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Exchanging Traffic Management Plans data between Traffic Management Centres and Service Providers in Traffic Management 2.0

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Abstract

Traffic management operations in general and the exchange of traffic management plans data in particular are very heterogeneous across Europe in terms of availability and quality, mostly due to different levels of facilities availability, tools, processes and the lack of standards in place. The ERTICO Innovation Platform on interactive traffic management, TM2.0, aims to enable, facilitate and accelerate the information exchange among traffic management stakeholders across Europe. Within this innovation platform, the taskforce on Traffic Management Plans Exchange has defined five concrete use-cases in which sharing this information could be mutually beneficial for road authorities and service providers. Based on these use-cases, the taskforce has identified the challenges that come with exchanging this information, and has drafted first recommendations and guidelines for stakeholders involved in the Traffic Management evolution towards a European TM2.0 ecosystem.

Keywords:

Traffic Management, Traffic Management Plans Exchange, TM2.0

Introduction

Across Europe, traffic management operations in general and the exchange of traffic management plans data in particular are very heterogeneous in terms of availability and quality, mostly due to different levels of facilities availability, tools, processes and the lack of standards in place. At the same time, as a result of increased connectivity, use of in-car services and improvements in traffic management ICT infrastructure, new opportunities and developments arise in working from the usual traffic management with ‘collective’ measures, towards more individualised, more functional and tailor-made traffic management. The 34 members of the TM2.0 innovation platform[1] believe in cooperation among European traffic stakeholders in order to work towards (1) better insights in the infrastructure status for road authorities, (2) more effective tools to influence this status where needed,

and (3) improved information that service providers can offer to their users. TM2.0 is both a concept and a platform. The TM2.0 concept focuses on enabling vehicle interaction with traffic management plans and procedures. By discussing business models and enablers, the TM2.0 Platform aims to pave the way for the TM2.0 concept to be implemented in various cities and regions around Europe based on the win-win of its actors. The group of members consists of traffic management stakeholders such as Public Authorities, Road Operators for cities and regions, OEMs, Traffic Information Service Providers, Road Infrastructure Providers, ITS research centres and road-network users associations.

The different taskforces of the TM2.0 platform are working on minimum required sets of data to be used in providing TM2.0 services to drivers and traffic management centres (TMCs), along with the reliability and quality of the data used, as well as agreeing on common interfaces. This will improve the total value chain for consistent traffic management and mobility services and avoid conflicting guidance information on the road and the vehicles themselves. The taskforce on the exchange of traffic management plans (TMPs) aims to define the concept of TMPs (decisions, procedures and strategies), and how these could be exchanged in practice. Within the question how these plans could be exchanged, a specific focus lies on how the stakeholders involved can avoid misinterpretation of each other's data and measures, and better understand and communicate each other's intention. This could for example be done by increasing the standardisation in this communication and agreeing on each other's role and scope of responsibilities in these collaborations.

Traffic Management Plans

For a correct definition of TMPs, it is important to understand that traffic management solutions are often not directly interchangeable between different urban areas or regions. It is therefore necessary that they are tailored to local requirements and should be reflective of local priorities and sensitivities. Therefore three levels of Traffic Management are defined: Strategic, Tactical and Operational. The overall goal is to ensure safe and efficient use of the road network by a good cooperation between road authorities and service providers.

Policy decision makers will be fully involved in decision making regarding traffic management strategies and actions, which is covered by the level of Strategic Traffic Management. Based on the traffic policy road authorities define the priority of the traffic flow on the several roads in the network. Roads where traffic jams are acceptable, will have a tolerable delay as a limit. The goal of this assignment is to optimize the traffic flow in the total network. The suggested ways of working have to be accepted by all involved stakeholders.

Tactical Traffic Management is the liaison between the strategic and the operational level. The situation in the network will be described and compared with the traffic policy to determine and analyze the bottlenecks, incidents and emergencies. Strategies will be developed to solve these issues.

Within these strategies, possible measures are traffic flow control, traffic flow redistribution (rerouting), traffic demand control (traffic diversion, restrict inflow, promote inflow/outflow, traffic buffering and reduce traffic demand) and capacity control (reduce capacity restriction/obstruction time, maximize bottleneck capacity, capacity redistribution). Measures will be defined to realize these strategies, and a traffic management plan consists of a set of measures.

Operational Traffic Management is the execution of the traffic management plans by the road authorities and the service providers. General use cases are Sharing information, Optimize traffic flow and Rerouting. The goal of the general use case Sharing Information is that service providers are informed about the measures the road authorizes are executing. Service providers are than aware of the information that is been presented by the roadside systems. The reason behind the general use case Optimize traffic is that service providers can execute their own services to contribute to this optimization. The background of the general use case Rerouting is that service providers can reroute their customers. Rerouting by Variable Message Signs is based on predefined routes. The added value of service providers is that they could have more alternative routes.

Traffic Management Plans contain different elements:

- (Where) description of the geographical context;
- (What) description of the traffic situation that might or (in case of events and road construction works) will occur;
- (Why) this traffic situation needs to be managed and what enhancement in traffic this management needs to bring;
- (When) moments in time when these traffic situations are expected (e.g. morning rush hours, tunnel closure, football match, et cetera);
- (Who) the target groups on which the traffic management actions will focus (e.g. motorists traveling from the south towards the city center, or cyclists in order to give them a better position in the traffic flow), or a prioritized combination of these groups in certain circumstances;
- (How) what traffic measures will be activated and deactivated (on what triggers and where on the road network) in order to manage traffic. Traffic control measures can be grouped in 4 classes: reduce inflow, increase outflow, increase throughput and reroute traffic.

The ‘where’, ‘what’ and ‘when’ is needed to get an understanding of the needs of the traffic manager (read: the collective of road users). The ‘who’ is needed to get an understanding on who to approach and guide or support. In the ‘how’ the transition from TM1.0 to TM2.0 becomes clear. In TM 1.0 the traffic strategies will be translated in measures as configurations of road side instruments such as traffic signal controllers’ ramp meters, variable message signs, or even road closures using barriers. In TM 2.0 the strategies can be implemented via information, advices and warning appearing on the human machine interface of the navigation device.

TM2.0 approach in the exchange of Traffic Management Plans

According to how navigation in-car systems currently function, the driver submits his destination to the in-car device and expects to be advised in the best routing. The driver's destination and request for routing goes to the traffic information service provider's back end and she is immediately provided with route options based on real-time conditions with regard to congestion and the weather conditions in the identified area. Thanks to the data exchange enabled by TM 2.0, the traffic information service provider, when receiving the destination the driver wishes to reach, will be able to cross-check and cross-fertilize the destination data plan with what the Traffic Management Plans (TMP) provided by the TMC. In this way the service provider will be able to send better informed advice to drivers. The other way around, data from service providers will help TMC's to be better informed about the real-time status of the infrastructure and traffic intensities, as well as possible feedback actively provided by individual drivers through their navigation device on incidents, hazardous situations, or more specific traffic jam information. Also, the toolbox that TMC's have to resolve traffic issues is enriched when measures could be communicated through service providers to sub-groups of drivers or even individuals to make measures more specific and only for drivers that could contribute to resolving traffic issues. This could also be done through the service provider taking these measures into account when calculating optimal routes for their users.

Use-cases

In order to work on concrete use-cases where the exchange of traffic management plans might provide benefits for TMCs, SPs or both, five use-cases were identified: Flow Intensity Control, Infrastructure Objects Status, Variable Message Sign Intention, Driver Feedback and Aggregated Origin-Destination information.

Flow Intensity Control

The Flow intensity use-case is about sharing information from road operator to service provider on activated flow intensity control measures with traffic lights, or plans to do so in the near future. These measures could be activated on traffic lights or ramp meters near highways in order to reduce the traffic flow through these traffic lights, which could relieve congested roads behind these lights. Sharing this information could enable service providers to plan routes for individuals which will avoid network parts where less traffic capacity is, or will be, available. Measures are shared with the service provider before the service provider detects the effects of the measures and could incorporate the measure in its route calculation in this manner.

An example of this use-case is shown in figure 1

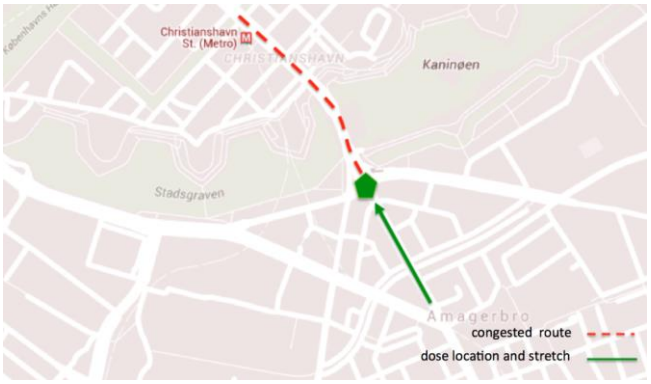

Figure 1 – Example of Flow Intensity Control measure

Communicate:

- Exactly which stretches where traffic flow is or will be controlled by traffic controller or ramp meter (intersection/node, direction)
- Severity of flow control (strong/medium/weak) and (expected) delay

Challenges:

- Expected delay is hard to assess
- Coherence in exactly which intersection/direction/severity the flow control measure is, might be difficult to achieve
- Understanding and expecting what actions other stakeholders will take after receiving information, and what effects this will have
- Avoiding a direct feedback loop of actions from TMC followed by actions by service provider

Infrastructure Objects Status

The Infrastructural objects status use case is about sharing information from road operator to service provider on the status (e.g. opening/closing/delayed) of infrastructural objects such as stretches, tunnels and bridges. By sharing this information via standardized interfaces, the service providers can improve their services to individuals and negative effects in the vicinity of objects can be avoided.

An example of this use-case is shown in figure 2

Figure 2 – Example of Infrastructure Object Status

Communicate:

- Objects of interest (Object type, Object location, optional: direction)
- Object notification (Status: open/closed/delayed)
- Optional: (Expected) open/closed time, and (expected) delay

Challenges:

- Expected time indications could be hard to assess
- Requires active data management (e.g. in case of planned tunnel closures/openings)
- Uniform EU standards

Variable Message Sign Intention

The Variable Message Sign Intention use case is about sharing information from road operator to service provider on the content and intention of variable message sign messages. These variable message signs are used to show drivers on certain stretches a variety of traffic related information and advices, ranging from congestion information, upcoming accident warnings, recommended routes to large events, etc. These VMSs could be located near roads as well as being used 'virtually' for informing in-car application users. Sharing information could enable service providers in improving their services by taking the aim of messages into account in individual route guidance and recommending users certain routes. This could then improve the follow-up rate of these messages.

Examples of this use-case are shown in figures 3 and 4

Figure 3 –VMS intention on regional level

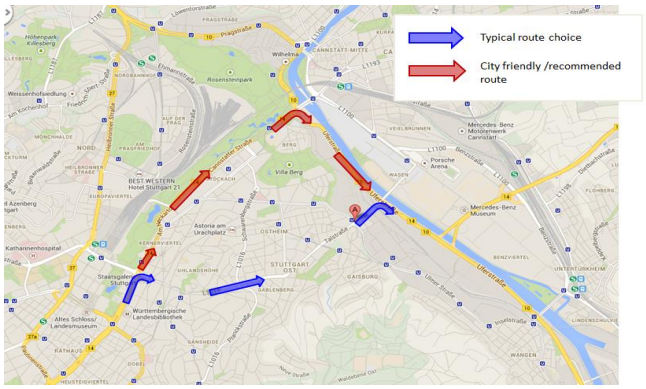

Figure 4 –VMS intention on local level

Communicate:

- Road / network areas of interest
  - Stretch(es) or area(s) that preferably need to be avoided
  - Stretch(es) or area(s) that preferable need to be used
- Aim of the advices
  - Reason (Incident, congestion, event, etc.)
  - Message type (Warning, advice, information (Level of importance))
  - (Expected) delay

Challenges:

- Number of involved stretches could be hard to establish for some VMS scenarios
- Standardisation of intention communication
- Translation of intention to practical measures
- Understanding and expecting what actions other stakeholders will take after receiving information, and what effects this will have

Driver Feedback

The Driver Feedback use case is about sharing information from service provider to road operator on the feedback provided by individual drivers on subjects such as incidents, hazardous situations, traffic jams, etc. Sharing this information could provide near-real-time data on infrastructure status that could otherwise be difficult to measure using known roadside sensors and data. This driver feedback could also help in interpreting information retrieved from roadside sensors and service provider data (e.g. Floating Car Data) in order to come to effective measures and decisions.

An example of this use-case is shown in figure 5

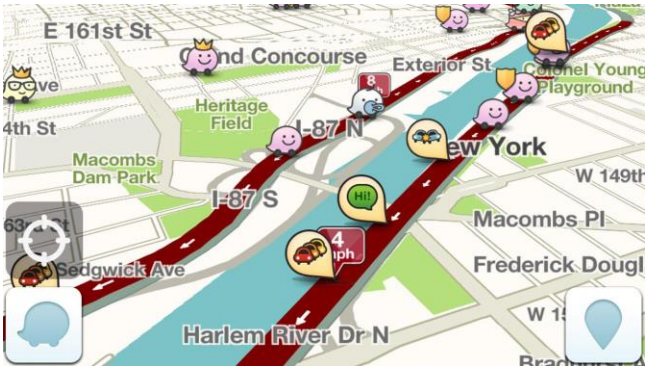

Figure 5 – Example of Driver feedback through Waze navigation

Communicate:

- Traffic event type (Incident, Traffic Jams, Put holes, Hazardous situations, etc.)
- Traffic event location
- Traffic event direction
- Reliability level of data
- Optional: Traffic event severity (e.g. traffic jams)

Challenges:

- Create a standardized interface for sharing this kind of data
- Assess reliability of event detections by individuals
- Avoid misuse by (groups of) users

Aggregated Origin-Destination Information

The Origin-Destination Information use cases is about sharing information from service provider to road operator on aggregated origin-destination information from drivers. Sharing this information helps to predict traffic demand in certain stretches or in certain areas, and anticipate this demand by taking preventive measures. In order to avoid privacy infringement, only aggregated of multiple drivers, in time-intervals (e.g. quarter of an hour), and only on regional detail level are shared. Despite this information being aggregated and are not traceable to individual drivers, the information is still useful for traffic predictions, as the assumption is that in most cases there are not too many alternative routes to travel from region to region.

An example of this use-case is shown in figure 6

Figure 6 – Example of Aggregated Origin-Destination information

Communicate:

- Oncoming traffic demand on stretches, using Aggregated Origin-Destination information from navigation users. The aggregation by the service provider disables tracing individual drivers.
    - Origin (region/district)
    - Destination (region)
    - Time-of-departure (interval; e.g. quart of an hour)
    - Estimated time-of-arrival (interval; e.g. quart of an hour)
    - Number of vehicles

Challenges:

- Provision of sufficient and reliable data
- Validation of assumptions
- Availability of appropriate standard

Tactical-level Guidelines document

The evolution within the Traffic Management ecosystem towards TM 2.0 deployment, necessitates that the abovementioned issues and challenges with regards to the use-cases described in this paper have to be resolved. In the case of exchanging traffic management plans within the TM 2.0 concept, stakeholders from very different backgrounds have to collaborate and exchange data. They therefore are required to understand and respect each other's motives, intentions and strategies. The paper attempts to issue draft recommendations/guidelines with regards to the deployment of TM 2.0 on tactical level and will focus both on road authorities and service providers. The 2015 ITS Platform deployment guideline document[2], where data-exchange guidelines are presented for regional and cross-border European traffic management collaborations between different public road authorities only has been used as a model structure for these guidelines.

General service description

On the tactical level of traffic management, as this has already been described in this Paper, the situation in the network will be described and compared with the traffic policy to determine and analyze the bottlenecks, incidents and emergencies. For the services and measures to be triggered into action under TM 2.0, the vision and mission of the two main groups of road stakeholders have to be clarified: road authorities and service providers differ to a great extent in this respect given their different background, interests, operations and dependencies.

The vision on behalf of the road authorities is:

- Safe, efficient and sustainable management of road infrastructure
- Use available means for traffic management in the most (cost-)effective way
- Responsibility for road infrastructure

The vision on behalf of the service providers is:

- Fast, efficient and safe driving experience for its users
- Make routing and navigation a tool for reliable journey planning and better driving
- Competitive advantage

The mission on behalf of the road authorities is:

- Cooperation with service providers so that a better overview of road infrastructure in gained, and more effective and individualised measures are available
- Gain better insight in what is happening on the roads by collecting data
- Improve ways of taking measures to adapt road infrastructure use

The mission on behalf of the service providers is:

- Cooperation with the road authorities so that they can contribute to their tasks on traffic management

- Acquire knowledge of the TMPs well in advance so that the user/driver has the best information and service

The differing interests and viewpoints of the two groups of stakeholders in traffic management, those of TMCs and Service Providers, have to be aligned according to the TM 2.0 concept. For the TM 2.0 to work, the stakeholders understand and respect each other's interests and effectively translate the traffic management strategy towards measures taken by both. This can happen on a chain of collaboration phases.

Traffic Management Collaboration phases under the TM 2.0 concept

In order to have the best alignment between different stakeholders when exchanging Traffic Management Plans information, stakeholders must commit to a longer term collaboration, encompassing both the TMP preparation, actuating the TMPs as well as the evaluation of TMPs effects. The whole functionality of a traffic management plan can be divided into three different phases which by their nature strongly differ:

- **TMP elaboration phase:** A common management task of various stakeholders/organizations involved, not only in combining Traffic Management Services and Traffic Information Services, but also with regards to networks operated by different authorities. Hence a thorough preparation of the service and documentation by means of intermediate deliverables is a must in order to create and agree upon a clear common understanding between all stakeholders involved.
- **TMP operation phase**: This is the phase where a traffic management plan is executed.
- **TMP evaluation phase:** Traffic conditions change rapidly. In particular, end users change their behavior when confronted with traffic management measures. Hence a thorough analysis of impact a measure has and – if necessary - revision of the service as this is offered, is also a must and should be undertaken recurrently. The evaluation results must be documented and, in-turn, provide input for improving the traffic management plan that was executed.

In all the above mentioned three phases, road authorities and service providers can strengthen each other's role and impact with regard to insights in traffic management situations and effects, the toolbox of measures that could be included in a TMP, and the short iterative evaluation possibilities.

Guidelines for the traffic management collaboration phases

In the following initial guidelines/recommendation for the implementation of the traffic management collaboration phases are provided based on the uses cases mentioned above.

Collaboration of stakeholders in TMP elaboration phase

General aspects:

- Establish common understanding of goals and responsibilities (e.g. user optimum versus network optimum)
- Establish common understanding of means/measures (e.g. detour recommendation via VMS, flow control via traffic lights, route recommendations (based on traffic information) via navigation service) to influence user behaviour, improve user acceptance
- Establish common understanding on existing means (e.g. speed data, demand data, volume data, cameras) to identify traffic state or incident information
- Identify means to derive user acceptance ratio

Location specific aspects

- Agree/discuss/understand local policies
- Identify local means to influence traffic, improve traffic (e.g. available infrastructure and alternative (roads)
- Establish common understanding of goals and possibilities
- Define triggers and measures for TMPs
- Agree on protocols and distribution channels

Collaboration of stakeholders in TMP operation phase

General aspects:

- Identify and agree on proceedings for evaluation of active strategies/measures in real-time
- Agree and define on feedback loop

Location specific aspects:

- Identify and agree on available measures for actuating TMPs
- Identify and agree on local ‘special’ restrictions for TMPs deployment

Collaboration of stakeholders in TMP evaluation phase

General aspects:

- Identify and agree on proceedings/methods for evaluation of active strategies/measures (continues before and after evaluation)
- Identify required (and available) data for evaluation

Location specific aspects:

- Avoid local direct feedback loops by measures from different stakeholders

Conclusions and next steps

In order to work on concrete use-cases where the exchange of traffic management plans will provide a win-win for TMCs and SPs alike, the TMPs taskforce has identified the above-mentioned- five use-cases and has set out in detail the relevant expected challenges which cover basic but core functions of traffic management. Having identified the challenges that come with exchanging this information, planning for the next steps in solving these issues is a natural follow up. The aim of this TM 2.0 Platform taskforce is to ensure that the above-mentioned information can be exchanged as clearly as possible between stakeholders, avoiding misinterpretation and ensuring the correct understanding of each stakeholder's intentions. With regards to the strategic level, the taskforce will not undertake any work. Strategy is based on political decisions taken by the stakeholders and these fall out of the scope of this taskforce. The new tools that are developed in this taskforce are there to create opportunities for stakeholder's strategic level decisions, and do not intend to influence strategic level decision making. In this respect, the stakeholders who support the implementation of the TM 2.0 concept are by definition strategically aligned in their goal towards a win-win based on better traffic management system. Hence, the taskforce intends to focus on how the different stakeholders could align their interests in order to come to an effective translation of the traffic management strategy towards measures taken by TMCs and service providers. This is the tactical level of traffic management: what traffic measures can lead to what impact, and how these measures could be promoted by all stakeholders involved. At this level the guidelines recommendations will be further explored and developed. With regards to the operational level, the taskforce intends to explore the possibilities of existing TM communication protocols in exchanging TM2.0 TMPs data, and identify what adaptations are required to enable the above-mentioned use cases. In this respect the taskforce will continue its collaboration with those organizations that are involved in working on traffic management exchange protocols, such as the Traveler Information Services Association (TISA)[3] for the extension of the TPEG protocol, the DATEX-II[4] community for the DATEX-II protocol, and the DVM-Exchange[5] community for the DVM-Exchange protocol.

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