TF Value Proposition

Final Report

03/31/2016

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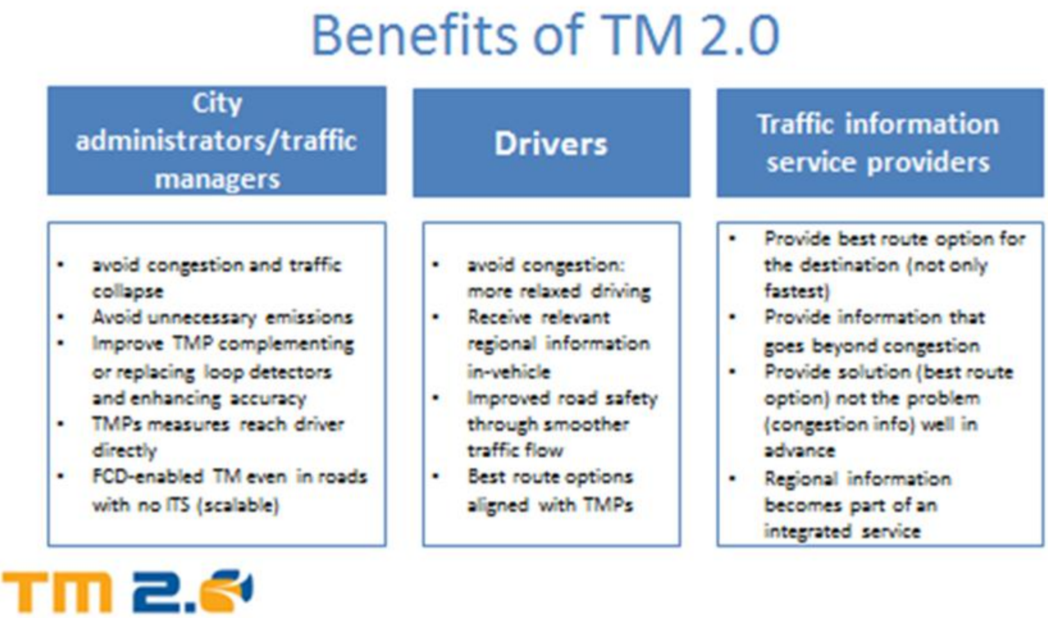
Executive Summary

The TM 2.0 ERTICO Innovation Platform Task Force (TF) on Value Proposition envisages the definition of value propositions under consideration of different ITS stakeholder perspectives. The stakeholder group consists of both traffic management representatives and traffic information service providers. Managing traffic efficiently is agreed to be a service and as such it has to service customers' needs rather than just answer general policy related requirements. Delivering state of the art services in traffic management has to focus on responding to the very specific needs faced by the cities and regions where the TM 2.0 will be implemented / deployed. In order to assess the diversity of needs, and ensure the 'win-win' principle is followed, the TF on Value Proposition examined four cities / regions in Europe, namely Thessaloniki, Helmond – Eindhoven – Tilburg, Salzburg and Barcelona and assessed their common vision in how TM 2.0 can help in facing the different challenges in their traffic management practices.



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Introduction

The TM 2.0 ERTICO Innovation Platform which was formally established during the 2014 ITS Europe Congress in Helsinki, focuses its work on discussing new solutions for advanced active traffic management. It aims to agree on common interfaces, data sharing principles and business models which can facilitate the exchange of data and information from the road vehicles and the Traffic Management and Control Centres (TMC), and back, improving the data value chain for consistent traffic management and mobility services as well as avoiding conflicting guidance information on the road and in the vehicles.

Traffic Management today falls under the responsibility of road operators who have to execute the planning as this is agreed by the public authorities aiming at a general public benefit. Road operators and public authorities, for example, increasingly aim at environmental-friendly traffic management solutions. On behalf of the public authorities, road operators or traffic management centres (TMCs) are delivering services being paid by tax-payers as part of the general state/city budget. On the other hand, traffic service providers, including the road network infrastructure industry, the traffic information service providers and the automotive industry, aim at keeping their customers satisfied. Profit and customer satisfaction is what gives to the industry competitive advantage in the market. Benefits for the general public rank lower than individual demand for fast and efficient service.

Until recently, these two stakeholder groups (the publicly funded TMCs and private traffic information service providers) in their quest for user satisfaction and support, went on separate and sometimes conflicting ways. The TMCs focused on monitoring and informing the mass of drivers using their road infrastructure while traffic information service providers aimed at guiding drivers towards alternative and better suited routes addressing their individual requirements (points of interest, avoiding tolls etc.). The 26 members of the TM 2.0 Platform share a common vision on the TM 2.0 concept. The latter is perceived to be key towards providing a holistic information loop between the vehicle, the service providers, the infrastructure and the TMCs which will enable the traffic information service providers or the TMCs (depending on who assumes the role of alignment and coordination) to inform and guide the road network users to their destination while at the same time optimizing the road network throughput responding to the prevailing traffic conditions.

The evolved scheme of TM 2.0 aims at building trust among the various transport actors involved and at the same time supports the creation of new business models and efficient services. Innovation is key in order to ‘do things out of the box’ which until recently prevented the road-network stakeholders from cooperating. New trends on Mobility and Transport, such as self-driving vehicles, mobility as a service, green mobility etc. necessitate a change, not only in technology but also in the user’s acceptance and the way business is conducted aiming at profit and also in the way public services are offered, the latter usually not taking into account pertinent financial loss.

Task force 'Value Proposition' in the context of TM 2.0

The TM 2.0 ERTICO Innovation Platform Task Force (TF) on Value Proposition consists of both traffic management representatives and traffic information service providers. Managing traffic efficiently is agreed to be a service and as such it has to service customers' needs rather than just answer general policy related requirements. Delivering state of the art services in traffic management has to focus on responding to the very specific needs faced by the cities and regions where the TM 2.0 will be implemented / deployed. In order to assess the diversity of needs, the TF on Value Proposition agreed to examine four regions in Europe, namely Thessaloniki, Helmond – Eindhoven – Tilburg, Salzburg and Barcelona.

Case Study Thessaloniki

Thessaloniki is the second largest city in Greece, currently accommodating 1.006.730 citizens in its greater area. Situated in Northern Greece, Thessaloniki covers a total of 1.455,68 km^2 with an average density of 665,2 inhabitants per km^2. Due to its geographical location, Thessaloniki plays an important social, financial, and commercial role in the national and greater Balkan region, also due to the development of a transportation hub within the city's limits. According to the General Secretariat, the total number of vehicles in the city exceeds 777.544, including private cars, heavy vehicles and motorcycles.

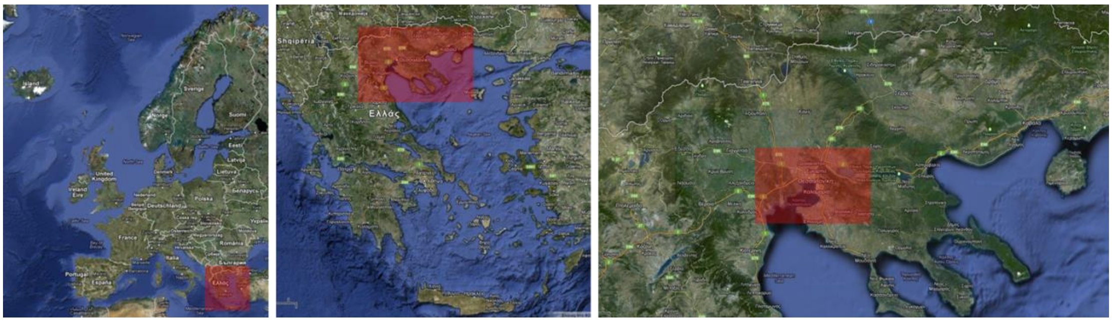


Figure 1: Region of Thessaloniki

Based on household phone surveys, the average number of persons in a household is estimated at 3,03 and the respective average of driving license holders per household at 1,75. Additionally, 58% of all citizens hold a driving license and 71% of the population owns at least one private car. **Error! eference source not found.** depicts the respective percentages of car ownership per number of owned cars.

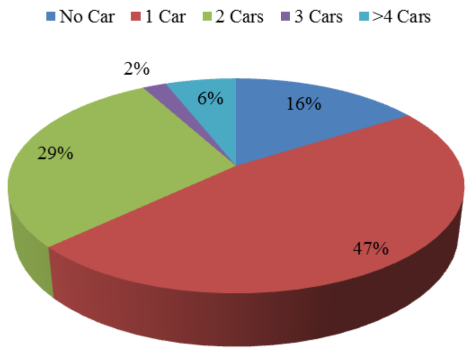


Figure 2: Percentage of car ownership by number of cars

The average number of trips per person is 2,08. 89,4% of the survey participants stated that they usually execute up to two trips per day: one trip for various purposes (work, education, leisure, etc.) and one trip for returning home. As depicted in Figure 3, among various trip purposes, 47,6% of the trips are conducted for work and 26,8% for leisure. The percentages for shopping, education and other purposes are 12,9%, 5,8% and 6,8% respectively.

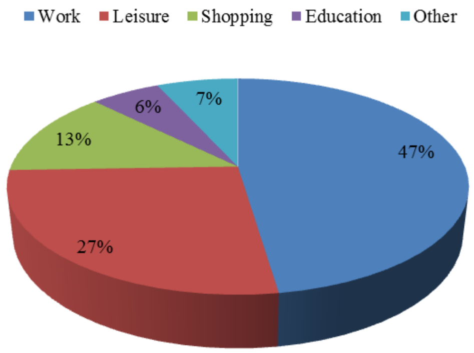


Figure 3: Share of trip purposes

The modal split analysis, presented in Figure 4, shows that the majority of trips is conducted with private vehicles (67% private cars, 4% motorcycles and 4% taxis), while 23% is conducted with public transport (PT) and 2% with non-motorized modes of transport (NMT).

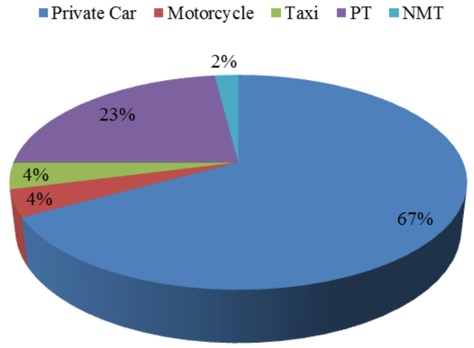


Figure 4: Modal split

Based on the RSS results, the average vehicle occupancy is 1,44. As depicted in **Error! Reference ource not found.**, 65% are single occupancy vehicles, while 28% and 6% of the vehicles travel with 2 and 3 passengers respectively.

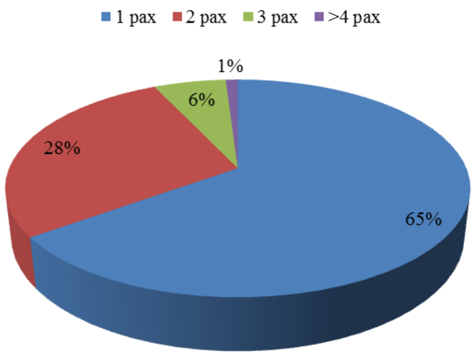


Figure 5: Vehicle occupancy

Concerning the vehicle type distribution, this is estimated as follows: 77% private vehicles, 5% motorcycles, 2% taxis, 11% vans and 5% trucks.

The temporal profile of the measured traffic volumes is presented in Figure 6, where the morning and afternoon peak traffic hours are observed between the 08:00-09:00 and 16:00-17:00 time intervals respectively.

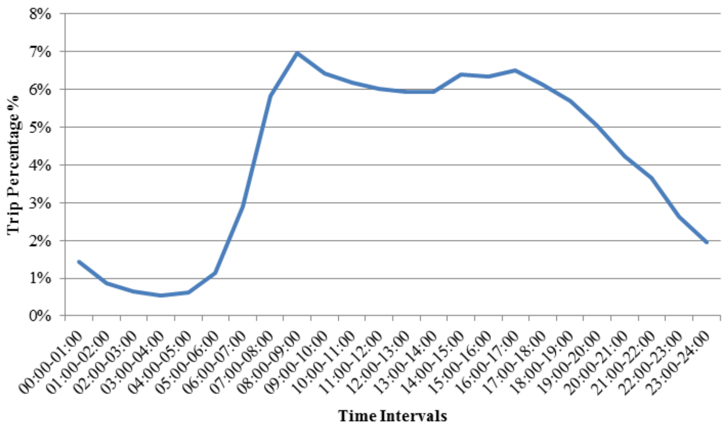


Figure 6: Daytime distribution of trips

The total travel demand for a typical weekday is estimated in the range of 1.300.000 vehicle trips. On a daily average, the city center attracts a total of 11,5% of all trips.

During the morning peak hour of a typical weekday, average travel time for all trips conducted in the network of Thessaloniki is 33,13 minutes and the average vehicle speed is 37,8km/h.

Traffic management scenario

Currently there are three Traffic Management and Control Centres in Thessaloniki, which are hosted by RCM. The latter is responsible for the management of the traffic lights and the surveillance systems of the central arterial and the peripheral Ring Road. There are three ITS regions in Thessaloniki.

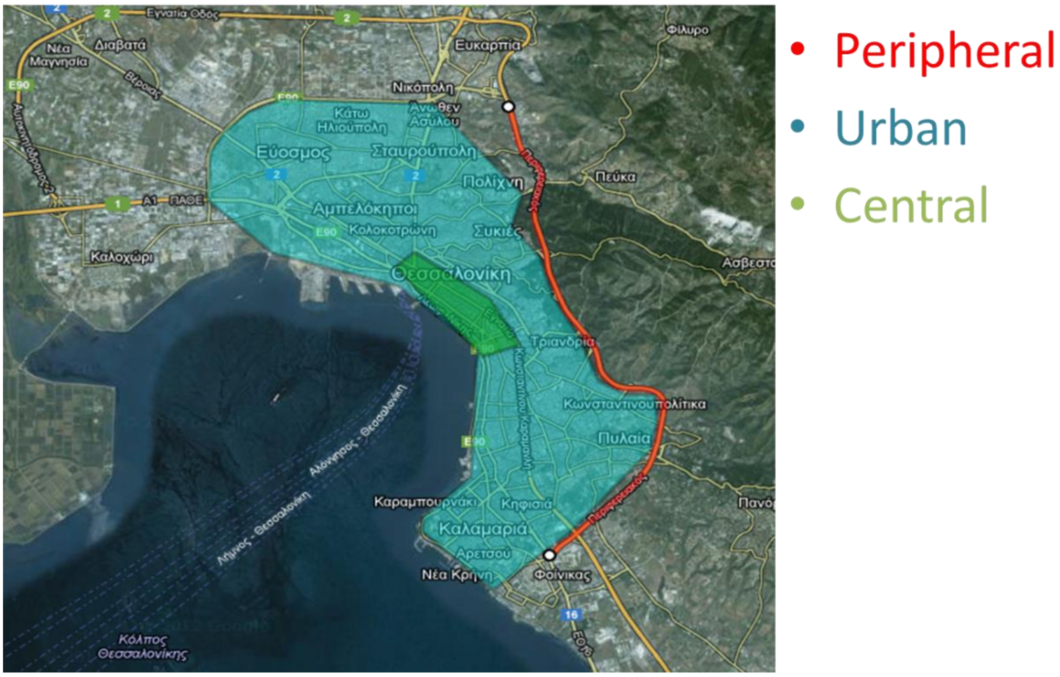


Figure 7: Traffic Management and Control Centres in Thessaloniki

Peripheral ITS

- Area: Peripheral ring road expressway network (13 kms)
- Traffic: ~3.700 veh/h/dir during peak hour
- Services: Traffic management, congestion and incident detection and warning
- Equip.: Cameras, VMSs, Telecom infrastructures, Traffic control centre, Software

Urban ITS

- Area: Wider urban area of Thessaloniki
- Traffic: 94.000 veh/h during peak hour
- Services: Traffic lights control, centralized plan selection
- Equip.: ~200 signal controlled intersections, ~800 loop detectors, telecom infrastructures

Central ITS

- Area: CBD of Thessaloniki
- Traffic: ~30.000 veh/h
- Services: Adaptive signal control, incident management, real-time ATIS www.mobithess.gr
- Equip.: AID & PTZ, VMSs, traffic detection radars and cameras for 68 lanes, telecom infrastructures

The three TMCs responsible for managing the city Traffic in the three regions are briefly described below. The earliest system is by SIEMENS, and it is responsible for the control of the traffic lights in the city composed of more than 500 traffic counters and 300 traffic lights (Urban ITS).

The TMC responsible for the detection and information of events along the peripheral Ring Road, is based on NETWORKS software of Delcan and composed of 5 VMS and 9 traffic count locations (Peripheral ITS).

The latest system is based on the ITS platform OMNIA by SWARCO, which supports an open architecture whereby any system can be integrated within the platform independently of the supplier, product or technology (Central ITS). It acquires all traffic measures and stores it in a central system archive together with their estimated statistical profile such as traffic volumes, speed, etc.

and traffic related data (e.g. signal plan, clearance capacity, turning proportions). OMNIA platform is comprised of two sub-systems:

- UTOPIA, a distributed adaptive traffic control system which is used for traffic lights management. The local management of the 12 traffic lights is executed by SPOT at each traffic controller. The system provides real-time monitoring of the traffic conditions as well as signal phase optimization along Tsimiski Street.
- MISTIC platform Swarco, managing 1 surveillance camera, 5 AUTOSCOPE cameras, 29 traffic detection units and 5 VMSs located at the main gates of the city centre. MISTIC is another information mobility platform or Town Supervisor for cooperative traffic monitoring in the TMC with the following capabilities:
    - Integrates data from legacy systems;
    - Supplies real-time information on multiple communication channels;
    - Manages in real-time and forecast traffic model;
    - Operates according to EU standards (e.g. DATEX 1-2, TPEG, RDS-TMC).

The locations of the three sets of sensors are presented below.

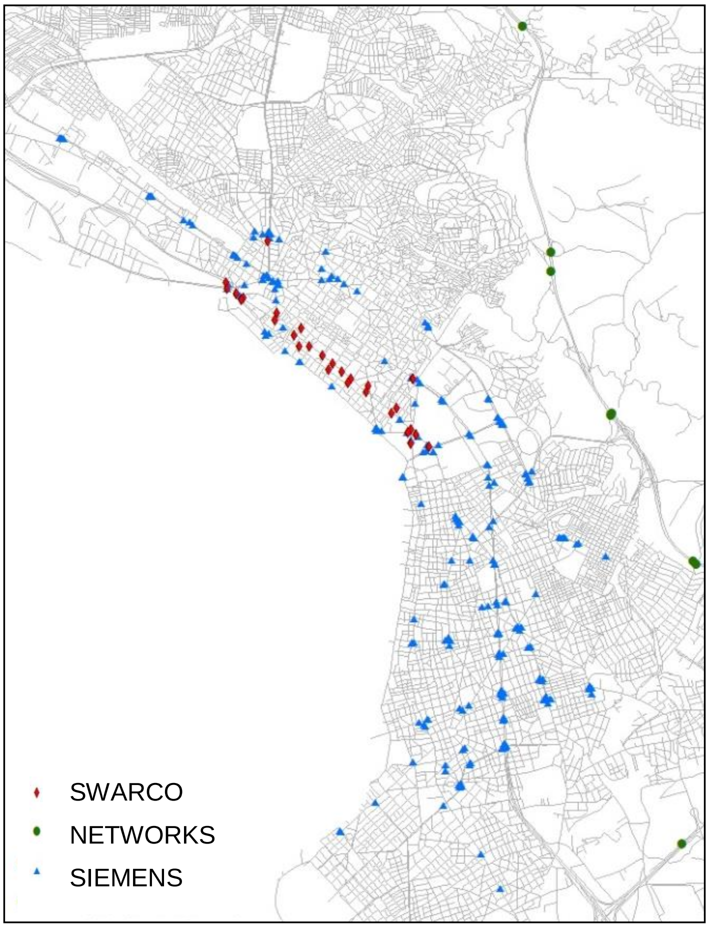


Figure 8: Sensor locations

In addition, Thessaloniki has implemented two cooperative services, one in the city center provided through LTE and one along the Peripheral Ring Road provided through G5. The next table includes the positions of the installed RSUs.

Table 1: Coordinates of the RSUs along the Peripheral Ring Road of Thessaloniki

Code	Sector	GPS Coordinates	
		Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
RSU1	East	40,569216	22,986289
RSU2	East	40,589349	22,987706
RSU3	East	40,598848	22,997322
RSU4	Central	40,615134	22,98627
RSU5	Central	40,639387	22,969897
RSU6	West	40,659876	22,968436
RSU7	West	40,673708	22,960426

The next figure presents the positions of the newly installed RSUs along the Peripheral Ring Road of Thessaloniki. RSUs were installed either on pillars and traffic cameras or on top of VMS

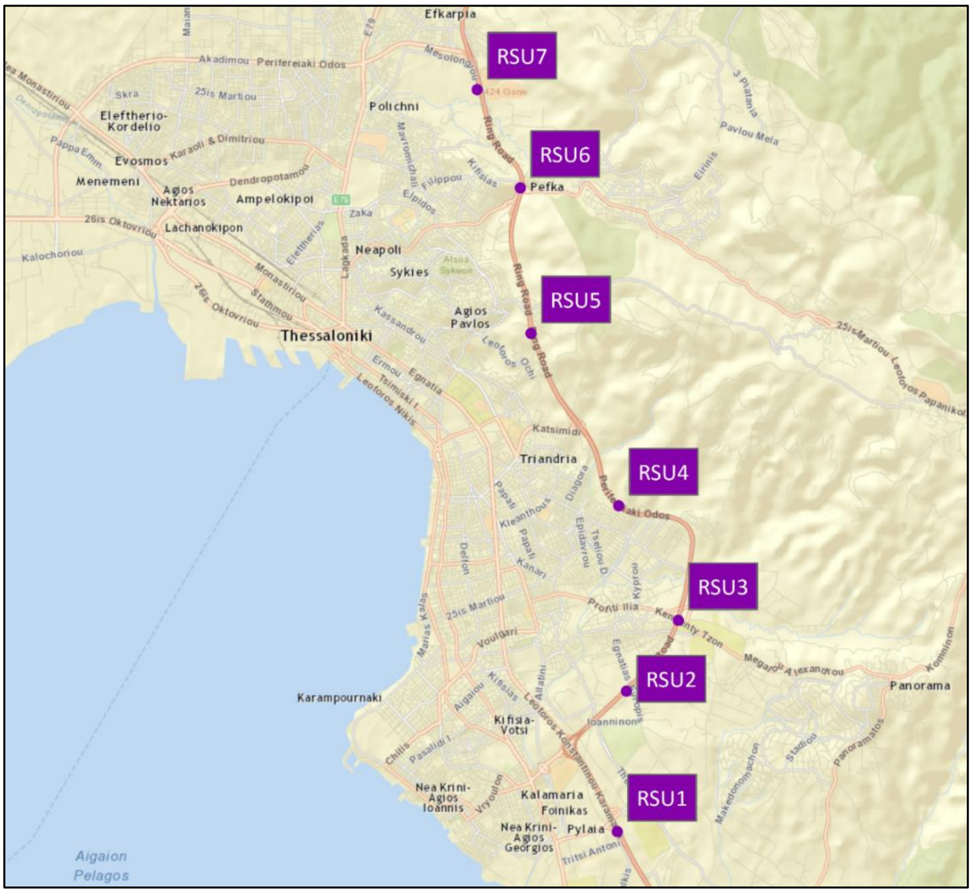


Figure 9: Locations of RSUs along the Peripheral Ring Road

Finally, CERTH-HIT has implemented and operates a mobility management center (MMC) at the mobility laboratory. Two innovative data sources are monitored in the MMC, floating car data (FCD) from a fleet of 1200 taxis providing traffic status (speed) in almost the whole network in real time and a network of more than 40 Bluetooth detectors tracking trips along the main routes of the city also in real time. In addition, data coming from social media (tweets and face-book check-ins) is being collected and it will be introduced soon to the MMC capabilities.

The MMC is composed by hardware (2 large screens) and software responsible for filtering and analyzing the data to be monitored as well as to generate the respective alerts when necessary.

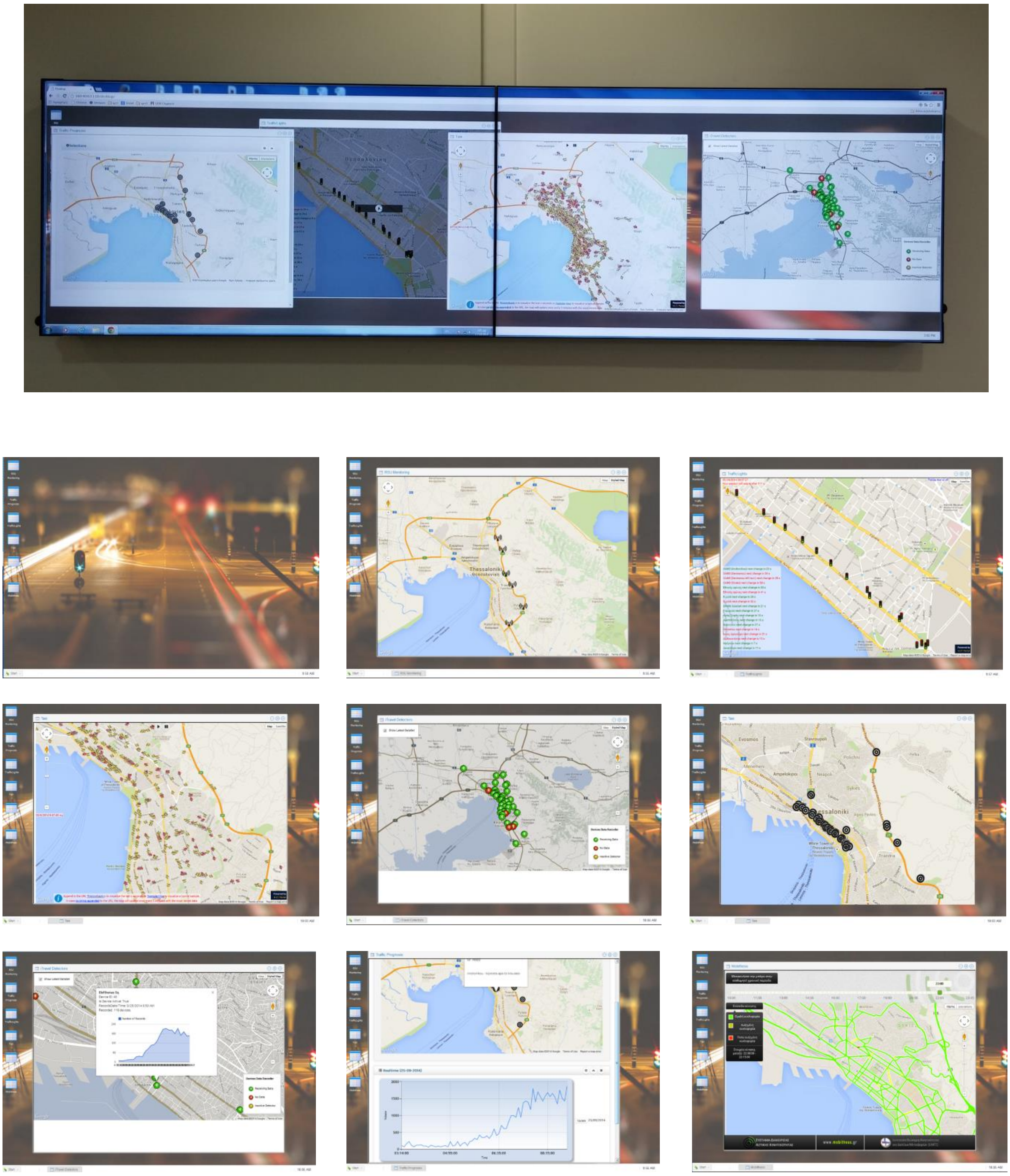


Figure 10: Mobility Management Centre (MMC)

How can TM 2.0 help?

TM2.0 can help by linking the FCD collected by the service providers (through their fleets of users) to the traffic managers so they will have a better monitoring of the traffic status and providing the traffic management measures to be implemented in advance so the service providers can improve significantly the services offered to their users regarding the status of the road network of Thessaloniki.

Value propositions for different stakeholders

For the traffic managers:

- Better tackling congestion and traffic collapse (and consequently CO2 emissions)
- Better understanding of the traffic status through the collection of FCD
- Better performance of the execution of the traffic management plans

Drivers:

- Avoiding congestion and traffic collapse
- Better decisions based on more accurate and real-time information

Service providers:

- Better service offered to their customers

Pilot demonstration

The proposed pilot demonstration in Thessaloniki aims at shifting form TM1.0 to TM2.0 by connecting the drivers with the traffic manager and providing them with the measures of the traffic management plans along the Peripheral Ring Road at a first stage and within the city center at a second stage. The current traffic management is the following:

- Traffic jam and congestion detection along the peripheral Ring Road through cameras.
- Activation of the existing Traffic Management Plans (re-routing advices) at the Public Authority side (RCM)
- General re-routing information provision to drivers through 5 existing VMS

The TM 2.0 will be the following:

- Traffic jam and congestion detection along the peripheral Ring Road through FCD, BT detections and user content (FCD and BT already implemented by CERTH, user reports implemented by Infotrip + content from social media collected and analyzed by CERTH).
- Personalized re-routing information provision to drivers through various in-vehicle devices (COMPASS4D app, COGISTICS app, my-route.gr)

Various components are already in place since they have been developed and implemented through research and deployment project and will be used for the TM2.0 pilot activities. In addition, data collection and analyses will be done using existing data loggers and monitoring tools.

Case Study Helmond – Eindhoven – Tilburg

The region Helmond – Eindhoven – Tilburg is the Dutch Deployment Site to continue operating the C-ITS services that have been implemented, operated and evaluated in the frame of the EU co-funded project Compass4D. The ultimate goal is to move from pilot to large scale deployment for a self-sustained market. This activity is set up as an ERTICO Partnership Activity through a “Compass4D

Memorandum of Understanding", a "Compass4D Support Activity Agreement" and of a "Compass4D Deployment Site Agreement" for each of the participating cities, and it is coordinated by ERTICO – ITS Europe.

On the A58 motorway between Eindhoven and Tilburg 34 WiFi-P beacons have been placed as part of the Shockwave traffic jams A58 project. On top of this an IT infrastructure containing open connecting interfaces and data enhancers is been available to enable service providers to roll out traffic services over the whole road section.

The Traffic Innovation Centre in Helmond, an experimental and development area within the South Netherlands traffic centre, was founded to facilitate the transition to TM 2.0.

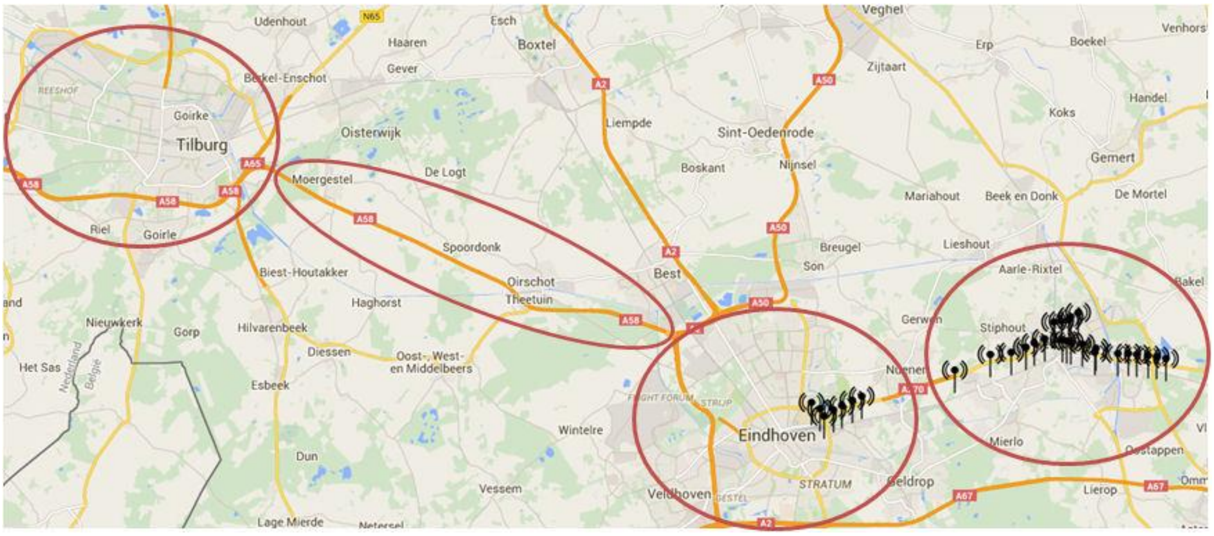


Figure 11: Overview of the Helmond – Eindhoven – Tilburg Region

Traffic Management Scenario / user story

The Energy Efficient Intersection Services will continue to be operated as a C-ITS service in Helmond. An extension of this service is foreseen in Eindhoven and Tilburg. Other related services in the domain of road safety and fuel efficiency are Red Light Violation Warning and Road Hazard Warnings.

The goal of the first service on the A58 Motorway is to subdue the traffic jam shock waves. The research question is to investigate whether the provision of in-car speed advice to road users can reduce or even prevent the occurrence of shockwaves and the growth of traffic jams. 'Road Works Warning' is planned as second service.

How can TM 2.0 help?

More than ever, support of the road user with information, advice, orders and prohibitions will become a joint public-private effort. The reliability experienced by road users ultimately depends on the consistency between the information and advice they receive and the actual situations they encounter on the road. The social importance of a stable supply of information to road users will therefore necessitate public-private coordination and supervision. TM 2.0 creates a framework for this cooperation.

Market parties will focus on providing (information) services that are geared to the needs and wishes of individual road users. These services will enable those road users to make the best possible choices when using the road network - before, during and after their trips. However services providers are not considering the traffic management plans of the road operators for the best possible choice. The provided TM 2.0 information by the road operators could be extended with the traffic management plans.

Road operators will facilitate the choices of the individual road user to the maximum by making sufficient road capacity available within the social pre-conditions for safety, quality of life and accessibility. Due to TM 2.0 it will not be derived from the roadside-based information channels but also from information collected by service providers.

Value proposition for different stakeholders

For the city administration/traffic managers:

- An improvement of the quality of the traffic light control plans with a higher traffic throughput;
- A reduction of emissions
- Better use of the road network
- Execution of traffic management plans based on information from roadside systems and information collected by the service providers

For the drivers:

- Less fuel consumption
- Improved road safety

For service providers

- Harmonisation of the information provided by the service providers with the information on VMS by the road operators
- Provide services based on not only the traffic state of the network but also the traffic managements plans of the road operators

Case Study Barcelona

Barcelona is the capital city of Catalonia with a population of 1.6 million within its administrative limits. Its urban area extends beyond the administrative city limits with a population of around 4.7 million people, being the sixth most populous urban area in the European Union after Paris, London, Madrid, the Ruhr area, and Milan.

Concerning road traffic Barcelona is characterized as follows:

- Barcelona lies on three international routes, including European route E15 that follows the Mediterranean coast, European route E90 to Madrid and Lisbon, and European route E09 to Paris.
- It is also served by a comprehensive network of motorways and highways throughout the metropolitan area, including A-2, A-7/AP-7, C-16, C-17, C-31, C-32, C-33, C-60.
- The city is circled by three half ring roads or bypasses, “Ronda de Dalt” (B-20) (on the mountain side), “Ronda Litoral” (B-10) (along the coast) and “Ronda del Mig”.

As most big metropolitan areas in Europe Barcelona is heavily affected by congestion and CO2 / pollutants emissions caused, among other factors, by the thousands of commuters that drive to the city on a daily basis. In order to tackle these issues the "Servei Català de Trànsit – SCT[1]" (Catalan Traffic Service, as translated from Catalan), which is the public body in charge of traffic management and road safety in Catalonia, launched back in 2009 a variable speed traffic management system in the following access corridors to Barcelona:

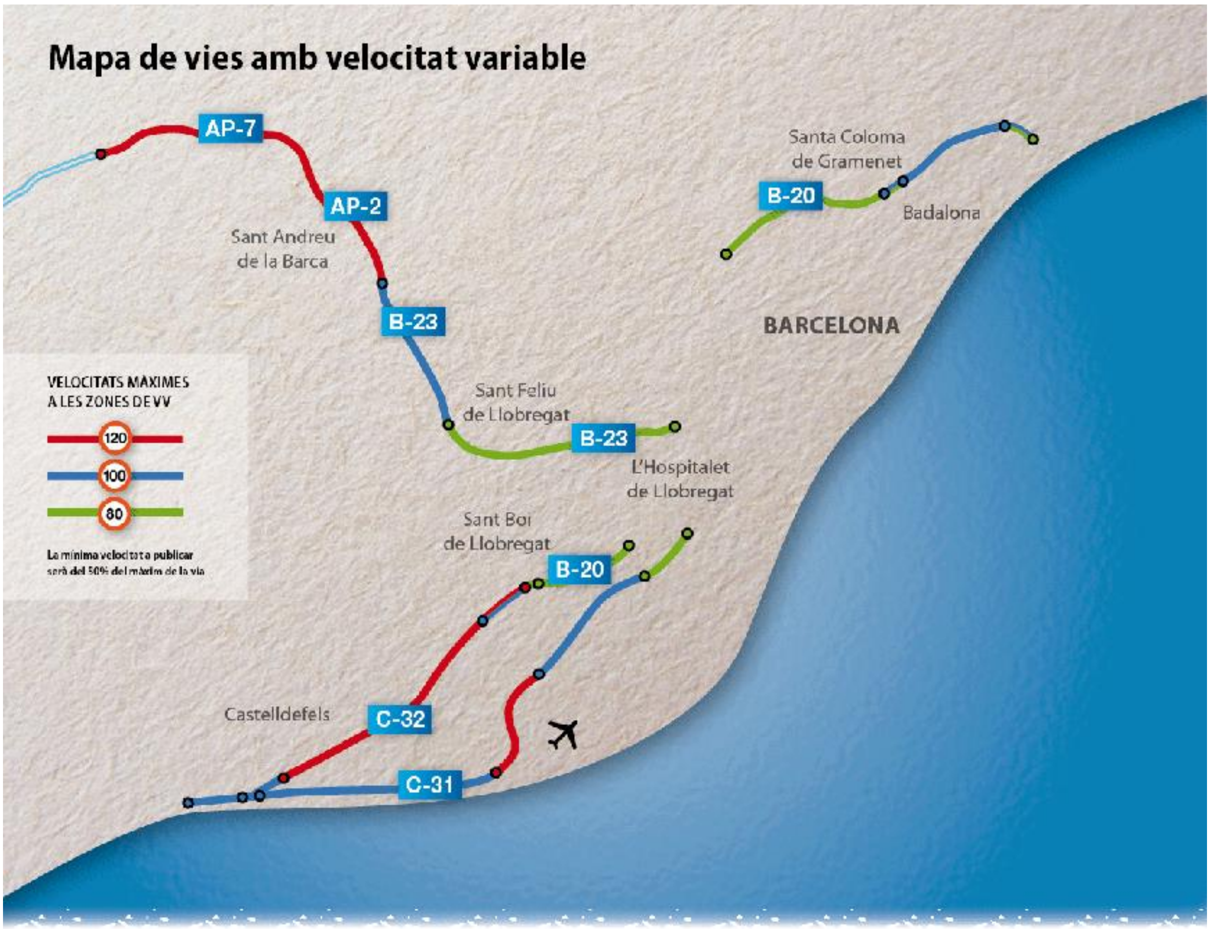


Figure 12: Schematic map of the three access corridors to Barcelona where variable speed management is currently implemented

Variable speed is a traffic management tool that dynamically reduces the allowed speed limit (which is informed to the drivers through Variable Message Signs) depending on:

- Congestion levels
- Incidents, such as accidents, road works, etc.
- Bad weather: heavy rain, fog, wind
- Pollution

The advantages of variable speed TM are:

- It is a precise and effective tool for the management of road incidents (foreseen and unforeseen) through speed management
- It reduces and minimizes the severity of congestion

[1] http://transit.gencat.cat/ca

- It reduces "stop & go" of vehicles, making mobility more homogeneous and thus contributing to the reduction of emissions
- It improves road safety and reduces accidents, as homogenized speed reduces the likelihood of accidents

Traffic management scenario / user story

Ariadna is driving on a highway accessing Barcelona from a city within the Barcelona metropolitan area. She commutes twice every day by car, driving home to work in the morning rush hour, and back in the afternoon. At a certain point on her daily commute Ariadna must choose to continue driving on the "C-31" or "C-32" highway[2]. Either option would take more or less the same travel time under "normal" conditions. When approaching the junction, to choose the "C-31" or the "C-32" is a decision Ariadna usually takes on the fly, mostly based on her own preferences or driving habits, unless she has information (coming from the news on the radio or from indications shown on VMS's, for example) on any incident in her usually preferred route that would recommend her to take the alternative route instead. Current detection of congestion is based on inductive loops measuring traffic volumes, and thus allowed (variable) speed limit is informed to the drivers through VMS, plus enforcement reinforced by means of speed cams.

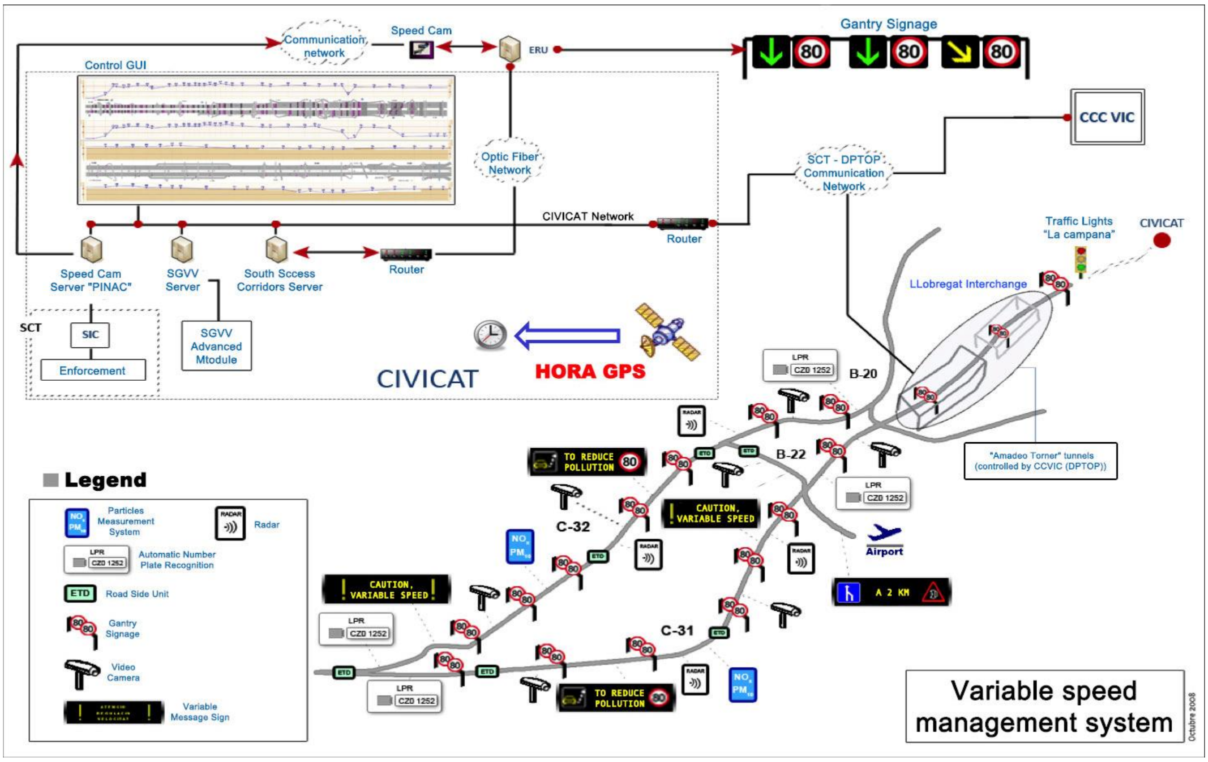


Figure 13: "C-31" / "C-32" access corridor to Barcelona with detailed ITS infrastructure

Detection of congestion through inductive loops is a rather old-fashioned methodology. Precision and accuracy of the data provided by this type of sensors is limited and maintenance of the system is

[2] The "C-31" / "C-32" access corridor to Barcelona is a well-dimensioned pilot area to validate the concepts described, with the AADT - i.e. vehicles travelling to Barcelona before the "C-31" / "C-32" junction - an average of 28.000 vehicles per day, and the SCT handling very detailed statistics on the % of drivers taking one or other access corridor, which will be used as a baseline reference for assessing whether targeted information sent by the SCT to connected drivers indeed is able to influence drivers' choices

expensive. Besides, congestion and pollution caused by heavy traffic does affect other roads and highways where variable speed TM is currently not implemented. Deploying /extending variable speed TM to further access corridors to Barcelona would require installation (and further maintenance) of more roadside ITS infrastructure.

How can TM 2.0 help?

TM 2.0 bottom line is about unlocking the potential for improved TM strategies through the dynamic exchange of data / information between TM and users enabled by ICT. Traditional TM is one-way, meaning that information is provided by traffic managers to the users but not vice versa – e.g. variable speed limit currently being informed by the SCT to the drivers through VMS – while TM 2.0 attempts to go one step further and implement a two-way communication channel where all parties receive relevant information in a timely manner under win-win cost-effective scenarios.

Building on the Barcelona case study: starting point is that there are usually congestion (and pollution) problems in the main access corridors to Barcelona. Luckily, Ariadna and other connected users in the piloted area will be able to download an app to their smartphones showing them the best commute option based on highly accurate and updated travel time estimations. This will be a "proof-of-concept" app[3] to demonstrate how (on a technical and, more importantly on an organizational / tactical level) the TM can send highly relevant, targeted and updated information directly to connected drivers, in a simple and timely manner, with the goal to contribute to a smoother traffic flow as part of a global TM strategy.

The TM 2.0 data / information to be generated will be:

TM -> users, through mobility service providers delivering in-car applications: allowed (variable) speed limit that is below the official speed limit when given system conditions are met. This information is currently not used nor shown by navigation applications of any kind currently available in the market. Current connected navigation services obtain itineraries and provide recommendations based, among other inputs, on the current traffic status and rather static map data (e.g. official speed limit). When the driver exceeds the allowed speed limit a warning is also displayed on the screen as an additional feature / information. Expected travel time is often not so accurate because it only relies on the traffic status (basically based on how connected drivers ahead in the planned route are performing) and official speed limits obtained from the data layer of the maps used for navigation. Consider, for instance, a road segment where current traffic conditions would allow for "free flow" (that is, driving at the maximum allowed official speed limit as per road type). If this road segment is in a variable speed zone and the traffic manager has reduced the allowed speed limit (as part of a global traffic management strategy) then the estimated travel time and advice should be provided accordingly, because drivers tend to drive at the official speed limit when traffic conditions allow them to do so (even when the "recommendation" is to slow down).

[3] Meaning that a smartphone app is to be developed to demonstrate the overall concept, to define the content and format of the messages to be exchanged, implement and test interfaces and communication protocols between the different parties, etc. But the final goal is to reach the users whatever type of connectivity / communication system they might have in their cars, be embedded connectivity (with built-in navigation services, typically), smartphone integration (Car Play, Android Auto, Mirror Link), etc.

Users -> TM, through mobility service providers: FCD and planned itineraries. Mobility SP will aggregate FCD from Ariadna and other connected users in the area, fuse these data with other data sources - namely inductive loops measuring traffic flow, FCD from other connected fleets, TMC-coded incidents, travel times from detection of Bluetooth enabled devices in vehicles - and provide an aggregated data feed to the traffic manager in the area (SCT). The SCT will use these data to finetune their variable speed algorithm, especially to better detect traffic congestion prior to the trigger of a variable speed plan. As side applications to be developed, TM might consider to use this direct communication channel with drivers to send targeted instructions to specific user groups (e.g. like in the Thessaloniki case study, tell taxi drivers only – not other users - to avoid the ring roads when there is very heavy congestion).

Value propositions for different stakeholders

For the city administration / TM:

- Reduced congestion
- Reduced CO2 / pollutants emissions
- Improved road safety consequence of smoother traffic flow
- Improved Traffic Management plans: more accurate detection of congestion based on FCD complementing or replacing loops
- Reduced operation costs: FCD cheaper technology, no maintenance on the field is required as with road side sensors like loops
- Positive business case where societal benefits and reduced operational costs are to be accounted; overall reduced travel time translates into increased competitiveness of society, and this can be estimated in €; same with avoided CO2 and pollutants emissions, and reduced fuel consumption due to smoother traffic flow, with different methods for the estimation of savings in €
- FCD-enabled variable speed TM is easily scalable to roads where there is currently no ITS infrastructure installed with very little investment, maximizing the benefits of the overall system • Aggregated data feed to be provided by mobility SP for TM to be used for different applications such as, for instance, traffic information

For citizens / drivers:

- Increased competitiveness due to less time wasted in congestion and less fuel consumption
- Less stress, more comfort
- Improved road safety

For mobility service providers:

- Providing a benefit to their customers in terms of the best route option to the destination (not only the fastest or shortest car route)
- New business opportunities with the public sector (traffic managers)
- New business opportunities to provide value-added in-car connected services (e.g. intermodal advice, where highly accurate ETA for the road segment of a given trip is key in order to continue a trip using public transport)

Challenges

State-of-the-art ICT together with well-delimited use cases following TM 2.0 concepts will generate business opportunities and win-win scenarios for all the actors involved in the mobility provision value chain. Technology is an enabler, while the following challenges have been identified that need to be tackled:

- Financial restrictions: EU instruments like H2020 help fund demonstration pilots of TM 2.0 concepts; TM need to invest towards deployment of piloted applications after these have finished
- Positive business case is needed that targets both societal benefits and sustainable operation of TM 2.0 applications; cost-benefit analyses needed
- Critical mass of users is needed to demonstrate actual benefits of deployed TM 2.0 solutions; recruiting of users and user uptake needs investment (e.g. in marketing)
- TM 2.0 to target EC objectives as set out in the ITS Directive, the 2011 Transport White Paper “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”, etc.

Case Study Salzburg

The Federal State of Salzburg is one of the nine federal states in Austria, located in the North-Western part of Austria, aligned to the German border (Bavaria). The federal state’s capital is the City of Salzburg, a mid-sized historic city with around 150.000 inhabitants, recognized for the city center labelled as world heritage site.

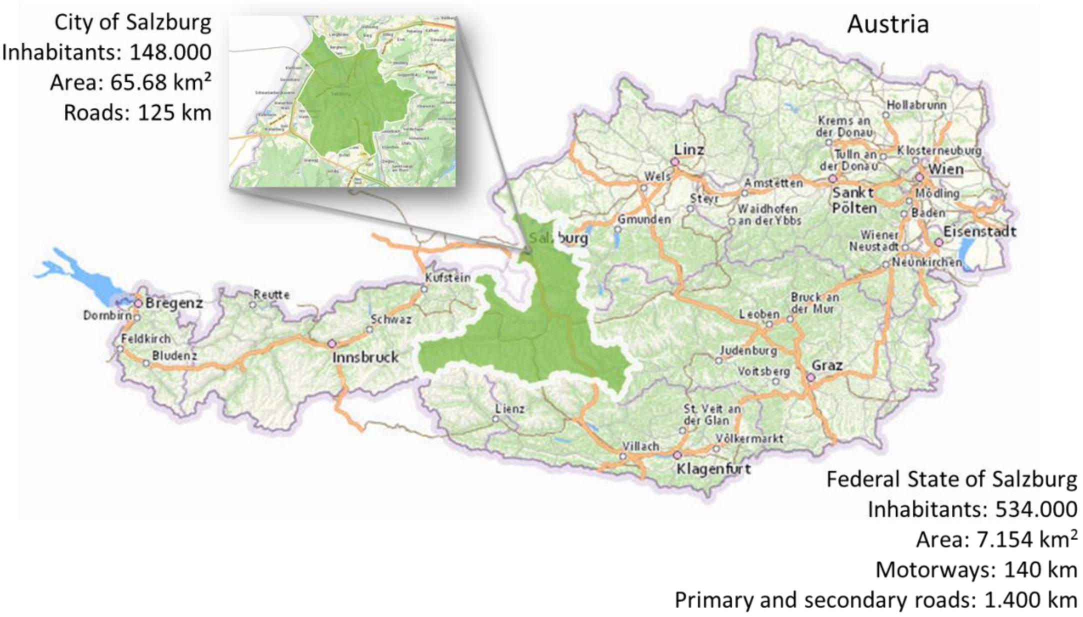


Figure 14: Federal State of Salzburg with the City of Salzburg

Concerning traffic and transport the Salzburg region can be characterized as follows:

- High volume of commuter traffic from the Northern territories to the city center
- Cross-border commuter traffic from Southern Bavaria
- Substantial volume of touristic traffic (winter and summer)

- Historic city center, limited possibilities to extend road network
- Trolley bus system as main public transport infrastructure in the City of Salzburg
- High share of bicycles (around 20 %) in the City of Salzburg

Over the last years several initiatives for realizing intelligent traffic management have been started:

- Implementation of a region-wide real-time traffic state estimation system using floating car data technology (Floating Car Data Testbed Salzburg[4]), also involving public transport
- Region-wide sensor network for collecting traffic counts
- Adaptive traffic lights in the City of Salzburg
- Traffic-adaptive network control[5] (provided by Gevas software GmbH)
- Dynamic speed adaption and variable message signs on the motorway ring (A1 and A10) around the City of Salzburg (operated by ASFINAG)

Traffic Management Scenario

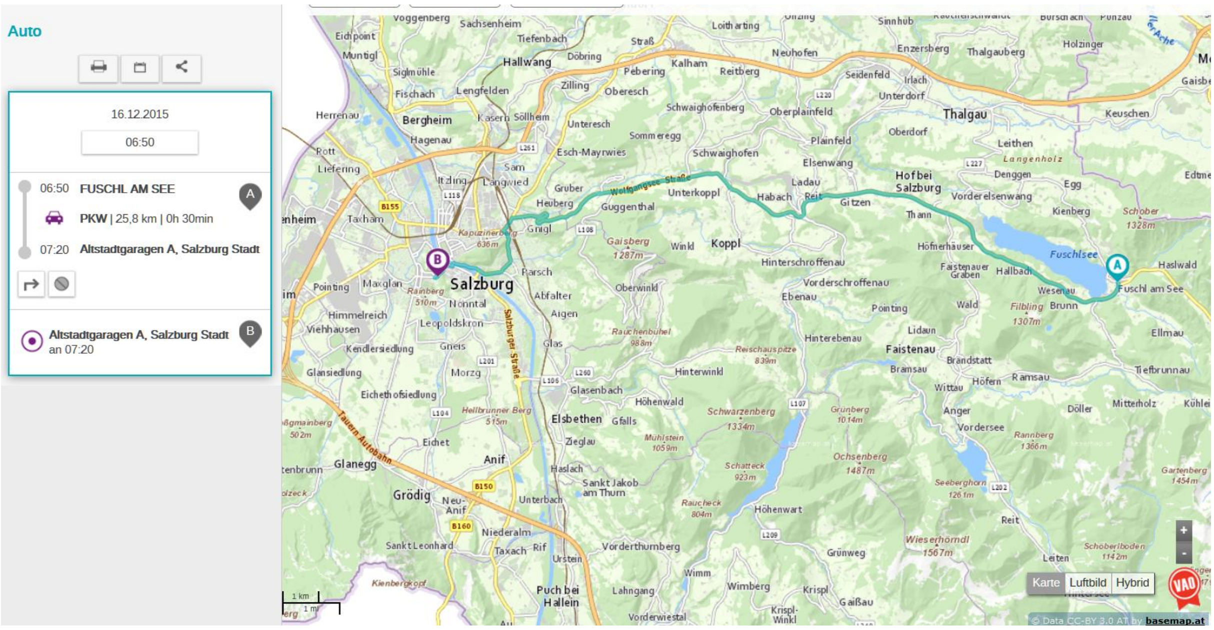
During the summer season, many tourists spend their holidays in one of the touristic villages around Salzburg. On rainy days, a high number of tourists visit the city center. Most of the tourists go to the city center by private car, which results regularly in traffic collapses on such days. As a result of these high traffic volumes, also the public transport system collapses, since the trolley buses share the road network with individual transport and not all roads are equipped with bus lanes. The overall traffic management strategy on these days is to guide tourists to P+R facilities outside the city center where a bus line brings the tourists to the city center. However, since this traffic management strategy is not working, it regularly results in a closing of the city center for foreign cars (based on number plate selection). One of the problems that the city administration is facing is that car drivers are not following the advices provided by local signs, but follow the calculated routes of their navigation systems. Although they are guided to P+R facilities at police checkpoints, they are leaving the indicated route at the next junction and follow the route to car parks in the city center again. This is a phenomenon that has become worse over the last years with the increasing share of cars being equipped with navigation devices.

User Story

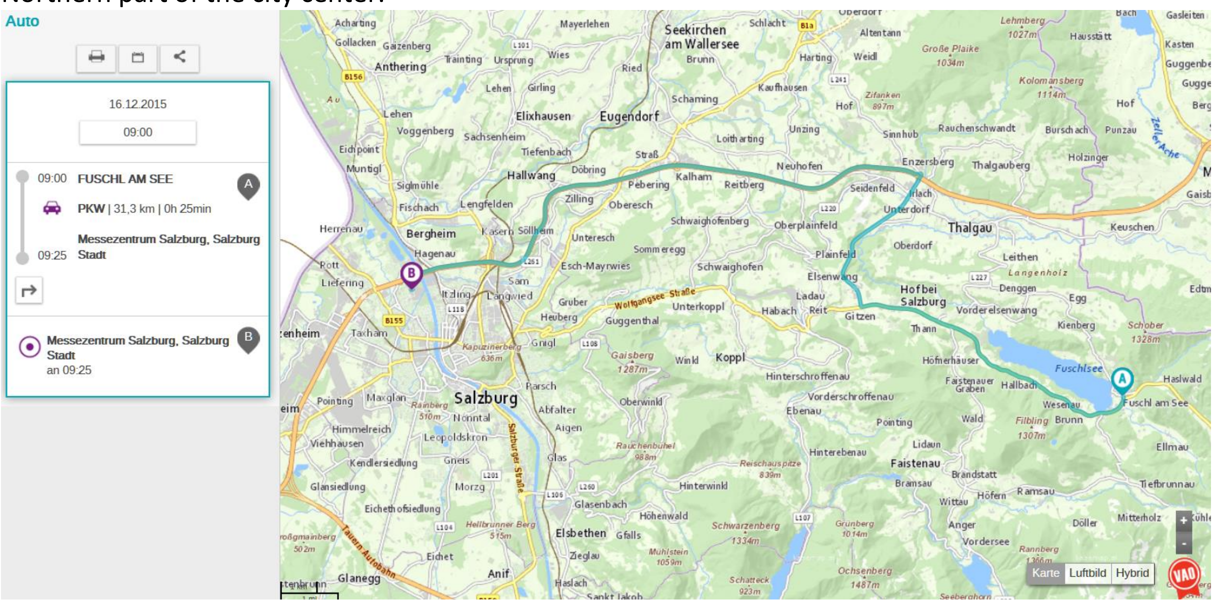
Eva and Heinz from Kassel (Germany) spend their summer holidays in the lovely village Fuschl near the city of Salzburg. To be flexible during their holidays they decided to take their private car for driving to Fuschl. On sunny days they love to go swimming in the clear water of lake Fuschl or hiking on the hills and mountains surrounding Fuschl. Due to the forecast of a rainy day, they decide to visit the world heritage site in the city center of Salzburg. They are using their private car with a built in navigation system for the 26 kilometers and 30 minutes trip. Their navigation system suggests to park in the so called “Altstadtgarage A+B” in the city center of Salzburg.

[4] http://www.fcd-testbed.at/

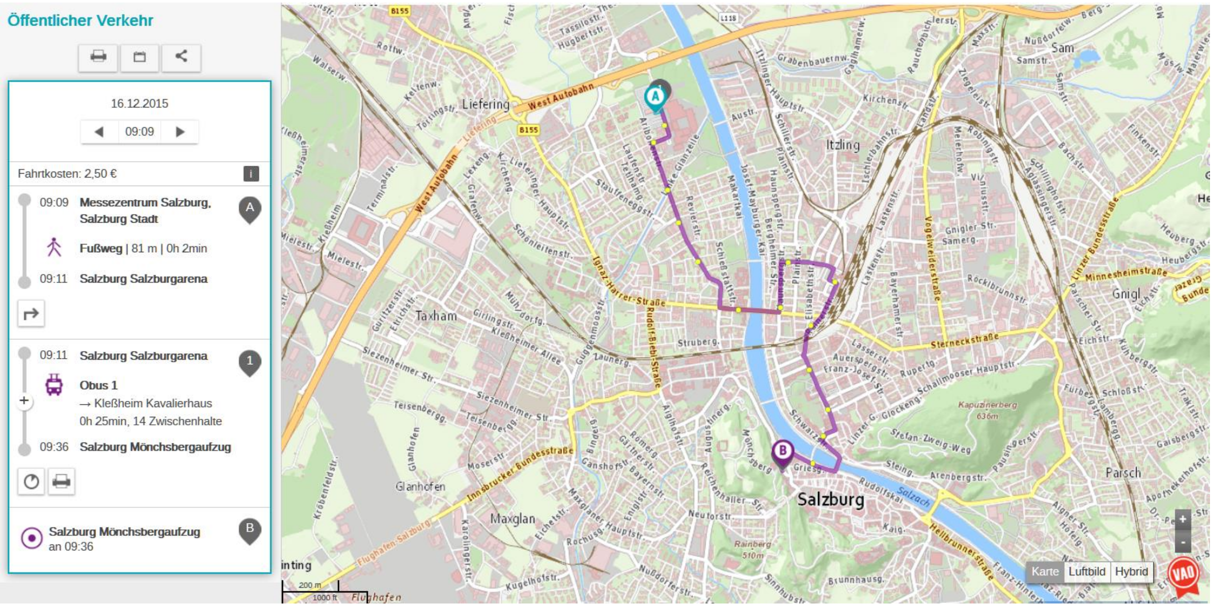
[5] http://www.gevas.eu/1/news/news/article/sens-netzsteuerung-in-salzburg/



During their trip they get the information that the capacity of car parks in the city center is exhausted and that they should change their route to the P+R facility “Messezentrum” in the Northern part of the city center.



There they have the possibility to change to the public bus system taking bus line 1 to the city center, being served in a 10-minutes interval.



Upon confirming the route change the navigation system guides them automatically to the P+R facility. Upon arriving at the P+R they get the information which bus line to take, when the next bus leaves and at which stop they have to get off. Additionally, they get the information that there is a special P+R ticket offer (EUR 14 for parking and 5 persons travelling with the public transport system the whole day) and that they may access further information via Smartphone Apps called "Salzburg Verkehr" or "Qando Salzburg". Eva and Heinz enjoy their visit of the world heritage site and due to the provided information they are luckily able to find their way back to Fuschl after the visit.

How can TM 2.0 help?

One of the missing links in the traffic management strategy is that the dynamic information provided by the city administration is not considered in routing strategies of navigation systems. The provided TM 2.0 information could be:

- Real-time occupancy information of car parks
- Waiting times for entering a car park in the city center
- Information on which parts of the city center are temporally closed for non-inhabitants due to congestion
- Which are the preferred P+R facilities and which are the preferred routes to these facilities?
- What are the public transport options to get into the city center and back again?
- What are the special offers for tourists to use P+R facilities and public transport?
- Real-time travel times to the city center with different means of transport

Value propositions for different stakeholders

City administration / citizens:

- Avoiding congestion and traffic collapse
- Avoiding unnecessary CO2 emissions
- Traffic management plans are delivered to navigation systems which increases the chance that they are followed by drivers

Public transport operators:

- Avoiding congestion and traffic collapse
- Winning additional customers
- Providing a good service for the regular customers

Tourists:

- Avoiding congestion
- Avoiding waiting times in front of car parks
- Getting regional information from their favored service/device
- Gaining better touristic experience

Service providers:

- Providing a benefit to their customers in terms of the best route option to the destination (not only the fastest or shortest car route)
- Providing added value to their customers beyond congestion information
- Providing a solution (= route option) not the problem (= congestion information)
- Regional information being part of an integrated service

Challenges

City administration:

- How to prepare the information for different service providers? –> standards necessary
- How to deliver the information to different service providers? -> national access points
- How to ensure that the provided information is used in the envisaged way by the service providers?

Public transport operators:

- They have to open their services for the use by service operators

Tourists:

- Different sources of information –> Is the information consistent?
- Which sources are trustworthy? -> national access points
- It needs more time to get to the city center -> P+R and PT concept has to be convincing
- Tourists have to leave their preferred means of transport, e.g. their private car -> support outside the car (e.g. Smartphone App) necessary

Service providers:

- Collection of regional information is challenging
- How to deal with quality issues? Who is responsible for quality assurance?
- Who pays for the service? –> end users are possibly not paying for the additional information -> new revenue shares necessary

Pilot demonstration and next steps

Salzburg is actively searching for partners to test the interoperability of local traffic information (services) and in-vehicle navigation systems (pre-installed or after sales) within a field operational trial. Salzburg offers to coordinate the stakeholders for such a trial and may support in providing the local information and services.

Conclusions and next steps

The four case studies examined in this task force share a common vision how TM 2.0 can help in facing the different challenges in their traffic management practices. The following elements have been identified as key to enable a more efficient and effective traffic management:

- TM 2.0 can establish a new bi-directional communication channel between users (as well as their service providers) and TMCs. In some cases this will be through road-side infrastructure (i.e. V2I, and Infrastructure to TMC, and vice-versa) or through mobile communication networks (i.e. Vehicle to TMC, and vice-versa). Irrespective of the configuration at each pilot-specific application, communication will be supported by already existing industry standards (LTE, V2I – I2V) while there is a need to agree on common formats for the exchange of specific contents between the different stakeholders, so that TM 2.0-compliant applications are interoperable EU-wide.
- Some contents to be shared among the different stakeholders in the TM value chain are already well defined and there are standards available to format them (e.g. DATEX II for many TM-related concepts; or the widely accepted "Floating Car Data" specification etc.). At the same time, there are other contents the definition and formatting of which, will need to be commonly agreed (e.g. traffic management plans), this specific aspect being tackled by a dedicated task force within the TM 2.0 platform. The different pilots discussed in this Paper, share the common view that the communication channel between vehicles/users and TMCs can be as well used to target specific user groups with tailored information/instructions (e.g. Thessaloniki to target taxis under certain congestion conditions; Salzburg to foster tourists to use park and ride facilities and enter the city center by public transport; Barcelona to convince commuters to adapt their speed or take alternative routes). Specific contents to support each pilot-specific use case/scenario will need to be clearly defined and formatted using a commonly agreed protocol (e.g. location of park and ride facilities and available parking lots for the Salzburg case study).
- The four regions share the common vision that TM may not end with road traffic management only. Specifically, the vision is that efficient traffic management must integrate and exchange information from other modes of transport as well (e.g. guiding tourists to P+R locations, then continue the trip to the city center using PT; Barcelona to provide very accurate travel time to destination to support inter-modal travel planners). This vision adds additional stakeholders to the value chain - i.e. PT operators - and extends the need to agree on common interfaces for the exchange of data and related formats/protocols.
- Common to the four regions is the need to elaborate viable business cases for the deployment of win-win scenarios for all actors involved aiming at the shared goals of reducing congestion and pollution, improving road safety and being cost-effective at all levels. The public benefit ranks equally with the private driver’s satisfaction in the TM 2.0 concept.

To foster the development of viable business cases, the main benefits of TM 2.0 with respect to different stakeholder groups have been identified as well (Table 2).

Table 2: Benefits of TM 2.0 from the perspective of different stakeholder groups

Stakeholders	Benefits of TM 2.0
City administrations / traffic managers	• Avoiding congestion and traffic collapse • Avoiding unnecessary emissions (smoother traffic flow) • Improve traffic management plans (FCD complementing or replacing loop detectors and enhancing accuracy in traffic information) • Traffic management plans measures are reaching the driver directly (in-vehicle) • FCD-enabled traffic management being easily scalable to roads where there is currently no ITS infrastructure installed with very little investment, maximizing the benefits of the overall system
Drivers	• Avoiding congestion: more relaxed driving • Receiving relevant regional information in-vehicle • Improved road safety through smoother traffic flow • Best route options aligned with traffic management plans
Traffic information service providers	• Provide the best route option to the destination for their customers (not only the fastest or shortest car route) • Provide added value to their customers with information that goes beyond congestion (potential for new business opportunities) • Provide a solution (= best route option) not the problem (= congestion information) well in advance • Regional information becomes part of an integrated service • New business opportunities with the public sector (traffic managers)

TM 2.0 provides an important framework for real-time traffic data to become available to road network operators. This additional real-time information is key for improved traffic and asset management. Traffic planners and road operators can make use of floating car data for estimating traffic flow, deriving origin-destination matrices and for studying traffic mobility patterns.

On the other hand, making traffic management plans and strategies available to service providers is expected to bring in-depth knowledge about TMC operations to service providers and their customers. This knowledge provides new insights into how the road-network is managed and what would be the optimal ways to ensure the end-to-end efficient movement of people and goods. The success of the TM 2.0 concept lies on the fact that it aims to consistently combine and align the sets of objectives that the traffic stakeholders aim to satisfy: public benefit (environmental, congestion, prioritisation policies) and private (fast and efficient routing) in every step of the TM chain.

The TF completed its work in February 2016 with the submission of a paper for the ITS Europe Congress 2016. As next steps the task force recommends the deployment of TM 2.0 in the four pilot cities / regions.

Annexes

Annex 1: Paper 'Traffic Management 2.0 - The Win-Win' for ITS Europe Congress 2016

Paper number ITS-XXXX

Traffic Management 2.0 – The Win-Win

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Abstract

The TM 2.0 ERTICO Innovation Platform members are cooperating under the common belief that interactive traffic management and the alignment of the individual driver's objectives to those that the Traffic Management Centre (TMC) should adhere to is both feasible and advantageous to all stakeholders involved. As traffic operators, acting usually on behalf of the public authorities are challenged to keep the traffic flowing, reduce environmental and noise pollution and keep up with new mobility demands on the existing transport infrastructure, the users (drivers and passengers alike) are seeking more and more information that is tailor-made and relevant to them and their mobility requirements. In the era of TM 2.0, vehicles should be able to interact and exchange information with the TMCs so that tailor-made traffic information can be provided to the tax-payers and services payers while having a better picture of the traffic status without needing expensive investments in equipment and related infrastructure. Service providers and the automotive industry are seeking ways to facilitate the evolution of traffic management to the next level while ensuring business viability. It is all about the Win-Win. The paper discusses the value proposition of the TM 2.0 concept and uses four urban regions as deployment paradigms to prove that even every region has unique needs and characteristics; there is still a set of basic principles that need to be covered when it comes to ensuring a good business case.

Keywords:
Traffic Management 2.0, Real-time Traffic Information, Public-Private Collaboration, Win-Win

Traffic Management 2.0: The Evolution

The TM 2.0 ERTICO Innovation Platform which was formally established during the 2014 ITS Europe Congress in Helsinki, focuses its work on discussing new solutions for advanced active traffic management. It aims to agree on common interfaces, data sharing principles and business models which can facilitate the exchange of data and information from the road vehicles and the Traffic Management and Control Centres (TMC), and back, improving the data value chain for consistent traffic management and mobility services as well as avoiding conflicting guidance information on the road and in the vehicles.

Traffic Management today falls under the responsibility of road operators who have to execute the planning as this is agreed by the public authorities aiming at a general public benefit. Road operators and public authorities, for example, increasingly aim at environmental-friendly traffic management solutions. On behalf of the public authorities, road operators or traffic management centres (TMCs) are delivering services being paid by tax-payers as part of the general state/city budget. On the other hand, traffic service providers, including the road network infrastructure industry, the traffic information service providers and the automotive industry, aim at keeping their customers satisfied. Profit and customer satisfaction is what gives to the industry competitive advantage in the market. Benefits for the general public rank lower than individual demand for fast and efficient service.

Until recently, these two stakeholder groups (the publicly funded TMCs and private traffic information service providers) in their quest for user satisfaction and support, went on separate and sometimes conflicting ways. The TMCs focused on monitoring and informing the mass of drivers using their road infrastructure while traffic information service providers aimed at guiding drivers towards alternative and better suited routes addressing their individual requirements (points of interest, avoiding tolls etc.). The 26 members of the TM 2.0 Platform share a common vision on the TM 2.0 concept. The latter is perceived to be key towards providing a holistic information loop between the vehicle, the service providers, the infrastructure and the TMCs which will enable the traffic information service providers or the TMCs (depending on who assumes the role of alignment and coordination) to inform and guide the road network users to their destination while at the same time optimizing the road network throughput responding to the prevailing traffic conditions.

The evolved scheme of TM 2.0 aims at building trust among the various transport actors involved and at the same time supports the creation of new business models and efficient services. Innovation is key in order to 'do things out of the box' which until recently prevented the road-network stakeholders from cooperating. New trends on Mobility and Transport, such as self-driving vehicles, mobility as a service, green mobility etc. necessitate a change, not only in technology but also in the user's acceptance and the way business is conducted aiming at profit and also in the way public services are offered, the latter usually not taking into account pertinent financial loss.

Four Case Studies: Thessaloniki, Helmond – Eindhoven – Tilburg, Salzburg, Barcelona

The TM 2.0 ERTICO Innovation Platform Task Force (TF) on Value Proposition consists of both traffic management representatives and traffic information service providers. Managing traffic efficiently is agreed to be a service and as such it has to service customers' needs rather than just answer general policy related requirements. Delivering state of the art services in traffic management has to focus on responding to the very specific needs faced by the cities and regions where the TM 2.0 will be implemented / deployed. In order to assess the diversity of needs, the TF on Value Proposition agreed to examine four regions in Europe, namely Thessaloniki, Helmond – Eindhoven – Tilburg, Salzburg and Barcelona.

Thessaloniki

Thessaloniki, the second largest city in Greece, accommodates for nearly 1 million citizens. Due to its geographical position, Thessaloniki plays an important social, financial, and commercial role in the national and greater Balkan region. The transportation hub within the city's limits caters for a total number of more than 777.544 vehicles (including private cars, heavy vehicles and motorcycles).

Figure 1 – Traffic Management Centres in Thessaloniki (peripheral, urban and central)

Research shows that among various trip purposes, 47.6% of the trips are conducted for work and 26.8% for leisure (Mitsakis et al., 2013). The modal split analysis shows that the majority of trips is conducted with private vehicles (67% private cars, 4% motorcycles and 4% taxis), while 23% is conducted with public transport and 2% with non-motorized modes of transport. With single occupancy vehicles at 65%, only 28% and 6% of the vehicles travel with 2 and 3 passengers respectively. The peak hours are indicative of the commercial hub as the city serves in the greater Balkan area (between the 08:00-09:00 and 16:00-17:00 on typical work days).

Currently there are three TMCs in Thessaloniki (Table 1), which are hosted by the Region of Central Macedonia. The latter is responsible for the management of the traffic lights and the surveillance systems of the central arterial and the peripheral ring road.

Table 1 – Characteristics of the three ITS systems deployed in the Thessaloniki area

Peripheral ITS	**Urban ITS**	**Central ITS**
Area: Peripheral ring road expressway network (13 kms) **Traffic**: ~3.700 veh/h/dir during peak hour **Services**: Traffic management, congestion and incident detection and warning **Equipment**: Cameras, VMSs, Traffic Control Centre	**Area**: Wider urban area of Thessaloniki **Traffic**: 94.000 veh/h during peak hour **Services**: Traffic lights control, centralized plan selection **Equipment**: ~200 signal controlled intersections, ~800 loop detectors	**Area**: Central Business District of Thessaloniki **Traffic**: ~30.000 veh/h **Services**: Adaptive signal control, incident management, real-time advanced traveller information system[6] **Equipment**: automatic incident detection & pan-tilt-zoom, VMSs, traffic detection radars and cameras for 68 lanes

[6] http:// www.mobithess.gr

In addition to the ITS systems, Thessaloniki has implemented two cooperative services, one in the city centre provided through LTE and one along the Peripheral Ring Road provided through G5. RSUs have been installed along the Peripheral Ring Road of Thessaloniki, either on pillars and traffic cameras or on top of VMS. From its part, CERTH-HIT has implemented and operates a Mobility Management Centre (MMC) at the mobility laboratory. Two innovative data sources are monitored in the MMC, floating car data (FCD) from a fleet of 1,200 taxis providing traffic status (speed) in almost the whole network in real time and a network of more than 40 Bluetooth detectors tracking trips along the main routes of the city also in near real time. In addition, data coming from social media (tweets and Facebook check-ins) is being collected and it will be added soon to the MMC capabilities. The MMC is composed by hardware (2 large screens) and software responsible for filtering and analysing the data to be monitored as well as to generate the respective alerts when necessary.

The shift from TM 1.0, which is what is currently being used to manage traffic in Thessaloniki, to the evolved concept of interactive traffic management, TM 2.0, will take place by connecting the drivers with the traffic managers and thus providing them with the measures of the traffic management plans along the Peripheral Ring Road at a first stage and within the City Centre at a second stage.

Helmond – Eindhoven – Tilburg

The region Helmond – Eindhoven – Tilburg is the Dutch deployment site to continue operating the C-ITS services that have been implemented, operated and evaluated in the frame of the EU co-funded project Compass4D. The ultimate goal is to move from pilot to large scale deployment for a self-sustained market. This activity is set up as an ERTICO Partnership Activity through a "Compass4D Memorandum of Understanding", a "Compass4D Support Activity Agreement" and of a "Compass4D Deployment Site Agreement" for each of the participating cities, and it is coordinated by ERTICO – ITS Europe.

On the A58 motorway between Eindhoven and Tilburg 34 WiFi-P beacons have been placed as part of the Shockwave traffic jams A58 project. On top of this an IT infrastructure containing open connecting interfaces and data enhancers is been available to enable service providers to roll out traffic services over the whole road section. The Traffic Innovation Centre in Helmond, an experimental and development area within the South Netherlands traffic centre was founded to facilitate the transition to TM 2.0.

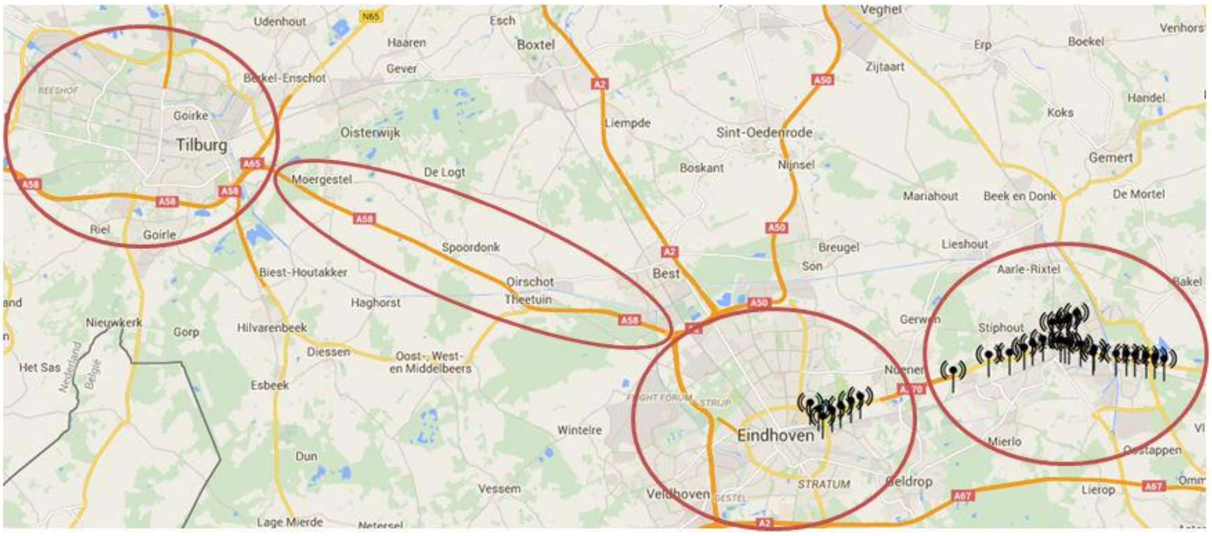

Figure 2 – ITS deployment in the region Helmond – Eindhoven - Tilburg

The Energy Efficient Intersection Services will continue to be operated as a C-ITS service in Helmond. An extension of these services is foreseen in Eindhoven and Tilburg. Other related services in the domain of road safety and fuel efficiency are Red Light Violation Warning and Road Hazard Warnings. The main goal of providing TM 2.0 services for the A58 Motorway is to subdue traffic jam shock waves. The research question is to investigate whether the provision of in-car speed advice to road users can reduce or even prevent the occurrence of shockwaves and the growth of traffic jams. The reliability of such a service experienced by road users ultimately depends on the consistency between the information and advice they receive and the actual situations they encounter on the road. The social importance of a stable supply of information to road users will therefore necessitate public-private coordination and supervision. TM 2.0 creates a framework for this cooperation. As second service a Road Works Warning service is planned.

Salzburg

The case of Salzburg is different. As one of the nine federal states in Austria, Salzburg is located in the north-western part of Austria and immediately adjacent to the German border. The federal state's capital is the City of Salzburg, a mid-sized historic city with around 150.000 inhabitants while its city-centre is a world heritage site.

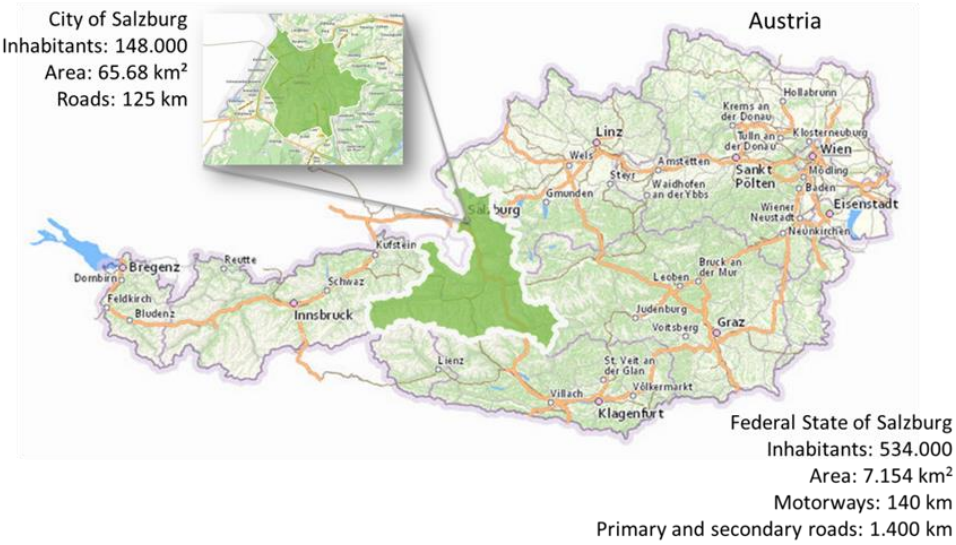

Figure 3 – The Austrian Federal State of Salzburg with the City of Salzburg

With high commuter traffic from the northern parts of the federal state reaching the city on weekdays, it is also a significant share of tourist traffic aiming at the historic city centre that the city has to tackle as the possibilities to optimize traffic capacities are limited. The main public transport infrastructure in the city is the trolley bus system with a share of 14.7% of all trips. In addition, bicycles are used for approximately 19.6% of all trips and 20% of all trips are walking trips (Herry & Tomschy, 2014).

Over the last years several initiatives on implementing intelligent traffic management have been realised:

- Region-wide real-time traffic state estimation system using Floating Car Data (FCD) technology (Floating Car Data Testbed Salzburg)[7], also covering public transport
- Region-wide network of loop detectors
- Adaptive traffic lights in the City of Salzburg
- Traffic-adaptive network control (provided by Gevas software GmbH)[8]
- Dynamic speed adaption and variable message signs on the motorway ring (A1 and A10) around the City of Salzburg (operated by ASFINAG)

With regards to the challenges the city is faced with traffic management- wise, it is the summer touristic season that TM 2.0 can bring added value to the existing solutions. On rainy days during summer, a high number of tourists visit the city centre with limited car capacity due to its historic nature. On such days, most of the tourists reach the city centre by private car, and this regularly results in traffic collapses which have a snow-ball effect. As a result of these high traffic volumes, also the public transport system collapses, since the trolley buses share the road network with individual transport and not all roads are equipped with bus lanes. The overall traffic management strategy on these days is to guide tourists to P+R facilities outside the city centre where a bus line brings them to the city centre. However, this traffic management strategy has not the desired effects. The target group (tourists with city centre destination) cannot be efficiently informed. Closing the city centre for foreign cars (based on number plate selection) is not an optimal solution. Local VMS signs are not able to fully reach the drivers who are mostly guided by navigation systems. The latter are not aware

[7] http://www.fcd-modellregion.at/home?lang=en
[8] http://www.gevas.eu/1/news/news/article/sens-netzsteuerung-in-salzburg/

of the city's traffic management plans and route users to closed roads. Most of the times, tourists are guided to P+R facilities at police checkpoints but leave the indicated route at the next junction and follow the route to car parks in the city centre again as indicated by their navigation system. This is a phenomenon that has become worse over the last years with the increased penetration rate of navigation systems in vehicles.

Shifting TM 1.0 to TM 2.0 in Salzburg means to establish the link between the city administration authorities and the traffic information service providers. By sharing the traffic management strategy that is decided by the city administration with navigation and traffic information services providers, the chain of 'informing-guiding-managing traffic' is complete. The information reaches the driver directly via the in-vehicle system (using the in-dash or portable device in the vehicle). The challenges for the City Administration have already been identified. The road operating authorities have to agree on a standard format (preferably a common European one) for sending information to different service providers. Possibly the national access points, as these are set by the EU Delegated Regulation on Real-Time Traffic Information[i], can deliver the information to different service providers.

Barcelona

Barcelona is the capital city of Catalonia with a population of 1.6 million within its administrative limits. Its urban area extends beyond the administrative city limits with a population of around 4.7 million people, being the sixth most populous urban area in the European Union after Paris, London, Madrid, the Ruhr area, and Milan. As most big metropolitan areas in Europe, Barcelona is heavily affected by congestion and CO_2 pollutants caused by, among other factors, the thousands of commuters that drive to the city on a daily basis. In order to tackle these issues the Catalan Traffic Service (SCT)[9], which is the public body in charge of traffic management and road safety in Catalonia, launched back in 2009 a variable speed traffic management system in the following access corridors to Barcelona.

Variable speed is a traffic management tool that dynamically reduces the allowed speed limit by informing the drivers via VMS. The advised speed limits depend on congestion levels; incidents (such as accidents and road works); bad weather (heavy rain, fog, wind); pollution. The advantages of this management tool of variable speed include: precision and efficiency in managing road incidents (foreseen and unforeseen) through speed management; reduction and minimization of the severity of congestion; reduction of the "stop & go" of vehicles, thus enhancing traffic flow and as a result reducing emissions; improvement of road safety and reduction of accidents due to the homogenised vehicle speed on the road network.

[9] http://transit.gencat.cat/ca

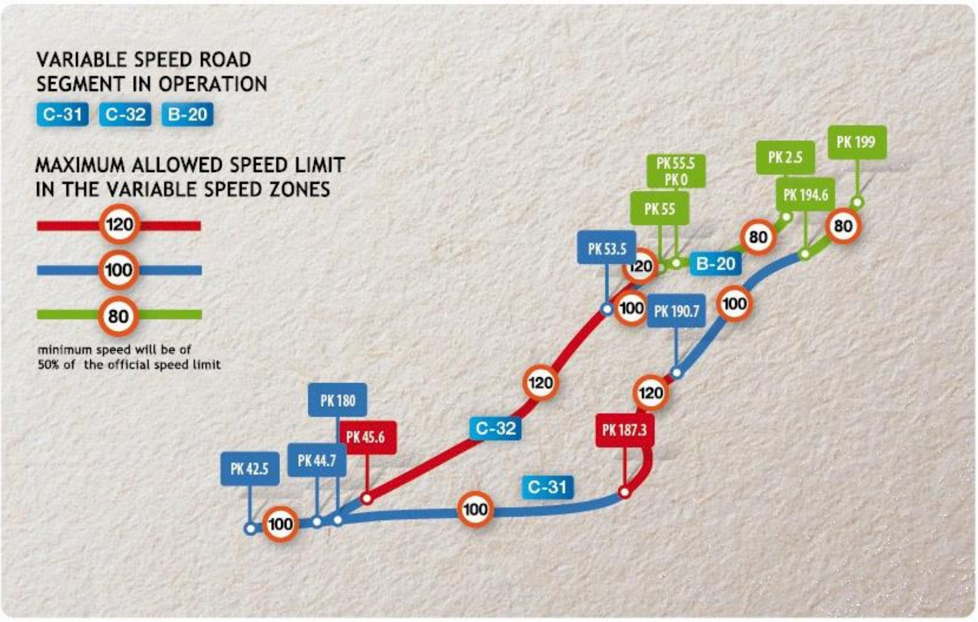

Figure 4 - Schematic map of the three access corridors to Barcelona where the variable speed traffic management system is currently implemented

Currently, detection of congestion in the city of Barcelona and its access corridors is based on inductive loops measuring traffic volumes, and thus allowed (variable) speed limit is informed to the drivers through VMS, plus enforcement reinforced by means of speed cams. However, detection of congestion through inductive loops is a rather old-fashioned methodology. Precision and accuracy of the data provided by this type of sensors is limited and maintenance of the system is expensive. Besides, congestion and pollution caused by heavy traffic does affect other roads and highways where variable speed TM is currently not implemented. Deploying / extending variable speed TM to further access corridors to Barcelona would require installation (and further maintenance) of more roadside ITS infrastructure.

The shift from TM 1.0 to TM 2.0 for Barcelona means unlocking the potential for improved TM strategies through the dynamic exchange of data / information between the traffic managers and the users enabled by Floating Car Data (FCD). Deploying TM 2.0 will empower the drivers to be informed on the best commute option based on highly accurate and updated travel time estimations. Real-time information will flow both ways: to and from the driver, to and from the traffic managers via the traffic information service providers- using an in-vehicle navigation device or an app. TM 2.0 facilitates the provision of highly relevant, targeted and updated information directly to connected drivers, in a simple and timely manner, with the goal to contribute to a smoother traffic flow as part of a global traffic management strategy.

Learnings from the four case studies and value proposition for TM 2.0

The four case studies examined in this paper share a common vision how TM 2.0 can help in facing the different challenges in their traffic management practices. The following elements have been identified as key to enable a more efficient and effective traffic management:

- TM 2.0 can establish a new bi-directional communication channel between users (as well as their service providers) and TMCs. In some cases this will be through road-side infrastructure (i.e. V2I, and Infrastructure to TMC, and vice-versa) or through mobile communication networks (i.e. Vehicle to TMC, and vice-versa). Irrespective of the configuration at each pilot-specific application, communication will be supported by already existing industry standards (LTE, V2I – I2V) while there is a need to agree on common formats for the exchange of specific contents between the different stakeholders, so that TM 2.0-compliant applications are interoperable EU-wide.

- Some contents to be shared among the different stakeholders in the TM value chain are already well defined and there are standards available to format them (e.g. DATEX II for many TM-related concepts; or the widely accepted "Floating Car Data" specification etc.). At the same time, there are other contents the definition and formatting of which, will need to be commonly agreed (e.g. traffic management plans), this specific aspect being tackled by a dedicated task force within the TM 2.0 platform. The different pilots discussed in this Paper, share the common view that the communication channel between vehicles/users and TMCs can be as well used to target specific user groups with tailored information/instructions (e.g. Thessaloniki to target taxis under certain congestion conditions; Salzburg to foster tourists to use park and ride facilities and enter the city center by public transport; Barcelona to convince commuters to adapt their speed or take alternative routes). Specific contents to support each pilot-specific use case/scenario will need to be clearly defined and formatted using a commonly agreed protocol (e.g. location of park and ride facilities and available parking lots for the Salzburg case study).
- The four regions share the common vision that TM may not end with road traffic management only. Specifically, the vision is that efficient traffic management must integrate and exchange information from other modes of transport as well (e.g. guiding tourists to P+R locations, then continue the trip to the city center using PT; Barcelona to provide very accurate travel time to destination to support inter-modal travel planners). This vision adds additional stakeholders to the value chain - i.e. PT operators - and extends the need to agree on common interfaces for the exchange of data and related formats/protocols.
- Common to the four regions is the need to elaborate viable business cases for the deployment of win-win scenarios for all actors involved aiming at the shared goals of reducing congestion and pollution, improving road safety and being cost-effective at all levels. The public benefit ranks equally with the private driver's satisfaction in the TM 2.0 concept.

To foster the development of viable business cases, the main benefits of TM 2.0 with respect to different stakeholder groups have been identified as well (Table 2).

Table 2 – Benefits of TM 2.0 from the perspective of different stakeholder groups

Stakeholders	**Benefits of TM 2.0**
City administrations / traffic managers	• Avoiding congestion and traffic collapse • Avoiding unnecessary emissions (smoother traffic flow) • Improve traffic management plans (FCD complementing or replacing loop detectors and enhancing accuracy in traffic information) • Traffic management plans measures are reaching the driver directly (in-vehicle) • FCD-enabled traffic management being easily scalable to roads where there is currently no ITS infrastructure installed with very little investment, maximizing the benefits of the overall system
Drivers	• Avoiding congestion: more relaxed driving • Receiving relevant regional information in-vehicle • Improved road safety through smoother traffic flow • Best route options aligned with traffic management plans
Traffic information service providers	• Provide the best route option to the destination for their customers (not only the fastest or shortest car route) • Provide added value to their customers with information that goes beyond congestion (potential for new business opportunities)

	• Provide a solution (= best route option) not the problem (= congestion information) well in advance • Regional information becomes part of an integrated service • New business opportunities with the public sector (traffic managers)

TM 2.0 provides an important framework for real-time traffic data to become available to road network operators. This additional real-time information is key for improved traffic and asset management. Traffic planners and road operators can make use of floating car data for estimating traffic flow, deriving origin-destination matrices and for studying traffic mobility patterns.

On the other hand, making traffic management plans and strategies available to service providers is expected to bring in-depth knowledge about TMC operations to service providers and their customers. This knowledge provides new insights into how the road-network is managed and what would be the optimal ways to ensure the end-to-end efficient movement of people and goods. The success of the TM 2.0 concept lies on the fact that it aims to consistently combine and align the sets of objectives that the traffic stakeholders aim to satisfy: public benefit (environmental, congestion, prioritisation policies) and private (fast and efficient routing) in every step of the TM chain.

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