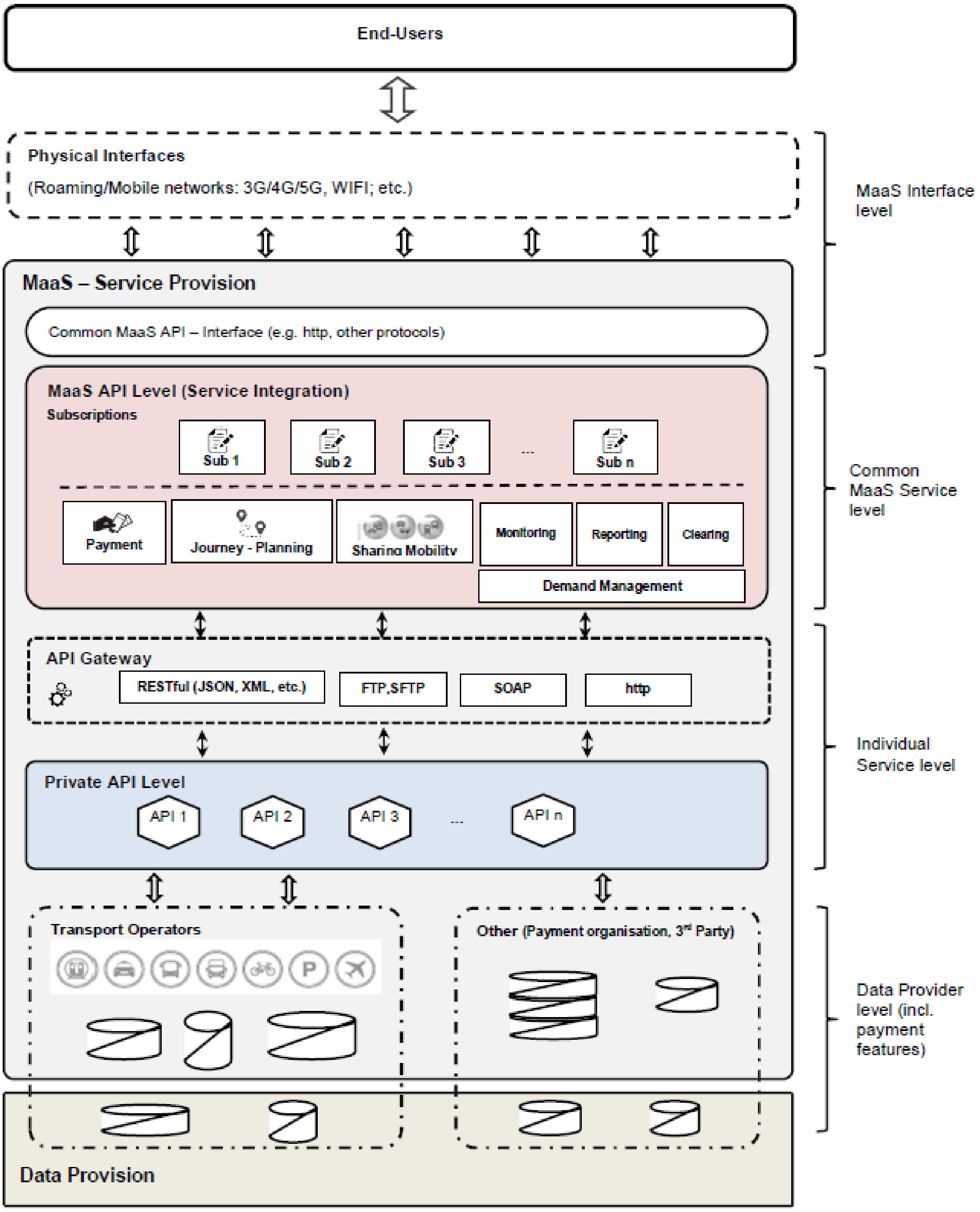


Figure 14: Technical MaaS system architecture (Source: MAASiFiE project - Deliverable 5: Technology for MaaS)

The main MaaS domain is represented by a new layer of the **MaaS API (service integration)**. From the current perspective, only some existing (mobility) service providers allow the integration of different subscriptions on a commonly provided end-user application. Besides the availability of end-user service features like booking, sharing or journey planning, within the MaaS API level, several new administrative aspects arise with integration, covering mainly demand management issues.

Several different mobility services/applications coexist that have no interfaces/connections among each other. The standalone, proprietary services are highlighted in the blue box (Figure 14), referred to as the **Private API level**. The Private API level presents the sum of all available mobility services being potentially made available on the digital service markets and used for instance directly by travellers already. These services might be provided for instance by transport operators being in the role of service providers as well. Depending on the applied role model, some transport operators might act as both data and service providers. It is important to remark as MaaS is more than multimodality, and more than overlaying an app on existing modes of transport or an existing mobility service, multimodal traveller information apps are a piece of the overall MaaS concept.

Furthermore, payment service provision requires billing and clearing between different stakeholder organisations (e.g. done via the MaaS operator) and information/booking and validation of user accounts. Mostly third-party payment providers offer their add-on service features.

To connect different services to one common access platform, technical service interfaces are required to gather all available content/information sources. Figure 14 shows the **API Gateway** describing some interface examples using web-service based distribution technologies. For instance, Restful (Rest), simple HTTP, and/or SOAP specify when to access/exchange data between different sites. All those web-service technologies are mostly implemented as part of back-end systems. Since end-users interact only with the MaaS service's front-end system, back-end systems need to be established between different data/service contributors.

Regarding **MaaS data provision**, several data sources form the basis providing high quality MaaS services. The most fundamental requirement for the provision of MaaS services is the provision of data for generating final end-user and transport operator services. In most cases, transport operators provide their own data and contribute to the digital MaaS architecture with their own 'opened' services or act as data providers. In some other cases, third parties or service providers are providing their data. Provided data might for instance cover real-time information on schedules, information on stop locations, locations of Point of Interests, road network or public transport event information.

The collection and provision of mobility data is indispensable for generating high-quality and real-time MaaS services. For both road and public transport-related data/information provision, different data standards are available. Closely related to the technical characteristics of MaaS defined by the system architecture, a platform-based model for MaaS is suggested. Depending on the business model arrangement, platforms can be supervised by separate platform service providers, by transport/infrastructure operators, or by the mobility service providers.

Wireless communications form the basis for realising MaaS services. They allow using the services almost everywhere at any time. Wireless networks are heterogeneous with respect to capabilities, coverage area, terminal to be used and usage cost. Accessibility to end-user devices is required for consuming final MaaS services and allows the provision of real-time interaction between end-users (travellers) and producers (e.g. transport operators and/or service providers). Wireless networks, especially, provide a key enabling technology fulfilling the physical requirements. For instance, the evolvement of 5G and 4G/3G mobile network technologies together with the integration and expansion of local wireless communication networks (e.g. WLAN and Bluetooth) pave the way towards a seamless access environment to MaaS systems.

Finally, roaming in the context of MaaS means using the transport services of other MaaS operator(s) than the operator to which one subscribes. The first MaaS pilots across Europe and beyond were carried out with a very limited set of transport providers and a limited geographical area. Although in the future some MaaS operators will cover many different transport providers and operate over large areas, even across country borders, any single MaaS operator will not be able to satisfy all the mobility requirements of all subscribers. Thus, cooperation between MaaS operators for expanding the coverage of their services and improving business opportunities becomes relevant.

A potential implementation of the **MaaS concept in the SOLEZ project (Turin)** is briefly described below by a first draft idea of possible scenario as well as of potential MaaS offering in the Turin site.

Scenario description

Giovanni is an employee working in Turin at the General Motors Global Propulsion Systems.

He lives in a small town 20 km out north within the FUA. He has no direct connection to his working place. The closest railway station is 20 km away and his office is 8 km away from Turin Porta Nuova.

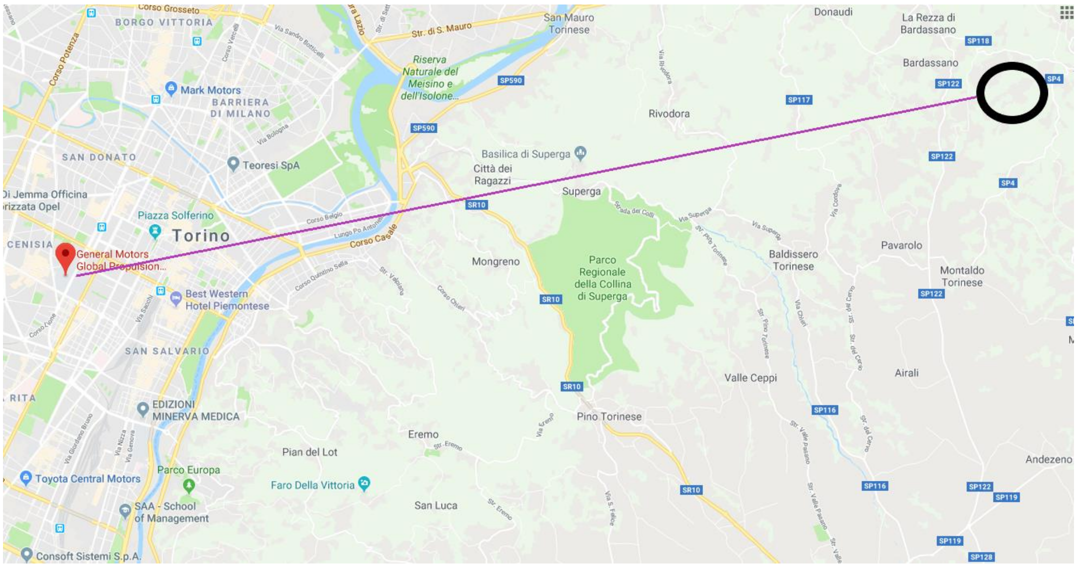


Figure 15: Example of home-work corridor for local commuting in the Turin FUA

Currently he is using his own car to go to the office, but he considers this solution not optimal due to the traffic on the main road, which strongly affects the duration and quality of his journey as well as to the limited and expensive parking space around his office. He would like to use public transport to commute or to use car sharing together with his colleague Giorgio who live close to him. Giovanni initially registers into the MaaS system to check for alternative options to reach his office. The system allows him to create his own profile including the possibility to select MaaS mobility package (e.g. standard MaaS mobility package, customized/personalized MaaS mobility package, etc.).

During the registration phase, he can indicate both to the transport means to use and the features of potential mate (colleague) for using existing car sharing service. Then, Giovanni can define his journey from home (20 km away from the office) to office (in terms of origin and destination) and the schedule for the entire month. The MaaS system prompts him with travel options (individualized multimodal traveller information) by integrated traveller information service provided via web-based and/or app-based (Android and iOS) solutions: from joining car sharing from his home to the office, to train and/or bus at destination. The system provides alternative routes (including multimodal transport solutions) according to his daily schedule and to the current state of the traffic.

The MaaS system might provide him different services such as real-time information on public transport schedules, routing information for different transport modes, journey planning, etc.

Once Giovanni entered pre-trip essential information (e.g. destination, times, preferred duration, etc.), the MaaS system might provide him different (ranked) multimodal route options accordingly and match the most suitable route based on the journey information he provided pre-trip.

Traffic conditions may suggest alternative public transport choices in the city/FUA. Giovanni (and eventually his colleague Giorgio) gets on board, travelling from home to General Motors Global Propulsion Systems office according with the multimodal transport solution provided by MaaS.

Payment represents the final step within the MaaS system. In addition to the traditional pay-per-use model, fixed or customized monthly packages might be offered as well. Giovanni might purchase a MaaS pre-paid mobility package in which direct debit and automatic renewal are available. On the other hand, the amount might be deducted at each time of use though the pay-as-you-go service provided by the system as well. Giovanni has options to either pay separately by receiving a monthly bill or proceed with direct debit to pay their monthly package plus the exceeding part altogether.

Potential ICT-based tool for MaaS offering

Employees can pick their preferred way of traveling every single time thought a **MaaS platform for companies.** This ICT-based platform can enable each company to create its own personalised mobility offer. It can organise company travels in one simple dashboard, inviting and connecting the employees to a company account, monitoring their travels and paying all at once.

The MaaS platform for companies aggregates all urban mobility services in one single app. Employees can search and book their favourite way of transport overtime from their pocket. All paid directly by the company. The MaaS offering is structured in an online dashboard and a mobile app.

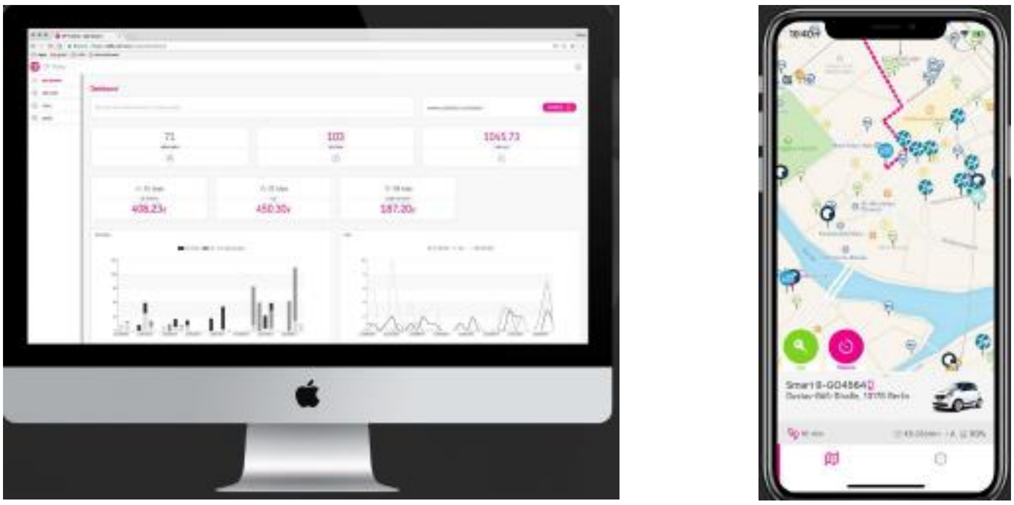


Figure 16: MaaS platform for companies: online dashboard and mobile app *(Source: URBIbusiness, 2017)*

Web-based dashboard of the MaaS platform for companies enables to:

- add users and easily review their profiles,
- filter by active users, time and type of mobility service used,
- monitor company's activity in detail and overview the overall costs,
- manage company's employees monthly budget, trips and their accounting.

Mobile app (available on Android and iOS) of the MaaS platform for companies enables to:

- search on map the nearest vehicle (ride sharing, taxi, car sharing) and bike (bike sharing),
- compare by time or costs,
- reserve (and open) the chosen vehicle and bike,
- buy integrated public transport tickets.

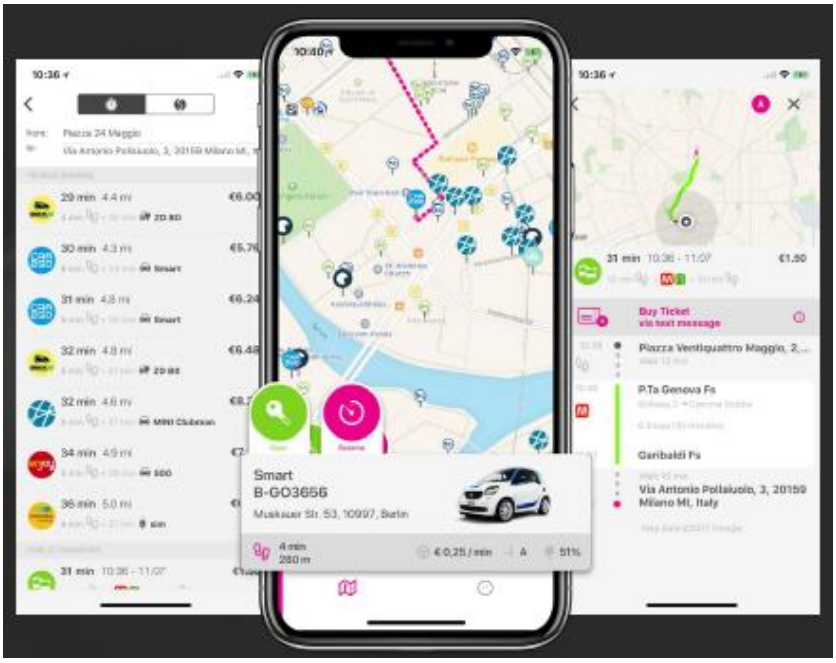


Figure 17: MaaS platform for companies: mobile app screenshot *(Source: URBIbusiness, 2017)*

Figure 18: MaaS platform for companies: how it works *(Source: URBIbusiness, 2017)*

4 Freight ICT-based supporting tool: Multi-users lanes development

4.1 Freight Value-Added Services: Multi-users lanes

Setting the scene

Urban freight transport and delivery services are characterized by the presence of many stakeholders. The main reason for this is that it takes place in the city and neighbouring – the central location where flows and activities intersect. Private stakeholders are very important in the decisional and implementation process of urban logistics measures and it became clear that public-private partnerships are crucial to develop efficient and low-carbon last mile mobility solutions.

In urban areas there is also a generalised desire to tackle in the best way possible de discipline of freight distribution, with basically the goal of realising a net benefit for operators, users, consumers and for the community as a whole. Public and private sector should work together to determine the success of last-mile logistics initiatives. Policy makers should try to create good working relationships with companies involved in freight transport and logistics working in their areas, through the creation of joint public and private sector working groups, platforms and networks. All stakeholders have to be included representatives of small and big transport operators, shopkeepers' associations, retailers, city residents, city interest groups. The process has to be coordinated by Local Authorities.

In the last few years the handling of goods went through some remarkable evolutions in the modes of distribution with the affirmation of the Just in Time (JIT) market concept and the diffusion of e-commerce. Just in time is an industrial philosophy that inverted the "old method" of producing final products for storage waiting to be sold (so called push logic) by switching to a pull logic according to which it's necessary to produce only what's already sold or that is foreseen to be sold shortly. E-commerce is the whole set of transactions for the commercialisation of goods and services between producers (offer) and consumers (demand), made via internet. The consequence of these two professional distribution models is the intensification of displacements for the delivery of the goods to distribution centres or final users. The service of delivery JIT is not exclusive of express couriers, but also involves structured or non-structured enterprises on account of third parties, whereas the first ones represent the value-added high end of such market. If, until a few years ago, the two segments of the good delivery market (traditional transport and urgent packages delivery) where clearly distinct in terms of characteristics and prices, today they got closer instead. The reason is that basic productive technology, cost structure and prices of inputs are pretty much the same.

Optimisation of freight transport and delivery routes is for sure a common practice with regard to freight transport optimisation. This measure refers to channelling trucks that drive into cities of the urban agglomeration through designated truck routes. Advisory or statutory truck routes can be used by the urban authorities to prevent goods vehicle drivers using unsuitable or sensitive routes.

A specific approach in promoting public-private partnership that succeeded to a certain extent, realised in several cities in the United Kingdom and then exports in other national contexts, is the one of Freight Quality Partnerships (FQP). These are basically local forums where the municipal administration and the representatives of the logistic chains as well as representatives local stakeholder or environmental groups meet to discuss about issues relate with urban freight transport.

FQP are effective when they rapidly bring to the implementation of practical interventions benefiting both the community and the freight transport operators with their customers.

Within this actual scenario, multi-users lanes measure aims at managing access to reserved bus lanes including freight transport. This is a pull measure, whereby freight vehicles are allowed free access to public transport priority / reserved lanes. In some cases, they must meet certain criteria set by the city administration to qualify for access, offering also an incentive towards cleaner or zero emissions vehicles. This measure can be considered an added-value freight mobility services enabling of sharing dedicated bus lanes by logistics operators without affecting public transport system (maintaining acceptable level of service) and reducing congestion for all categories of users in the road network.

Multi-users lanes include effective access management of recognized freight vehicles in bus lanes while maintaining an acceptable level of service (LoS) for the whole public transport system.

The usability of preferred lanes by specific recognised commercial vehicles (mostly by light commercial less polluting vehicles) needs to be monitored by dedicated ITS and recognition schemes.

ICT-based supporting tool: Multi-users lanes technical description

Once identified existing public transport reserved lanes to be shared between passengers and freight transport based on local stakeholders' involvement process and analysis of main traffic and mobility patterns, the core activity is represented by the implementation of agreed freight transport recognition scheme to enable using reserved lanes by efficient and greener logistics operators.

It is important to remind that to be eligible for permits/passes to use public transport reserved lines, logistics operators need to upgrade their vehicles to at least Euro 5 and using an on-board unit (OBU)

Logistics operators can use public transport reserved lanes during daily off-peak hours as well as times when buses are not using lanes based on **Automatic Vehicle Monitoring (AVM)** system as GPS-based vehicle location information in real-time showing those information on digital maps, etc.

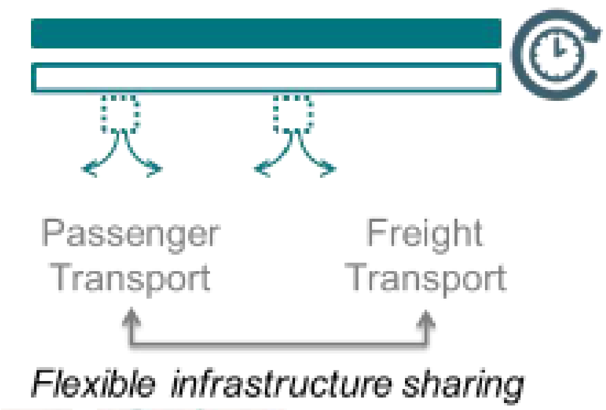


Figure 19: Sharing of public transport reserved lines (*Source: NOVELOG project*)

The use of existing ICT/ITS solutions for traffic control and management is quite important for the successful implementation of multi-users lanes concept as technological enabler of this Value-Added freight service. Monitoring access gates of public transport reserved lanes, it is possible to automatically verify if freight vehicles accessing lanes are authorised according with relevant permits.

In this respect, it is needed to set up and install cameras system enabling to "read" freight vehicle license plate and compare this data with allowed/registered vehicles' database (namely "White list").

A lot of software enabling license plate recognition are available in the market for the different operative systems such as Windows, Linux, Android, etc. **Automatic number-plate recognition (ANPR)** is a technology that uses optical character recognition (OCR) on images to read vehicle registration plates to create vehicle location data. It can use existing closed-circuit television, enforcement cameras as well as mobile units which are installed into freight vehicles (e.g. on-board unit). Algorithms should be able to compensate for all the variables that can affect the ANPR's ability to produce such as an accurate read time of day, angles between the cameras and plates, etc.

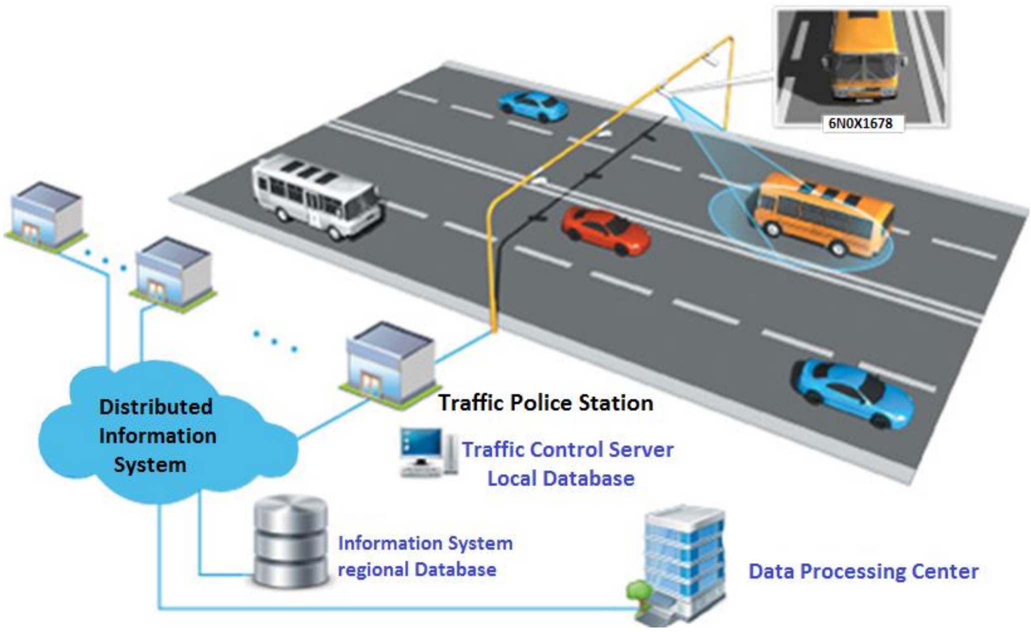


Figure 20: Example of ANPR system (*Source: Smart Traffic Management System, BioEnable Technologies Pvt. Ltd)*

There are different primary algorithms that ANPR software requires for identifying a license plate:

i) Plate localization, responsible for finding and isolating the plate on the picture;
ii) Plate orientation and sizing (adjusts the dimensions to the required size);
iii) Normalization (adjusts the brightness and contrast of the image);
iv) Character segmentation (finds the individual characters on the plates);
v) Optical character recognition;

vi) Syntactical/Geometrical analysis, check characters and positions against country-specific rules;

vii) The averaging of the recognised value over multiple fields/images to produce a more reliable or confident result.

ANPR systems commonly use infrared lighting to enable the camera to take the picture at any time of day or night. At the front end of system is the imaging hardware which captures the image of license plates. Relative vehicle's speed is a key issue that affects the camera's ability to read a license plate[3].

Moreover, **Automatic Vehicle Location (AVL)** system for real-time monitoring buses location and tracking on digital maps is important to manage and regulate time slots for freight vehicles in lanes.

Authorised freight vehicles should access public transport reserved lanes when buses are not using reserved lanes as well as when buses are not just entering/going out reserved lanes as well.

The system being developed for bus transportation system is satellite based (GPS) vehicle location method. AVL based on global positioning system, enables to monitor and control operations of vehicles and fleets in an efficient and cost-effective way. Positional data acquired from AVL system is used to visualize busses locations and movement in real-time. Vehicles positions are detected periodically, and updates transferred to the server located in control centre/room using GSM phone network and packet data transfer through cellular network (e.g. GPRS, UMTS, etc.). Bus location and tracking service is not required to implement independent wireless telecommunication network.

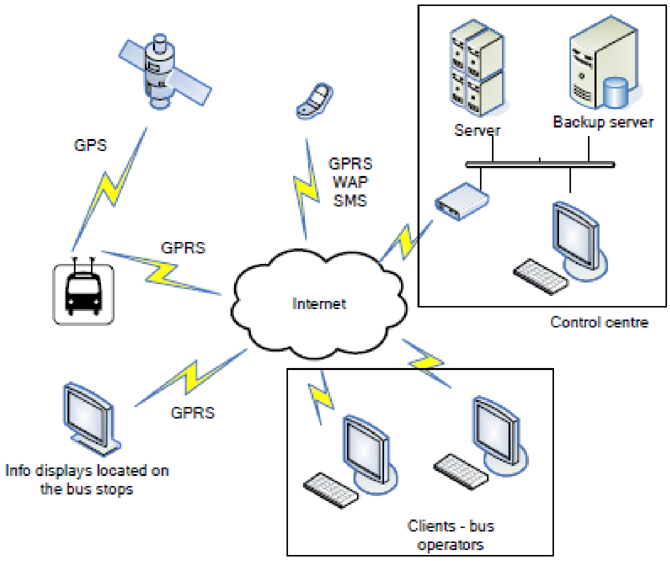


Figure 21: Components of bus public transportation tracking system (*Source: Automatic Vehicle Location in Public Bus Transportation System, Computer Science Department, University of Niš, Serbia*)

One of the most important issue when defining and implementing multi-users lanes is to verify if the sharing of public transport reserved lanes does not negatively affect level of service of public transport in terms of commercial speed along the reserved lines, frequency of the service, safety, etc.

[3] Source: https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#Technology

Multi-users lanes, sharing reserved lanes between public transport and logistics operators should be envisaged in the so-called **Freight Quality Partnership (FQP)**. City of Turin, after the implementation of a preliminary pilot experiment by the involvement of key express courier companies that deliver in the LTZ, decided to test the possibility to extend the use of reserved lanes by recognised freight vehicle. This cannot be tested in real-life immediately and that is the reason for the development and implementation of a pilot based on model simulation. If the inclusion of freight vehicles in these lanes will not affect the LoS of buses, it will be implemented at full scale in real environment as well.

The existing data collected in the City of Turin relates to the freight vehicles with a minimum number of 20 vehicles involved in the pilot where the on-board units (OBUs) which have been installed following specific characteristics. Data are collected from CAN BUS of the vehicles and they include timing (stop and run), average speed, estimated emissions, etc. Same data are collected from CAN BUS on board of sample public transport buses operating in the selected reserved (and shared) lanes.

Thanks to the data collected from the pilot's vehicles, it will be possible to calculate target key performance indicators. The public transport vehicles have an OBU system that is managed by a dedicated City Traffic Control Room. The sample freight vehicles involved in the NOVELOG project have a specific OBU (provided by VIASAT GROUP COMPANY) and these devices are connected at the City Traffic Control Room. The City Traffic Control Room is managed by City of Torino in house company "5T" (www.5t.torino.it) which is responsible either for data collection and elaboration.

Figure 22: City of Turin Traffic Control Room (*Source: 5T srl)*

From the preliminary piloting has been possible to record field data and assess the following KPIs:

- Congestion reduction (numeric, average speed),
- Emissions reduction (CO2, CO, NOx % or numeric reduction).

The results achieved by this pilot case have been very positive since all the impact area's objectives were fully reached and most of them manage to overcome the initial targets. The innovative aspects of shared public transport lanes for both passengers and freight mobility were successfully proven.

The implemented of this Added-Value freight transport service allow to reach environmental improvements: reduction of CO2, pollutant emissions and traffic (no queue at the LTZ gates to wait for the entry, freight vehicles allowed to use bus lanes without reduce the bus commercial speed).

5. References

- MaaS Alliance AISBL (2017), White Paper, Guidelines & Recommendations to create the foundations for a thriving MaaS Ecosystem
- König, D., Eckhardt, J. Aapaoja, A., Sochor, J., Karlsson, M. (2016), Deliverable 3: Business and operator models for MaaS. MAASiFiE project
- Eckhardt, J. Aapaoja, A., Nykänen, L., Sochor, J., Karlsson, M., König, D. (2017), Deliverable 2: European MaaS Roadmap 2025. MAASiFiE project
- Karlsson M., Sochor, J.a, Aapaoja, A., Eckhardt J., König D. (2017), Deliverable 4: Impact Assessment. MAASiFiE project
- König, D., Piri, E., Karlsson, M., Sochor, J., Heino, I. (2017), Deliverable 5: Technology for MaaS. MAASiFiE project
- UCL Energy Institute, Department for Transport (2015), Feasibility Study for Mobility as a Service concept in London
- Finger M., Bert N., Kupfer D., Florence School of Regulation, European University Institute (2015), Mobility-as-a-Service: from the Helsinki experiment to a European model?
- SOLEZ (2017) Study on specific supply chains in professional urban freight transport and delivery services
- NOVELOG (2016), D2.2 Urban Freight and Service Transport in European Cities
- NOVELOG (2016), D4.1 Integrated inventory of urban freight policies and measures, typologies and impacts
- NOVELOG (2016), D5.2 Mid implementation report
- NOVELOG (2017), D6.1 Evaluation
- Bratislav Predic, Dejan Rancic, Dragan Stojanovic, Aleksandar Milosavljevic, Computer Science Department, University of Niš (2007), Automatic Vehicle Location in Public Bus Transportation System
- URBIbusiness (2018), The first Mobility As A Service platform for companies
- CIVITAS ECCENTRIC (2017), MaaS Readiness Level Indicators for local authorities