Traffic Management 2.0

Preliminary Report of Task Force 1:

Viability analysis and recommendations

Revision history

Version	Date	Main author	Summary
0.1	23-10-2014	Nuno Rodrigues	Initial draft
0.2	11-11-2014	Laura Coconea	Reviewed structure
0.3	26-11-2014	Nuno Rodrigues	List of services (Nuno) and Cost benefits (Ulrich)
0.4	05-12-2014	Nuno Rodrigues Josep Maria Salanova	Introduction; State of the Art; List of services; Freilot; Multi Agent Multi criteria exercise
0.5	09-12-2014	Johanna Tzanidaki Nuno Rodrigues Laura Coconea	Review; Business models; List of services; Organizational
0.6	12-12-2014	Josep Maria Nuno Rodrigues	Update annexes and text review
0.7	16-12-2014	Nuno Rodrigues	Reviewed version
0.8	20-01-2015	Josep Maria Salanova Laura Coconea Ulrich Fastenrath	State of the art SWOT analysis Organizational architecture BMW Connected Drive LENA4ITS
0.9	26-01-2015	Josep Maria Johanna Tzanidaki Nuno Rodrigues	Review and inputs from Workshop
0.10	13-02-2015	Johanna Tzanidaki Nuno Rodrigues	Enablers and barriers and Workshop input
1.0	17-02-2015	Nuno Rodrigues	First release

1. Introduction

1.1 TM 2.0 and it's scope

Traffic Management 2.0 (TM 2.0) stands for an evolved collaborative concept for Traffic Management and Control. In this evolved system the vehicle and the TMC, through the use of new technologies and sensors exchange travel information and achieve fast, efficient and effective travel. The entire data supply chain is involved in this concept while the TM legacy is also supported. New opportunities for Traffic Management and Control are expected to result from the implementation of this interface, making mobility cheaper and more efficient for the road operators, and, at the same time more cost-effective for the users.

The TM2.0 platform is an open group of significant actors from the global traffic management and mobility service market who joined forces driven by the common vision and belief to "Enable vehicle interaction with traffic management". The public-private platform represents 22 members from traffic management solution providers, mobility service providers as well as traffic managers and road operators.

The scope of TM2.0 platform includes business models, deployment steps, public-private cooperation concepts, organisational architecture, and data exchange principles related to the interaction of the following type of services:

- Mobility services: Individual routing, Individual information and advice, High quality real time and reliable services, Interface to other modes of transport
- Road traffic management: Traffic management and control strategies, Collective routing, Adaptive and dynamic Traffic control, Traffic Management Procedures and Plans, Interface to other modes of transport

Adoption of specifications and standards, use of specific communication technologies and Vehicle-to-Vehicle (V2V) communication are NOT in the scope of TM2.0 unless the stakeholder cannot find the relevant body to liaise with.

1.2. Task Force 1 within the context of TM 2.0

The development and deployment of TM 2.0 services involves the cooperation of several actors and stakeholders from both "road side traffic management" and "in-vehicle" perspective, but as well spread out through the public and private sector. Task Force 1 (TF1) aims to identify and structure the roles and responsibilities associated to the possible actors in possible scenarios, projected for the different TM 2.0 services (**organizational architecture)**.

The TM2.0 platform will focus on reinforcing the cooperation and identifying win-win business solutions for all the involved stakeholder with a view to enhance the effectiveness and success of the envisaged services. TF 1 aims to study and develop feasible scenarios for **business and cooperation models** with benefits for all involved actors. The image below gives an overview of the methodology that supported the work within this TF in editing the present report.

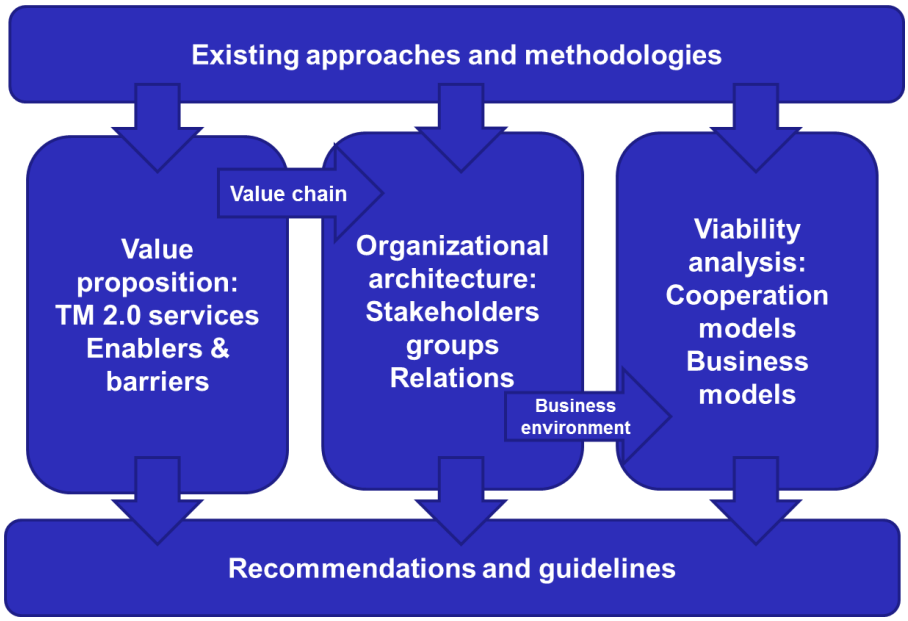


Figure 1 : Task Force 1 methodology

In parallel, another Task Force (Task Force 2) will be focussing on the identification of relevant **enablers and barriers** to which it shall propose in the future possible mitigation measures. The term ' enablers' is meant to denote the trends that are expected to boost the development of such services, while 'barriers' is the term used for the issues that need to be carefully tackled in order to facilitate these developments. The work of Task Force 2 will be fed into that of Task Force 1 as it helps in better fine-tuning the identification of services envisaged to result from TM 2.0.

At the same time, Task Force 3 which will be identifying data principles involved in the TM 2.0 concept will also be looking into the envisaged services resulting from the Platform. This will also be cross-fertilising the work of Task Force 1 in better understanding the possible actors and possible scenarios for the output of the system.

As a result, the **analysis and recommendations** of Task Force 1 come primarily as a result of the review and discussion of recent and current initiatives, projects or actual mobility services identified at this stage, against the objectives of TM2.0 and as relevant to the themes dealt by the Platform. At a second stage Task Force 1 intends to integrate the results of the other two Task Forces as well as the strategic guidance from TM 2.0 Steering Board into its final report.

2. State of the art

TF1 first focused on the identification and review of existing approaches and methodologies applied in recent and current TM 2.0 related initiatives which undertook similar work to that of TM 2.0, These related initiatives aimed at developing new business models and concepts for mobility services.

TF 1 assesses these in order to:

- Understand and characterize the most significant roles and responsibilities in the provision of Mobility services.

- Understand monetary and information flows of on-going and successful Business Models applied to the provision of Mobility services.
- Define good and bad practices in order to take them into account when defining the TM2.0 Business Model.
- List data sharing models that can be adopted in TM2.0

By analysis and juxtaposition of these existing initiatives and projects to the guiding concept of TM 2.0 TF1 borrowed the following concepts/lessons (also described in somewhat more detail in annex documents to this report):

1. The TM 2.0 system should offer benefits matching the needs and capabilities of the stakeholders (lesson from all initiatives examined)
2. It is important to differentiate monetary benefits from social and environmental benefits, especially when executing the cost-benefit analyses (lesson from Freilot project).
3. The whole trip chain should be analyzed and not only the areas where there is a benefit in order to provide realistic numbers to the stakeholders (lesson from Freilot project). A benefit of 15% at the traffic lights can be translated into 1% taking into account the whole route, while a benefit of 5% applying eco-driving already applies to the whole route.
4. TM 2.0 does not only focus on the V2X communication. It aims to go full circle: V2X-X2V and more (lesson from CONVERGE)
5. TM 2.0 is not technical but concept focused. We aim for an architecture or a set or possible architectures that would satisfy partners involved in almost all possible national/regional settings as we recognize that not one solution/architecture fits all (lesson from CONVERGE)
6. TM 2.0 does not have 'set rules' that should be followed. It aims to be more flexible (lesson from CONVERGE)
7. CONVERGE aims to be scalable at national and international level. However, the architecture system is closed and heavily regulates 'roles'. TM 2.0 should avoid that (lesson from CONVERGE)
8. TM 2.0, like CONVERGE, aims at non-proprietary systems and no post in the system should dependent in the way that the actor's presence or absence has the power to make the system dis-functional (lesson from CONVERGE)
9. CHARM, an initiative of two European national road directors/traffic managers, recognizes the potential of communication between vehicles and (roadside) infrastructure as a novel way of gathering traffic data and influencing the behavior of drivers based on personalized, frequent, vehicle and destination specific communication. It can be used to improve current measures (such as prevention of head-end collisions) but also to implement new services from a Traffic Management Centre point of view. A perfect match with TM 2.0 which needs to explored together with the HA and RWS
10. CHARM road directors define their role as not only a "launching customer" but also "launching partner" for development and deployment of new TMS product and service, based on an initial financing support to a business case including other further clients.
11. MOBiNET is meant to grow from a pilot organization towards an operational organization, and this might impact on the quality and reliability of the business plan. Within TM2.0 initiative future opportunities will also be analysed and explored; therefore the viability analysis could give an indication related to the revenue model related to short, medium and long term.

12. MOBiNET is an open platform. Any company that wants to offer services /data or become a service provider can join, and therefore the quality of the services is not controlled/ guaranteed. In case of TM2.0, there is a specific task force defining data requirements and constraints related to data quality (that would enable high quality services).
13. There is a perceived requirement from the stakeholders regarding Open Data trends, in relation to SWARCO systems. Through the involvement in TM 2.0, the Open Platform could be expanded.
14. Within the CORRIDOR ITS context, is suggested that more work is undertaken on the "open" business model and that consideration is broadened to the "market" business model to better understand their characteristics in the context of cooperative systems and particularly for information services. Within TM 2.0, "open" business models will be addressed also.
15. Recent technology development has raised the possibility that most of the benefits of cooperative systems of interest to NRAs could be delivered through cellular communication to SmartPhones. This communication option would allow NRAs to benefit from cooperative services without the need to install an extensive beacon network, so there is a need to be more focused on cellular communication technology within the CORRIDOR ITS. TM 2.0 will make use of cellular technology.
16. New business models are needed, which can satisfy the needs of both the private sector which aims at generating revenue and the public sector which prioritises at utilizing tax-payers money for the benefit of all in the road network. The Key to make TM 2.0 work is cooperation on terms that satisfy the needs and requirements of all. Traffic Control Centres and Service providers have to share the same vision of 'serving' the needs of the user and they have to share 'control' in providing it. In an age of cooperative systems, cooperation is the answer (Lessons from TomTom business model against TM 2.0).

From the above highlights, the following should be the base of the TM2.0 Business Models:

- All stakeholders should perceive real benefits (not only monetary benefit) from TM2.0, especially the ones directly involved in the data collection and processing. This should be done by improving existing services but also by defining new improved and reliable services from the point of view of each stakeholder (always in close collaboration with them).
- Business models and TM2.0 architecture should close the loop (V2x-x2V) but at the same time be flexible, having technical and business open modeles that can be combined depending on the local market characteristics.
- The solution proposed should be flexible enough for fitting all possible national/regional settings. This apply both to technical and organizational. Open platform and modular open business models will make easier the scalability and transferability of TM2.0.
- The users of TM2.0 (traffic managers and service providers) should be involved in the definition and development of the TM2.0 products and services. More services should be developed using a Traffic Management Centre point of view.
- The TM2.0 services should be provided through various communication channels in order to reduce costs and increase penetration while making easier their deployment and acceptance.

3. TM 2.0 value proposition

3.1. TM 2.0 services

TM 2.0 services are defined as the ones making use and benefiting from the interaction between the vehicle and traffic management systems, with the objective of supporting end users in their individual travel and driving choices while being aware of the collective traffic management context. These services provide us a basis for the identification of involved actors, data and value exchange, which can lead us to identification of supporting business models.

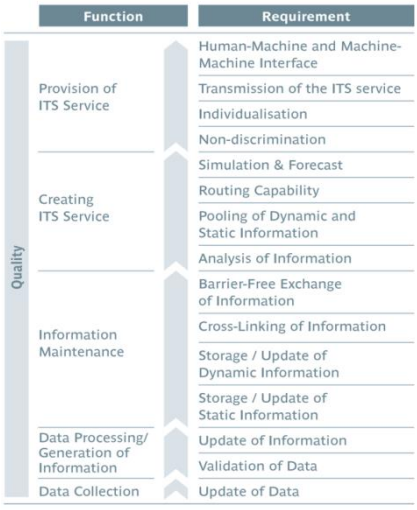
Task Force 3 (TM 2.0 Task force on principles for data) developed an exercise within the platform participants to identify TM 2.0 relevant services which provided a list of services that can be used as a reference for the current study and analysis. The results where consolidated in three services categories:

1 Advanced Navigation Services: individual turn by turn navigation taking into account road and traffic conditions predictions also based on traffic management plans ;
2 Adaptive and Dynamic Traffic Control: traffic management and control services with adaptive and dynamic decision making processes based on real time and historical probe vehicle data.
3 Traffic Status and Event Detection: traffic state information service including real time event (incidents and congestion) detection based on probe vehicle data.

The list of services will be further reviewed in 2015 and when necessary further developed in collaboration in with Task Force 3 in order to capture other relevant services or use cases

3.2. Value chain for TM 2.0

For the purposes of studying TM 2.0 services value of chain the ITS Austria functional framework [1] is initially applied in order to describe the several functions involved in the delivery of an ITS and describe the interdependencies in an harmonized and structured manner. The following functions are applied in the framework :



Data Collection: This encompasses the collection of all statistical data as well as dynamic raw data (e.g. individual position and speed, traffic or weather data).

Data Processing: The collected data must be processed (data filtering, mining, fusion and aggregation). Information is obtained from the "raw data" which then forms the basis for the ITS services.

Information Maintenance: Access to all information that is generated and required for the ITS services must be ensured by appropriate forms of maintenance at the information providers.

Figure 2 : ITS Austria functional framework

[1] http://www.its-austria.info/fileadmin/its-austria/images/ITS_Action_Plan/ITS_ActionPlan_EN.pdf

Creating ITS Service: The information is analysed, pooled and interpreted to generate a wide range of ITS services for ITS users.

Provision of ITS Service: Each service must be transmitted to ITS users in a suitable form (Human-Machine or Machine-Machine Interface).

Following this framework initial scenarios for the value of chain were modelled for two of initial service categories:

1. "Advanced Navigation Services" or **"Traffic Management- aware Dynamic Route Guidance"**: Data is collected and processed separately from both service provides and public authorities. Made available to further organizations through a public private "data broker" to be used for the creation of a service(s) aggregated and presented by a OEM or Navigation Service Provider to the driver inside the vehicle.

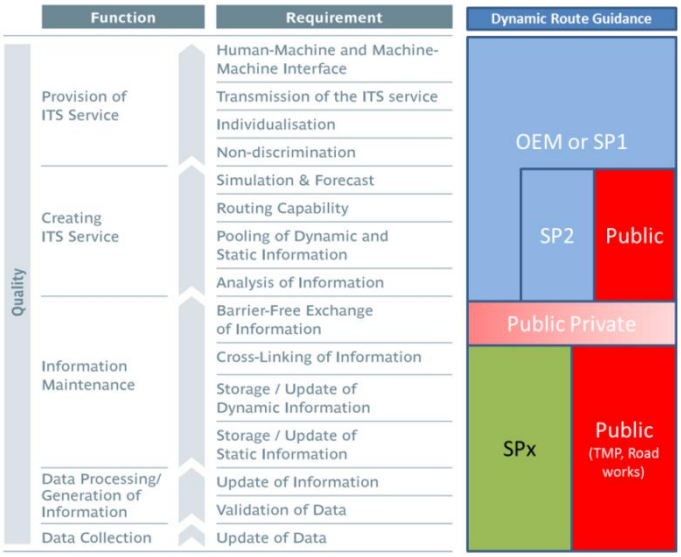


Figure 3 : Advanced Navigations service Value chain scenario

2. **Adaptive and Dynamic Traffic Control**: Traffic data is collected from road side systems (i.e. loops, video and radar) deployed at signalized intersections or strategic traffic count points, processed and aggregated with historical probe vehicle data into completed and consistent data sets structured in time and place., These data sets are applied to develop time signal strategies and plans (green – amber – red light distribution per intersection movement) either prepared beforehand in back office up to real time at local or central system. Real time probe vehicle data is also used to activate plans or strategies, for example vehicle priority at intersection. Probe vehicle car data enriches this service with the potential to fully replace road side detection systems functionality and provide personalized services.

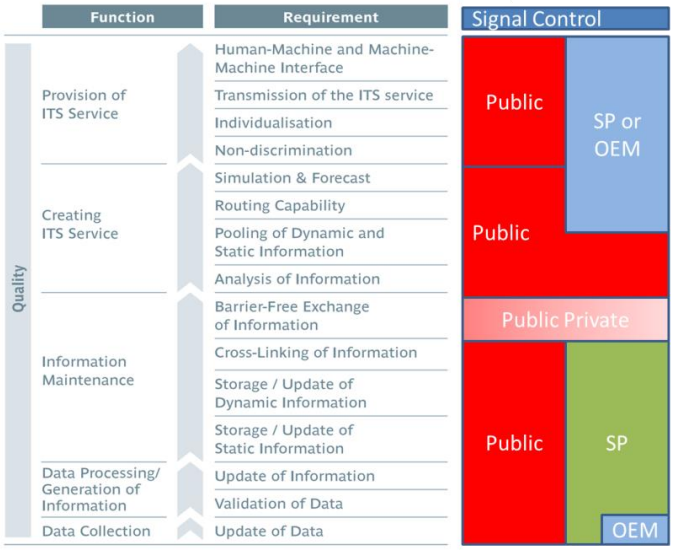


Figure 4 :
Adaptive and Dynamic Traffic control service Value chain scenario

The first analysis of this value of chain scenarios shows a complex number of possibilities for the delivery of an ITS service and the several of interactions and relationships between different actors at all levels of functionality, with a disperse allocation of functions in the chain to a specific actor or stakeholder.

During 2015 TF1 will examine the services and value chain be once the use cases / list of services collection exercise within TF3 is completed. The results will feed the organizational architecture concepts and recommendations

3.3. Enablers & Barriers

Among the activities of the TM2.0 group, Task Force 2 has identified the relevant enablers and barriers that are expected to boost the development of TM 2.0 services or that need to be carefully tackled in order to facilitate TM 2.0 developments respectively. Task Force 2 has also prioritised these enablers and barriers with regards to their importance and also according to how easy it will be to overcome them. The identified enablers and barriers have derived as a result of discussions among experts from the TM2.0 members, which have focused on five areas, technical, organisational, business-related, legal and conceptual one. External stakeholders, not members of the TM2.0 platform, were also consulted, in order to collect the opinions and experience from as many experts as possible.

The following table summarises the identified enablers and barriers and the priorities assigned to them by Task Force 2. The **Impact priority** is based on a scale from -5 (very severe barrier) to +5 (very important enabler). The **Implementation priority** is based on a scale from 0 (very difficult to implement or to overcome) to +5 (very easy to implement or to overcome).

Short name of the barrier or enabler	Impact *-5 (very severe barrier) +5 (very important enabler)*	Implementation *0 (very difficult to implement or to overcome) +5 (very easy to implement or to overcome)*
Technical		
High penetration of Navigation Devices	4.7	3.5
Increase in penetration of reliable traffic information	4.3	3.3
Lack of compatibility with legacy systems	-2.6	2.0
Lack of interface standardization for route/traffic management plan data between vehicles and service providers	-3.2	3.2
Lack of common standards for vehicle probe data and slow progress in standardization	-2.4	2.4
Need for a mechanism for open location data	-2.1	1.9
Long transition period to reach sufficient penetration of vehicles and compatible TMC's	-2.7	1.6
Need for correct mobile network dimensioning	-1.3	2.0

Short name of the barrier or enabler	Impact *-5 (very severe barrier) +5 (very important enabler)*	Implementation *0 (very difficult to implement or to overcome) +5 (very easy to implement or to overcome)*
Organisational		
Progress of Cooperative ITS data policy in Europe	3.1	2.7
Lack of Security Infrastructure for Cooperative Vehicle Data	-1.3	1.3
Need for common data formats for intermodal traffic information	-1.4	2.7
Business-related		
No clear return of investment for involved actors	-2.3	3.4
Users' Privacy concerns	-1.3	3.4
Legal		
Liability problems in case of wrong data provision	-0.6	3.9
Unspecified ownership of data	-2.0	3.3
Conceptual		
Concerns about the reliability of exchanged data	-1.7	2.6
Political acceptability	-2.1	2.7

Table 1 : identified enablers and barriers and priorities

The fact that the listed barriers are more than the enablers should not appear as discouraging Enablers should rather be seen as the existing opportunities that should be utilised by the traffic management community in the future, while barriers are still open issues where a solution should be given in due time.

Task Force 1 took into account the work of Task Force 2 and proceeded in constructing feasible scenarios of business models in its endeavor to identify roles and responsibilities as well as win-wins for the partners involved.

4. Organizational architecture

4.1. Stakeholders groups and actors involved TM 2.0

When looking at the viability of TM 2.0, it is important to consider the perspectives of different stakeholders groups, in order to find synergies among their interests and identify win-win strategies that will determine their actual involvement. Therefore, the following stakeholders groups have been identified:

- Infrastructure managers
- Service providers
- Content providers
- Technology providers
- Service Consumers
- Automotive OEMs
- Telecommunication providers

The relationship between actors was described in the draft figure below.

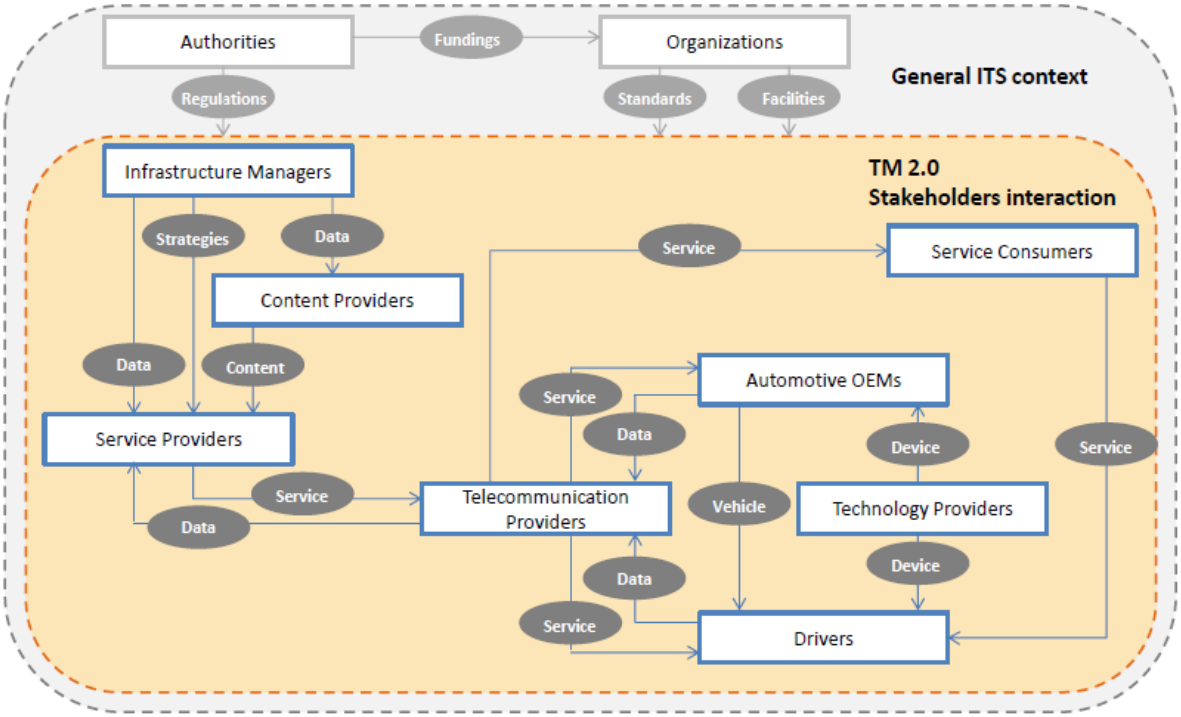


Figure 5 : TM 2.0 relations between actors

5. Viability analysis

5.1 Cooperation models

TM 2.0 sets a framework of cooperation between all the stakeholders involved in Traffic management. It does not regulate the roles and responsibilities in the delivery of the TM services, but it identifies various feasible scenarios for cooperation.

For the TM2.0 scheme to be successful, service providers and traffic managers must remain free to define and operate their respective domains, i.e. their products, services, displays, and other communication channels to road users. Cooperation happens behind the scenes by exchange of higher-level data than before. Information exchange is based on trust and value creation, which in turn is based on agreed rules how to use the data and under which conditions.

In the long run and, in particular, in the context of autonomous driving, the goals of public and private partners will move even closer, and their “business model” will be effectively the same. Making best use of the existing infrastructure and offering the best level of service to mobile people is not a big difference. It is conceivable, at the end of the TM2.0 development, that capacity management of a public road infrastructure could be done by private service providers according to a set of agreed rules, and public traffic managers focus on safety and environmental aspects.

The work of Task force 1 have up to now identified several initiatives (section 2) developing concepts, techniques or services which support the idea for the need of a collaboration model between all involved stakeholders groups. The next stage and challenge for 2015 is to identify the in which manner format these best practices can be combined into a viable and profitable cooperation model.

5.2 Business models

An important objective of TM 2.0 is to identify and/or develop an environment where win-win results are achieved for all involved stakeholders and actors. For private service providers that should be supported by a viable business model where positive business cases can be achieved. Public authorities are willing to support this concept, as long as their benefit cost ratio also increases (see "CHARM initiative").

Benefits preferences

TF1 aims at identifying these win-win business models concepts in a favorable business environment. An initial exercise (questionnaire) was developed in order to identify the most significant benefits and preferences per stakeholder. The results are presented below for a clustering of the stakeholders in the basic roles (Drivers, Service Providers and Traffic Management Centers), while detailed results per stakeholder are presented in the annex document .

	Drivers	SP	TMC
Develop new products, technologies, services, organisational structures and business cases fulfilling users' needs	17%	15%	10%
Efficient use of assets, technology and infrastructure / shared information / improve quality and use of data	6%	8%	15%
Improve drivers comfort	3%	6%	5%
Improve image of the company / city and enhance position in the market	17%	15%	5%
Improve safety conditions and incident management capabilities	5%	7%	16%
Improve traffic flow / energy efficiency / reduce emissions	15%	14%	17%
Provide to the drivers real choices between route alternatives	21%	19%	12%
Quality assurance of multi-level and multi layer "strategic multimodal traffic management" based on cooperative systems	12%	10%	13%
Reduced costs for users	6%	6%	8%

Table 2 : Questionnaire summary results

A quick reading of the summary results show that SPs are mostly aligned to/with drivers (individual) preferences: real choices between alternative routes, development of new services and products. TMC "guard" the collective concern (safety, emissions, public investment) and less preference to develop the solutions. Business models should be build up on these findings and explore further the stated preferences on benefits. In 2015 TF 1 will expand the questionnaire exercise to the rest of ERTICO members in order to collect broader and sustained results which should provide more confidence for conclusions.

Feasible scenarios

Based on preliminary input from both TF 2 (enablers and barriers) and TF3 (Data exchange use case model) a first quest on feasible scenarios was developed during a workshop.

With the help the TF3 use case of model of the 3 consolidated TM 2.0 services a review of the interactions/data exchange between stakeholders (numbered in the picture) was performed combined with identified top-rated barriers.

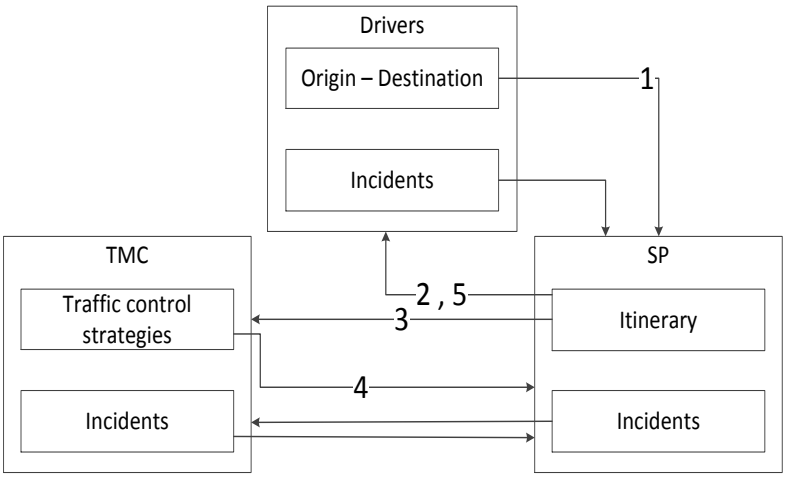


Figure 6 : TF3 use case model

An initial framework was developed identifying feasible scenarios and business principles for sharing data within the use case and respective pre-conditions.

Data exchange	Scenarios	Pre-conditions
1. Collection of OD data	a. Collect individual data b. Collect aggregated data	a. User permission under terms and conditions agreement
2. SP provide advise itinerary		
3. SP provision ODs and the itineraries to TMC	a. SP share data to TMC for improving (mutual) service(s) b. SP sell data to TMC (Public) operators / infra managers / c. SP sell data to other SPs (real estate, marketing, etc.)	"User permission" or "aggregated (anonymized) in time period and volume"
4. TMC optimizes TMPs and provides to SPs	a. TMC share data with SP1 for improving (mutual) service(s) b. TMC sell data to SPxyz	TMC update back office system: a. (technical) ability to interact with SPs, pe: exchange of real time data; b. Traffic engineering knowledge/methods p.e.: Traffic state estimation; Load balancing routing; user equilibrium to system optimum <EC directive minimum data for traffic

		safety (speciification b)>
5. SP update itinerary w/ new TMP and provides optimized navigation service	a. SP is free to choose if uses new data or not p.e. longer travel time route w/ green wave instead of shorter route b. SP uses the data (for free) under pre agreed conditions, provided as an option to the driver: avoid school areas during peak time even if is shortest route; avoid event location to create buffer; c. SP is paid to use/implement the new data with a SLA agreement, p.e. implementing load balancing d. SP is mandatory obliged to implement the "public" new data	a. The exchange of information between the parties (small number of iterations) until an equilibrium point is achieved. b. SP develops the load balancing based on pre agreed policy framework

Table 3 : Framework feasible scenarios and principles for sharing data

TF 1 will proceed with this exercise exploring further enablers and barriers identified in TF2 and taking into account further input from TF3 concerning the technical, organizational or legal feasibility for the exchange of the identified data sets

Cost benefit analysis (for traffic managers and road operators)

The potential benefit of TM 2.0 is undeniable. Research has shown that today's road users rely more on their navigation device/service than they do on the traditional means of traffic management 1.0 (like VMS). This presents a challenge to both the TMCs which have to find ways to communicate their TM/C measures to road network users and to the navigation service providers who need to be TM-aware, in order to become more effective.

TM 2.0 offers the possibility for new measures for traffic management which will be now able to reach/address road users individually. One example is load-balancing routing which takes into account dynamic demand patterns in the network and distributes traffic to minimize the risk of traffic breakdown. Another could be, the routing of one group of cars via a side road so as to reach destination B, known to the TMC when the latter has taken the action to close route A for users with destination X.

Annexes

A. List of TM 2.0 services

1. Adaptive and dynamic traffic control: The TM2.0 concept can be used at intersections or at artery levels using Adaptive Traffic Signal Control Systems (ATCS) together with probe vehicle data and In Vehicle Display. Adaptive Traffic Signal Control Systems (ATCS) seek to optimise traffic flow by considering traffic flow at multiple sites rather than a single intersection. They adjust, in real time, signal timings based on the current network traffic conditions, demand, and system capacity. Adaptive Traffic Signal Control enables traffic signal controlled intersections to interact with each other. This area wide approach can bring significant traffic management benefits including reduced congestion and faster more reliable journey times. Some ATCSs proactively adjust traffic control to meet estimated traffic demand at each intersection before vehicles arrive.
    a. Adaptive and dynamic traffic control
    b. Use historical probe data to analyse the impact of the traffic management control & decisions
    c. Aggregate probe data in a traffic management control & decisions as an additional source of real-time sensor information
    d. C-ITS services (Traffic light service such as speed advice, count down, Road hazard warning, In-vehicle signage)
    e. Road management could investigate more appropriate road network deployment plan and/or city structure plan incorporating the basic traffic behavior information including traffic O-D demand. OD data does not need to breach personal privacy: OD data can be segmented into road network grids with different sizes depending on need for accuracy.
    f. Legacy and evolution of current systems - Integration of traditional and probe data
    g. Traffic management procedures
    h. Enable the collection of probe data for the purpose of traffic management with a minimum of data
2. Advanced navigation services: taking into account information from the traffic managers such as their current Traffic Management Plan (TMP). Dynamic navigation utilizes current traffic event and transport network status data for adjusting the routing process in electronic navigation systems. This enables users to avoid routes with accidents, roadworks, road closure, and congestion in “real time”. The Traffic Message Channel (TMC) is mostly used to provide the basic traffic event information to countries in Europe using RDS radio communications. Other cellular based solutions offer more accurate traffic information. The deployment of short range communication networks like DSRC will enhance even more the ability to monitor accurately the traffic and give further possibilities to “micro-route” vehicles on the alternative road network. The services identified by the stakeholders participating in TM2.0 related to this service are the following:
    a. Navigation services
    b. Advanced navigation services taking TMPs into account
    c. Advanced navigation services taking capacity into account for prediction purposes
    d. Individual routing
    e. Individual information and advice
    f. Enable the delivery of individual information and recommendations to the road users
3. Traffic status and event detection: Traffic management information is brought to the driver via a In-Vehicle System. The driver receives information about currently active valid traffic signs. They raise drivers’ awareness of potentially dangerous conditions in case a traffic sign is not noticed. Traffic signs are displayed on the in-vehicle display. Speed limit information from VMS or post signs, School zone signs and Yield/Stop signs, and weather warnings probably have most impact

on safety in free-flow conditions. The TM2.0 concept makes sure that the information provided by the traffic manager on the VMS remains coherent with the one displayed in the vehicle including Variable speed limits and other information such as weather warnings, incidents or events. The services identified by the stakeholders participating in TM2.0 related to this service are the following:

a. Congestion detection
b. Detection of traffic relevant incidents
c. Probing
d. More detailed information on the current state of traffic
e. Privacy, Security and data collection
f. Speed profiles & Traffic Information Services for users/drivers; for OEMs; for Road Operators and Public Authorities

B. Reviewed initiatives and projects

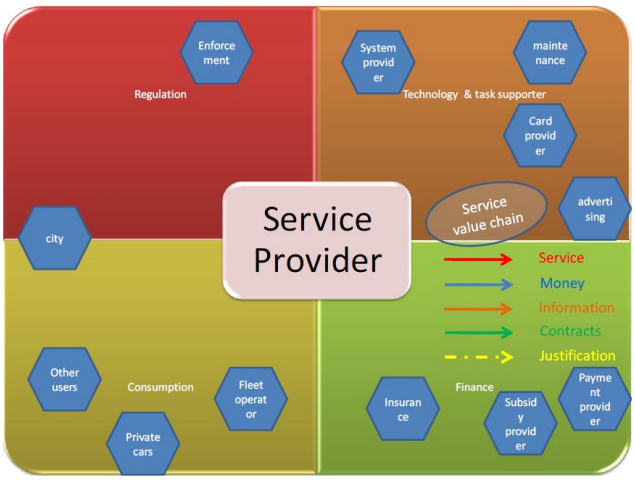
Freilot (R&D)

The FEILOT project aimed at piloting 5 technologies (eco-drive support, delivery space booking, energy efficient intersection as well as speed and acceleration limiters) during a whole year in real world conditions in order to estimate the benefits and define the Business Models for the further deployment of the services in Europe. Two analyses were executed, a cost-benefit analysis for evaluating quantificable impacts (in monetary terms, real money) and a multicriteria analysis for including environmental and social aspects, which although can be easily converted to euros are not related to real monetary flows. The cost-benefit analysis focused on cities, fleet operators, technological companies and truck manufacturers as stakeholders that will have direct monetary costs and/or benefits from the provision of the services, while the multicriteria analysis focused more on the drivers, the citizens and the social aspects of fleet operators and the cities.

The steps followed were the following:

1 - Definition of roles, identification of key stakeholders and matching of roles and stakeholders.

2 - Definition of the characteristics of the customer segments, the flows (service, money, information, rules and content) and the relationships of the stakeholders' roles for each service based on the Roles and Responsibilities of the CVIS model.



3 - Business roles/objectives, value chain and value propositions including economic, environmental and social impacts.

4 - Market benefits (description and indicators definition) and market research for comparison to the solution provided by the FREILOT project presenting the value of the service for each stakeholder.

5 - Definition of business scenarios and evaluation of the business scenarios based on the indicators defined above (market benefits)

6 - Multi-agent multi-criteria analysis and Identification of the barriers and constraints of the business model (Impact, Barrier severity, Other factors that influence, Implementation guideline/solution, Risk/cost of solution, Other factors that influence, Related stakeholder)

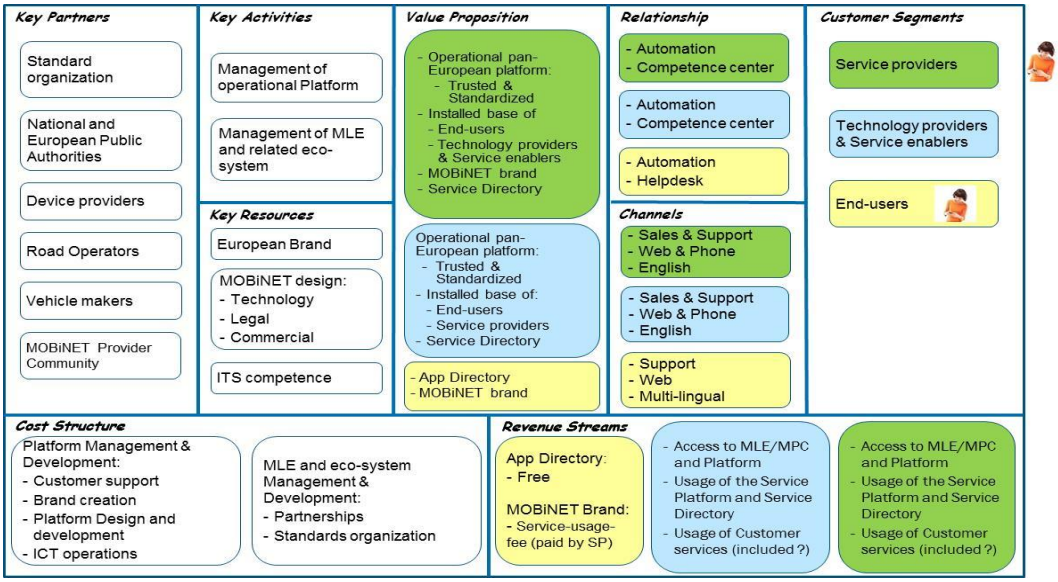
C. Mobinet (R&D)

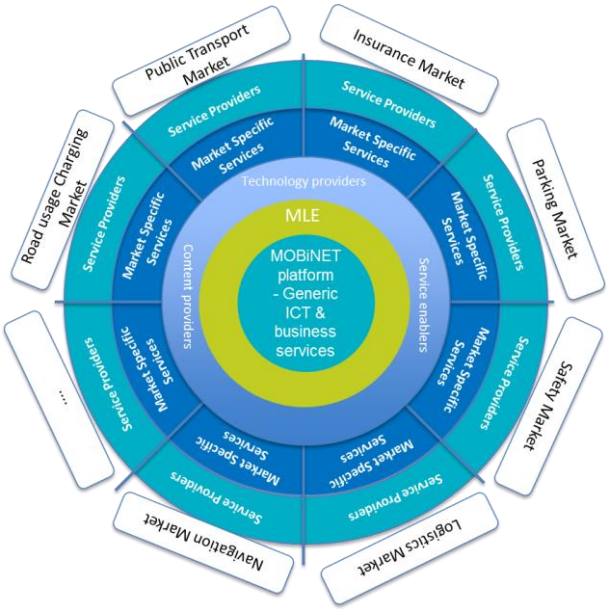
MOBiNET is developing a framework based on a multi-sided Business Model; it means that the MOBiNET Legal Entity needs to develop different value propositions to attract many kind of users and collect the money from (some of) them. MLE will enable business by:

- Using the running platform → no investments, easy start, standard components and interfaces;
- Availability of a large number of technology & content providers and End-users;
- Offering an app Directory that helps to reach End-users in all of Europe;
- A brand that helps attract End-users that are new to ITS or come from another ITS segment;
- A Service Directory that helps find other businesses that provide services or data.

Each target and value proposition require different relationships and channels for interacting and can generate adequate revenue flows only if big numbers of players are reached in each segment: End-users, Service providers, Content (data, technology, services, …) providers.

The Business Model Canvas methodology has been applied:





C. CHARM (innovation)

Example CHARM Pre Commercial Procurement initiative:

CHARM is a cooperation initiative between Highways Agency and Rijkswaterstaat for the deployment a of new generation of (central) Traffic Management System. The objective of CHARM is to move towards an open modular architecture for traffic management systems that enables to prevent future vendor lock-in and allows to plug in more easily new modules that can bring breakthrough innovations to traffic management services. The CHARM-PCP has the objective to create three new modules for the CHARM architecture that correspond to three sub-challenges that form part of the overarching challenge for this PCP shared by the CHARM traffic management authorities to achieve radical improvements in traffic management services. Challenge 3 “Support of Cooperative ITS Functions” is aiming at the realisation of a module that supports the implementation of cooperative system services requiring a participation of intelligent infrastructure, in order to optimise the performance of the road network.

CHARM recognises that Cooperative ITS systems offer a novel way of gathering traffic data and influencing the behaviour of drivers. Communication between vehicles (C2C) and between vehicles and (roadside) infrastructure (C2I) offers many new opportunities. In the traditional approach, information is aimed at groups of drivers passing e.g. a traffic sign. Specific drivers and/or types of vehicle can hardly be addressed, and there are limitations to the information that can be provided. Through cooperative systems personalised, frequent, vehicle and destination specific communication is possible. It can be used to improve current measures (such as prevention of head-end collisions) but also to implement new services from a Traffic Management Centre point of view.

CHARM (road directors) define their role as not only a “Launching customer” but also “Launching Partner” for development and deployment of new TMS product and service, based on an initial financing support to a business case including other further clients.

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D. Converge (R&D)

CONVERGE (2012-2015)- a TM project

It is a research initiative on the development of cooperative architecture for V2X communication. It seeks for a non-proprietary solution on V2X communication. The goal is a systems and operator independence- an architecture that stands alone regardless of the actors. The positions in the architecture are set but the actors have a choice to either enter and participate following the 'rules' set by the system or leave the post for another competitor/actor.

The companies and organizations in CONVERGE cooperate on an open yet secure system architecture. A dedicated communication infrastructure, interconnecting the participants of the CONVERGE systems network, shields the handling of sensitive information and system messages from misuse and protects privacy of data. Standardised access to transmission systems is based on authentication and authorization principles.

Role of actors involved

The partners in CONVERGE include OEMs (Opel, BMW, VW); Suppliers (PTV, Bosch); Cellular (Ericsson, Vodafone); Public authority (Hessen Mobil Road and Traffic Management); Research bodies (BASt), AISEC; FOKUS; htw saar) and associated partners (Federal Network Agency and City of Frankfurt).

The roles are set and the actors can assume any of the roles available as long as they adhere to the Code of Conduct agreed in the CONVERGE architecture. Services can be added or removed from the system architecture according to offer and demand.

Cost-benefit analysis/lessons learned

-Our TM 2.0 does not only focus on the V2X communication. It aims to go full circle: V2X-X2V and more.

-Our TM 2.0 is not technical but concept focused. We aim for an architecture or a set or possible architectures that would satisfy partners involved in almost all possible national/regional settings as we recognise that not one solution/architecture fits all.

-Our TM 2.0 does not have 'set rules' that should be followed. It aims to be more flexible.

CONVERGE aims to be scalable at national and international level. However, the architecture system is closed and heavily regulates 'roles'.

We also aim at non-proprietary systems and no post in the system should dependent in the way that the actor's presence or absence has the power to make the system dis-functional

The idea employed by CONVERGE of avoiding 'silo like' solutions, whereby a specific service is linked to a specific communication way and a specific application necessitating that the driver has to otp for the entire package could indeed be a barrier in TM.

E. ITS Corridor (Deployment)

C-ITS corridor represents the start of actual deployment of C-ITS services in Europe. Initiatives at European and national level are focused mainly on technical aspects, meant to support the actual corridor deployment. These initiatives are yet not producing a common view on bussiness models, mainly due to legal issues and due to strong competitions among involved entities.

Nevertheless, the Amsterdam Group carried an analysis of business models for the deployment of C-ITS services, based on a 4-step approach:

- Identification of stakeholder groups
- Distribution of benefits and costs
- Timescale considerations for stakeholders
- Individuation of benefits and costs from individual stakeholder groups perspective

The report created by the AG TF for Business Models refers in general to the phase concept of business modelling (business model, business case/cost-benefit analysis, business plan) with the third phase being out of scope of this activity.

Available cost-benefit analyses for Cooperative ITS (C-ITS) concentrate on impacts within the transport sector (i.e. safety, efficiency and environmental effects). In general, the studies show the socio-economic viability of Cooperative ITS. It also becomes clear that cost-benefit assessment involves a lot of implicit assumptions and choices. Wider economic impacts (i.e. productivity of transport industry, growth and employment) have not yet been thoroughly studied.

Current assessment practice reveals a number of assessment white spots. These comprise the importance of stakeholders' benefit-cost assessment as a basis for investment planning, the existence of hygiene factors and the need for a common understanding of value chains/webs, all to be in place for a successful implementation of cooperative systems. Moreover, wider economic impacts (i.e. productivity of transport industry, growth and employment) have not yet been thoroughly studied.

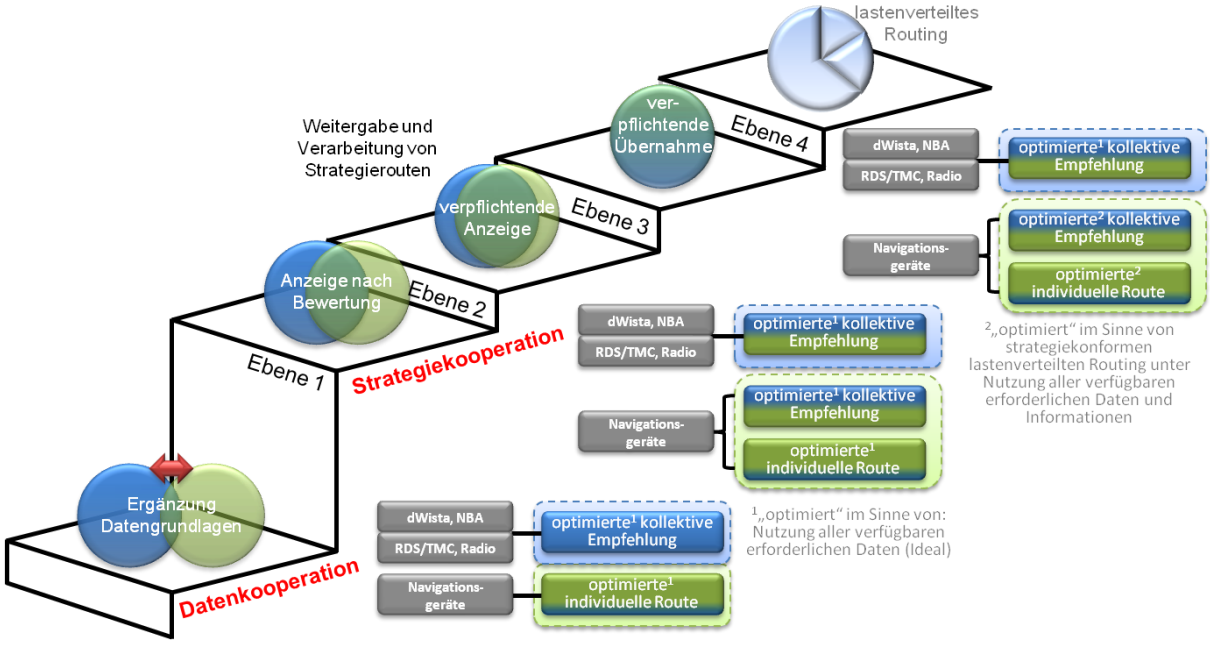
Business models for ICT applications constitute an area of growing interest. The STOF model and the business model canvas (Osterwalder), as applied by several recent projects such as SPITS and DRIVE C2X (ongoing), represent good starting points for analysis. In general, C-ITS increase the tendency (as known of other networks like the Internet) to free (basic) services and puts distinct pressure on the value chains or webs to explore other sources of revenues (e.g. freemium models, user-consented provision of data in exchange to free service provision, advertising models).

F. LENA4ITS <Ulrich>

LENA4ITS was a consortium founded by the German Federal Ministry of Transport, Building and Urban Affairs to investigate measures to ensure the interoperability of public traffic management and individual navigation services (German project title "Maßnahmen zur Gewährleistung der Interoperabilität zwischen öffentlichem Verkehrsmanagement und individuellen Navigationsdiensten*").*

Project partners were Hessen Mobil (the traffic management authority of the state of Hesse), momatec (a traffic consultancy), and Tomtom. BMW and the City of Frankfurt were associated with the project. It was concluded by the end of 2014.

The main result of the project is shown in the figure.



5 levels of cooperation between traffic managers and service providers were defined.

Level 0: data cooperation. The cooperation is limited to data exchange by mutually agreed terms and conditions. This is possible anywhere anytime and does not require new concepts like TM2.0.

Level 1: Traffic managers make their strategies (traffic management plans and capacity relevant measures) available to service providers together with context information about the quality of said strategies, their goals and intentions to enable service providers to evaluate the strategies in real time and to balance them with travel plans and preferences of their customers. The strategies enter route calculations depending on the results of these evaluations. From the point of view of the road users, these strategies are (hopefully) well advised recommendations. They constitute the largest share of all strategies.

Level 2 is a more binding level. Strategies must be displayed in the vehicle. It is up to the road user to follow them or not, but the service provider must not suppress them as he might do on level 1. A typical example would be the strategy to drive towards parking area 2 of some exhibition centre because parking area 1 has filled up.

Level 3, finally, is mandatory. Service providers receiving a strategy on this level must send their customers on routes prescribed by the strategy. Level 3 would typically be used in case of major emergencies or police actions and in conjunction with physical road closures and might precede or complement them.

Extensions to Datex II corresponding to levels 1-3 have been defined.

Level 4: Load-balanced routing. The service provider would use its capability to calculate individual routes, its knowledge of the traffic state and the capacity of bottlenecks in the network, along with the strategies of traffic managers to balance the load in the network and to minimize the risk of further traffic breakdowns, supporting the traffic manager who only has collective means to communicate with road users to reach his goals and, at the same time, offering the best possible level of service to his customers. This level of cooperation is the most sophisticated one. It is mentioned by LENA4ITS but there are no specific results. It should be, however, the long term goal of TM2.0 as it creates the win-win situation we are striving for.

LENA4ITS foresees “huge potential benefits” but does not make quantitative statements about cost-benefit ratios or business models.

G. TomTom: Our Business Model and our vision on TM 2.0

The TomTom Business Model

TomTom generates profit by collecting and aggregating probe data on traffic and travel. It takes advantage of the opportunities probe data present in the field of real time and historic traffic and travel information (weather included) in order to achieve fast, efficient and safe travel for users in less time and cost. TomTom also generates revenue by providing mapping and location services. It's clients include drivers, OEMs, public authorities, road operators and traffic management centres as well as other service providers in the area of traffic and travel information.

How does the TomTom business model match TM 2.0 services and products

The TM 2.0 concept may appear too high level and unclear. It is so because it is a concept which is in the making. It is not fully operational yet.

For TomTom the idea of setting up a Platform that would invite stakeholders to discuss is seen as a first step to build on new business models which will be able to satisfy the needs of both the private sector which aims at generating revenue and the public sector which prioritises at utilizing tax-payers money for the benefit of all in the road network.

TomTom already provides tailor-made routing solutions to both the automotive industry and the drivers. As already mentioned above, it's services and products include real time traffic information, weather, historic traffic databases and maps. Our company is able to route drivers towards alternative routes avoiding congestion and in the markets where we cooperate with Traffic management centres we contribute to Traffic management procedures and plans.

What is missing

1. A major drawback in making a system such as TM 2.0 work is the lack of common understanding on the benefits this would offer to both the private and the public sector. A change of mind-frame is required for service providers and public authorities alike. The end user should be satisfied and this is what will bring business to service providers and the much needed justification of investment choices with regards to the road network infrastructure to public authorities.

What does this mean? Public authorities indeed have a prerogative to make decisions in how to plan and manage traffic. There is no question about that. The decision is in the hands of decision-makers. Nonetheless, service providers are entitled to offer a service to users in how to reach their destination in a more efficient way and this includes aspects such as speed and safety. Only if service providers are informed about the Traffic management Plans and decisions, will they route their users in an effective and efficient manner and only if Traffic management and control centres have the information on how many drivers on the road will use (or are using) this or that road network (because of their destination), will they be able to plan and take better informed decisions on traffic management.

2. This brings us to the second drawback of this scheme: stakeholders fear the loss of complete control of the service. Indeed the control rests on more than one stakeholders acting on the road network: traffic control centres, service providers, drivers, OEMs. And this is the key to the system: cooperation and indeed cooperation on terms that satisfy the needs and requirements of all. Traffic Control centres and service providers have to share the same vision of 'serving' the needs of the user and they have to share 'control' in providing it. In an age of cooperative systems, cooperation is the answer.

3. Finally for an industry vision to work, the relevant regulation (at national and EU level) has to be supportive. As this Platform is an industry initiative, it makes sense to allow for cooperation models that are not imposed or regulated. Also, by enhancing a bottom up approach to an evolved TM scheme a wider acceptance rate is ensured as well as a stronger stakeholder engagement in conducting dialogue on related issues and challenges.

TomTom is dynamically engaged in the stakeholder dialogue process taking place in the TM 2.0 Platform because it sees added value to its services and products in cooperating and finding a win-win with other road network stakeholders involved. Efficient routing for users should include reliable and quality information on real-time traffic and traffic management decisions.

H. BMW Connected Drive

BMW Connected Drive is an eco-system of services and apps which can also be used from inside the vehicle just as it is known for smart phones:

http://www.bmw.com/com/en/insights/technology/connecteddrive/2013/index.html

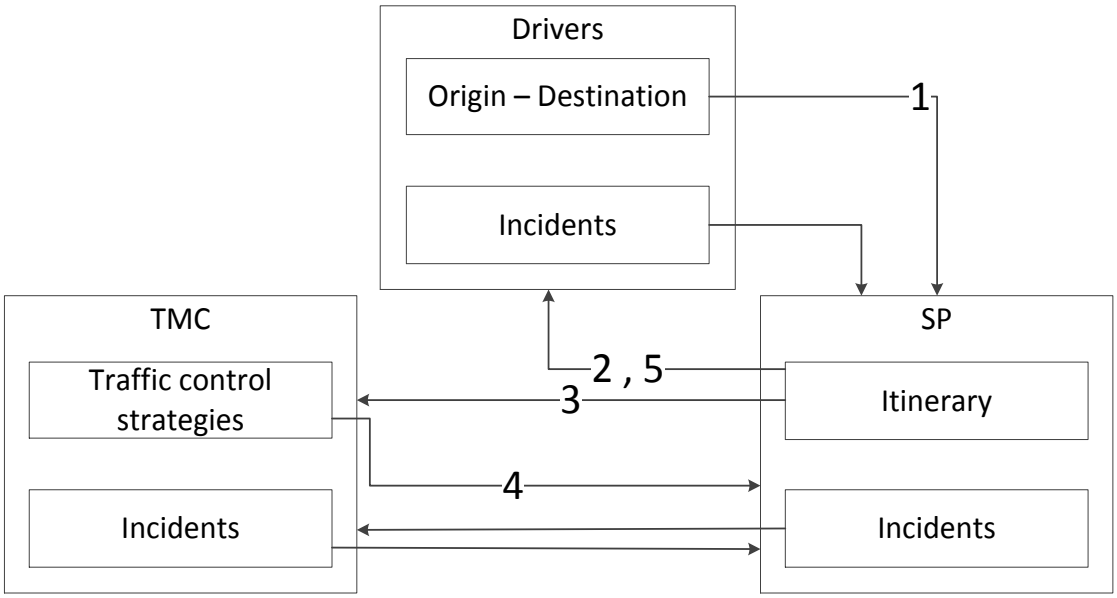
There are two elements of Connected Drive which generate specific revenues and which are relevant to TM2.0, namely the real-time traffic information service (RTTI) and the “navigation system professional” offering the “online alternative route”.

As the customer pays for these services, he expects a higher level of quality and reliability than free services can offer. This includes knowledge of plans, measures and schedules of traffic managers which affect either his way of driving or even the best route to his destination according to his preferences. More complete knowledge of these factors is clearly beneficial for both the driver and the traffic manager who wants to make them known to drivers. Intuitive integration into the MMI of those information elements which are relevant to the driver, and the omission of the others improves the information flow and increases the level of compliance.

For the TM2.0 scheme to be successful, service providers and traffic managers must remain free to define and operate their respective domains, i.e. their products, services, displays, and other communication channels to road users. Cooperation happens behind the scenes by exchange of higher-level data than before. Information exchange is based on trust which in turn is based on agreed rules how to use the data.

In the long run and, in particular, in the context of autonomous driving, the goals of public and private partners will move even closer, and their “business model” will be effectively the same. Making best use of the existing infrastructure and offering the best level of service to mobile people is not a big difference. It is conceivable, at the end of the TM2.0 development, that capacity management of a public road infrastructure will be done by private service providers according to a set of agreed rules, and public traffic managers focus on safety and environmental aspects.

I. TF 3 Use Case model description



(Developed by JMS for TF3- borrowed for TF1)

1. The drivers introduce their destination in the navigator (the origin in known from the GPS location).

2. The service provider estimates itinerary based in historical and real time data

a) Historical data of travel time along the links

b) Real data about incidents

3. The service provider shares the ODs and the itineraries with the Traffic / infra manager

4. The **Traff./ Infra manager** uses the ODs and the itineraries for optimizing the capacity of the network (traffic light programs, capacity increase measures) and shares this information with the service providers

5. The **service providers** update the itinerary based on the new data received from the TMC and provides en-route navigation service based on incidents and capacity modifications

6. The above is done a few times (small number of iterations) until an equilibrium point is achieved

7. Two optional modules can be the following:

a. Collective routing: the TMC can provide directly the individual routes for all the drivers (we need 100% penetration) in order to avoid the iterations and provide the best LoS to all the users.

b. C-ITS services can be also provided along the route followed by the drivers if available.

J. Multi Agent Multi criteria exercise

In order to identify the stakeholders involved in TM2.0 as well as the most significant benefits of these stakeholders a multi-agent multi-criteria analysis was executed. The steps are the following:

- Step 0 – Identify the "agents"
- Step 1 – Identify the benefits
- Step 2 – Define Indicators for each benefit
- Step 3 – Data collection
    - Step 3.1 - Ask relative significance of each benefit
    - Step 3.2 – Measure/estimate indicators
- Step 4 – Data processing
    - Step 4.1 – Calculate weights
    - Step 4.2 – Calculate score
- Results
    - R1 - Significance of each benefit for each stakeholder
    - R2 - Score of each Business Model for each stakeholder

At this stage steps 2, 3.2 and 4.2 were not executed, which means that R2 were not obtained.

Steps 0 and 1 were to define both the stakeholders and the benefits, which was done by interchanging mails with the core participants of the Task Force. The list of stakeholders is the following:

- Public Authorities
- Infrastructure manager
- Service provider
- Content provider
- Technology provider
- Consumers
- Professional drivers
- Fleet operators
- Automotive OEM
- Public Transport Operator
- Police/Enforcement
- Road Operator
- Telecommunication provider
- Automotive industry

The initial list of benefits included 14 entries, which were clustered in order to reduce the is the following. Both lists are presented below.

All benefits:

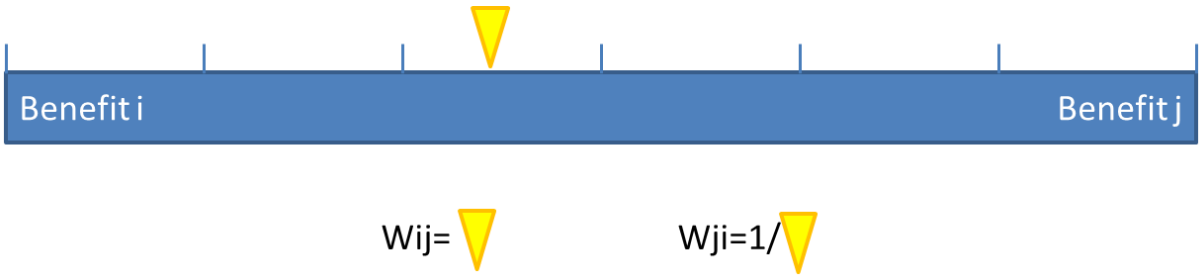
- Energy efficiency and CO2 emissions
- Reduce CO2 emissions

- Improve Traffic Flow
- Improve safety conditions
- Improve drivers comfort
- Efficient use of road infrastructure
- Improve image of the company
- Improve image of the City
- Improve quality of data
- Improve use of data
- Implement (road) traffic management (knowledge) in cooperative systems (technology and concept)
- Efficient use of technology and infrastructure (shared)
- Support authorities in deployment of new technologies
- Develop new business cases for implementation of cooperative traffic management

Clustered benefits:

- Develop new products, technologies, services, organisational structures and business cases fulfilling users' needs
- Efficient use of assets, technology and infrastructure / shared information / improve quality and use of data
- Improve drivers comfort
- Improve image of the company / city and enhance position in the market
- Improve safety conditions and incident management capabilities
- Improve traffic flow / energy efficiency / reduce emissions
- Provide to the drivers real choices between route alternatives
- Quality assurance of multi-level and multi layer "strategic multimodal traffic management" based on cooperative systems
- Reduced costs for users

Step 3 was executed through a questionnaire that was sent to all the stakeholders involved in TM2.0. The questionnaire was based on sliders containing all the possible combinations of the 9 benefits listed above and the answerers were asked to move the slider near to the most significant benefit of the two depending on the relative significance of both benefits.



The result obtained from each question was the relative significance between the two benefits. The relative significance for the same benefits located in the opposite order is the inverse of the obtained value, which allowed reducing the number of questions by 50%. A few pairs of benefits were asked in the two possible orders aiming at validating the consistency of the answers.

A total of 12 were received, covering 8 of the roles defined in step 0. Two of the answers do not include the role and were excluded.

Multiple roles per participant were provided (2 on average):

Public Authorities	4
Infrastructure manager	2
Service provider	3
Content provider	2
Technology provider	3
Consumers	2
Professional drivers	0
Fleet operators	0
Automotive OEM	1
Public Transport Operator	0
Police/Enforcement	0
Road Operator	1
Telecommunication provider	0
Automotive industry	0

The question used for validating the answers has been answered correctly by 5, while 3 more answered almost correctly. In 2 of the 12 answers the question was not answered correctly. These two questionnaires were also excluded.

The results are presented below for a clustering of the stakeholders in the basic roles (Drivers, Service Providers and Traffic Management Centers), while detailed results per stakeholder are presented in figure xxx.

	Drivers	SP	TMC
Develop new products, technologies, services, organisational structures and business cases fulfilling users' needs	17%	15%	10%
Efficient use of assets, technology and infrastructure / shared information / improve quality and use of data	6%	8%	15%
Improve drivers comfort	3%	6%	5%
Improve image of the company / city and enhance position in the market	17%	15%	5%
Improve safety conditions and incident management capabilities	5%	7%	16%
Improve traffic flow / energy efficiency / reduce emissions	15%	14%	17%
Provide to the drivers real choices between route alternatives	21%	19%	12%
Quality assurance of multi-level and multi layer "strategic multimodal traffic management" based on cooperative systems	12%	10%	13%
Reduced costs for users	6%	6%	8%

The two most important benefits as well as the two less important benefits per role are highlighted in green and red respectively.	All	Automotive industry	Automotive OEM (SP)	Consumers (Drivers)	Content provider (SP)	Fleet operators	Infrastructure manager (TMC)	Police/Enforcement	Professional drivers	Public Authorities (TMC)	Public Transport Operator	Road Operator (TMC)	Service provider (SP)	Technology provider (TMC)	Telecommunication provider
Develop new products, technologies, services, organisational structures and business cases fulfilling users' needs	13%		15%	17%	17%		7%			10%		8%	13%	13%	
Efficient use of assets, technology and infrastructure / shared information / improve quality and use of data	13%		15%	6%	6%		14%			15%		14%	8%	15%	
Improve drivers comfort	6%		15%	3%	3%		4%			4%		6%	5%	6%	
Improve image of the company / city and enhance position in the market	9%		15%	17%	17%		3%			3%		3%	13%	9%	
Improve safety conditions and incident management capabilities	12%		4%	5%	5%		17%			17%		21%	9%	13%	
Improve traffic flow / energy efficiency / reduce emissions	16%		14%	15%	15%		19%			18%		19%	14%	13%	
Provide to the drivers real choices between route alternatives	13%		15%	21%	21%		14%			13%		11%	19%	8%	
Quality assurance of multi-level and multi-layer "strategic multimodal traffic management" based on cooperative systems	13%		4%	12%	12%		13%			13%		8%	12%	16%	
Reduced costs for users	6%		1%	6%	6%		8%			7%		10%	8%	7%	

From tables above some quick findings:

- SPs are mostly aligned to/with drivers (individual) preferences: real choices between alternative routes, development of new services and products.
- TMC “guard” the collective concern (safety, emissions, public investment) and less preference to develop the solutions.
- “Improve drivers comfort” and “reduced costs” for users are the less significant benefits for most of the stakeholders, while “Improve traffic flow / energy efficiency / reduce emissions” and “Provide to the drivers real choices between route alternatives” are the most significant ones.
- The results of “Improve image of the company / city and enhance position in the market” and “Improve safety conditions and incident management capabilities” are opposite depending on the stakeholder (the first one is more important for private companies while the second one is more important for administrations).