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Optimising Network Traffic Flow with Cooperative Traffic Management in the Amsterdam Region

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Abstract

In the European project SOCRATES$^{2.0}$, a consortium consisting of eleven public and private organisations has been challenged to try different ways of working together to realise smart traffic and navigation services. The partners have selected and developed 3 types of services, which will be tested by at least 9,000 users in the regions of Amsterdam, Antwerp, Copenhagen and Munich. One of the Amsterdam services consists of smart route advice by means of the Use Case Optimising Network Traffic Flow in the Amsterdam Region. The pilot has started in December 2019 and includes motorways, regional roads, urban-interurban interfaces and urban roads. It is expected to lead to more business opportunities for the private partners, a more cost-effective traffic management for the public authorities and better service for the road users.

Keywords: Public-private partnerships, Traffic information and navigation services, Network optimisation

The Amsterdam Metropolitan Region issue

The issue at hand is that the densely populated Amsterdam Metropolitan Region suffers severely from congestion. Especially when the arterial road A10 is congested, huge delays can be expected. Service providers usually start re-routing when congestion already has established itself. Ideally, re-routing would commence pro-active: re-routing when the chance on congestion is increasing but traffic is still flowing. This will, however, go against private short-term goals of service providers. The proposed solution consists of a public-private partnership where all partners cooperate and where public and private goals are reconciled as much as possible. The partners build a common operational picture based on both public and private collected data and determine common goals, KPI's, and conditions for re-routing. To make this orchestration of cooperative traffic management succeed, well-established intermediary roles are necessary. This is piloted within the SOCRATES$^{2.0}$ project.

The SOCRATES$^{2.0}$ project

The SOCRATES$^{2.0}$ project consists of 9 activities and follows a V-model approach (figure 1). First, a common framework was defined (Activity 2), which was then specified for the four pilots (Activity 3). The designs will be validated in the pilots (Activity 4-7), evaluated (Activity 8) and the results will be used to update the framework (Activity 9).

SOCRATES$^{2.0}$ works as much as possible with existing techniques to realise smart traffic services and traffic management. So, what's new? To create these new and better services for road users, international service providers, car manufacturers, ITS companies and road authorities should cooperate and share information. The partners in SOCRATES$^{2.0}$ are defining and experiencing sustainable public-private cooperation and business cases in traffic management. This is an important step in the direction of implementation of smart mobility services. The collaboration makes SOCRATES$^{2.0}$ a unique and valuable project, from which lessons can be drawn for all stakeholders in the traffic management chain. It is expected that SOCRATES$^{2.0}$ will learn from different approaches.

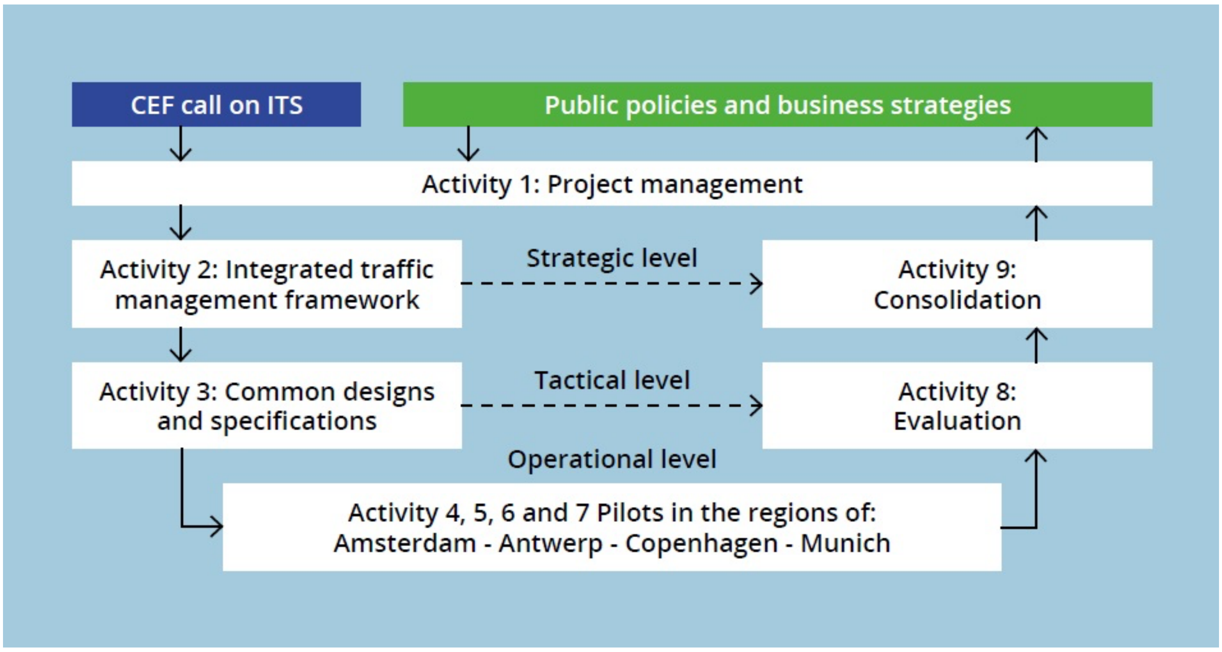


Figure 1: The SOCRATES$^{2.0}$ activities model

The needs and interests, both for the commercial parties (e.g. revenues, customer satisfaction) as well as authorities (fast, safe and green traffic), are evident. They are in some extent overlapping but are different on other aspects, and it may be a challenge to find a cooperation model that is attractive for all. Although there is research on cooperation within the Traffic Management domain (Heygi et al, 2001; Hoogendoorn et al, 2003; Kammouna, 2014), it predominantly handles joint control strategies, e.g. by means of scenario deployment. Models suitable for cooperation between several public and private organisations with the goal to come to one common strategic, tactical and operational framework are scarce or not well described. That is why the SOCRATES$^{2.0}$ partners started with defining a common ground for cooperation on a strategic level, the so-called SOCRATES$^{2.0}$ framework on public-private traffic management. This framework builds upon the TM2.0 concept (Rehrl et al, 2016; Vlemmings et al, 2017). The elaboration of the project set-up and the underlying public-private partnership was subject of a previous paper (Huisken et al, 2019).

The SOCRATES$^{2.0}$ Cooperation Framework

All SOCRATES$^{2.0}$ partners believe that by cooperating more business opportunities for private partners can be developed, more cost effective traffic management for public authorities achieved, and, maybe most importantly, better services for road users and communities provided, thus creating a so called "Win-Win-Win" for all stakeholders. The goal of SOCRATES$^{2.0}$ is to test if this added value is actually created by a closer cooperation and find out how this can lead to a sustainable business cases for all stakeholders.

To facilitate this, the SOCRATES$^{2.0}$ partners created a Cooperation Framework consisting of a set of cooperation models and enabling "Intermediary roles" to support these cooperation models (figure 2).

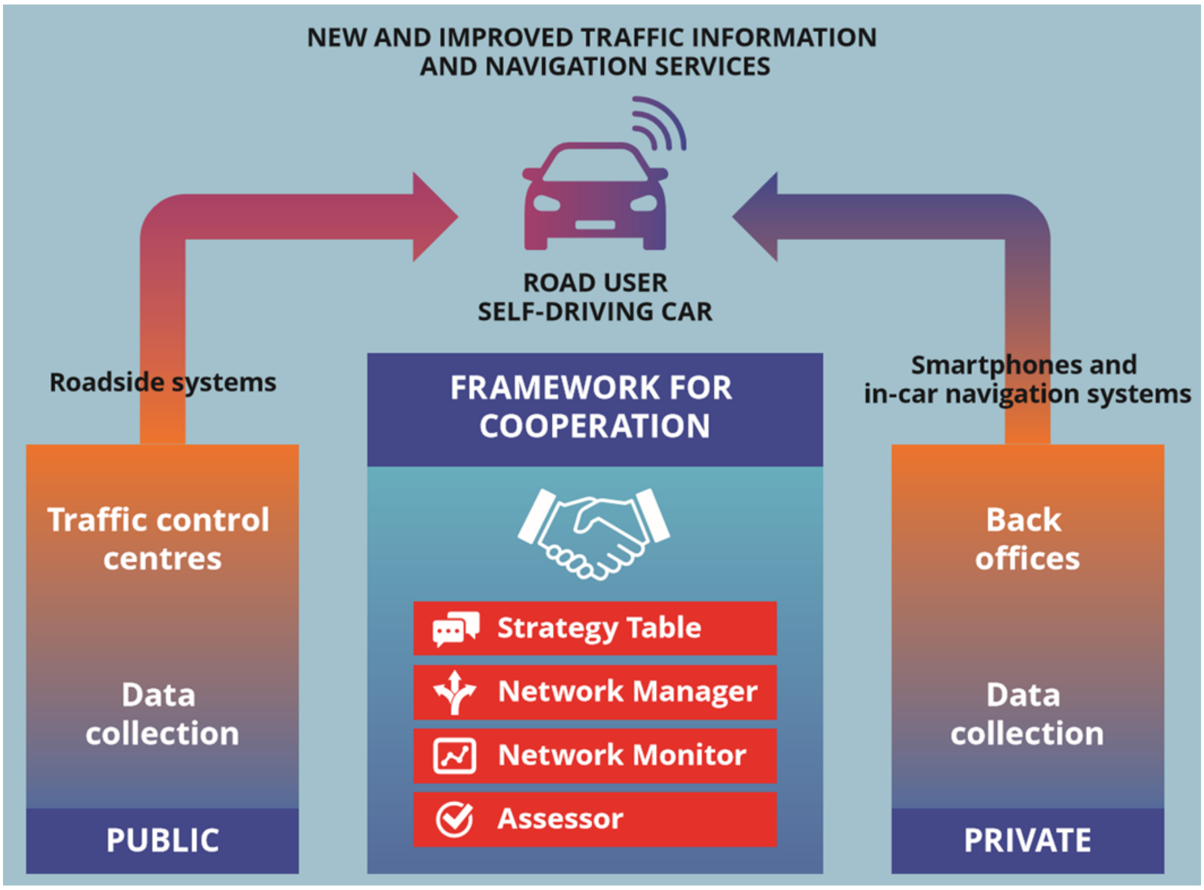


Figure 2: The SOCRATES$^{2.0}$ Cooperation framework

The cooperation models are based on the level of communality of the collaboration. The basic level comprises of simple agreements for sharing public and private traffic data, based on agreed data exchange formats ("Exchanged data"). To bring the cooperation a step further, partners can create a common view of current and predicted traffic situations on a network, based on the exchanged data ("Shared view"). The most elaborate level of cooperation arises when based on the created shared view, partners develop and implement coordinated actions and services towards communities of travelers ("Coordinated approach"). Enabling the cooperation models, SOCRATES$^{2.0}$ partners developed the "Intermediary Roles" Strategy Table, Network Monitor, Network Manager and Assessor (Figure 3).

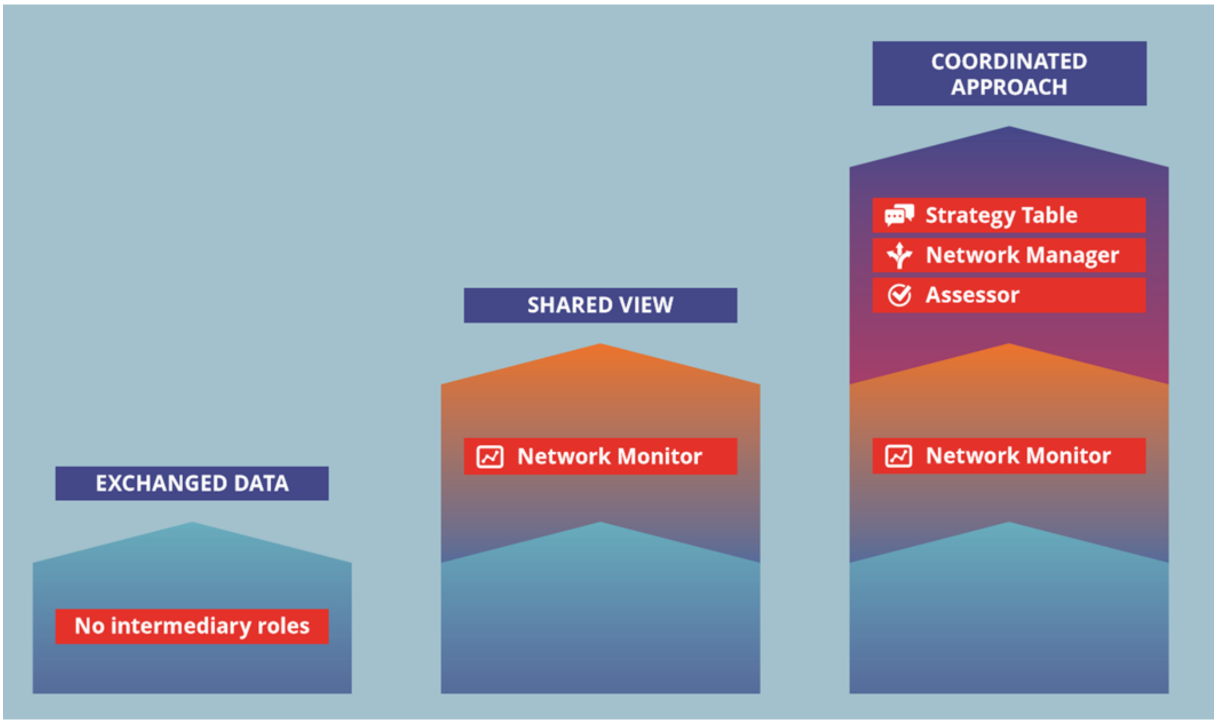


Figure 3: Intermediary roles to enable cooperation

Dependant on the level of the cooperation, partners need functions to actually exchange data, develop a shared view and define the coordinated approach to road users. Added to that, impact also needs to be evaluated in order to create feedback to the cooperation.

When partners decide to cooperate by exchanging their data and based on that create a shared view, the Network Monitor functions need to be implemented. This implies providing data collection, -fusion and -completion activities and determination of the common current (and if possible predicted) state for a pre-defined use case related network and indicators. Partners then can base their own services on a higher quality based shared view.

When partners aim for a coordinated approach (highest level 3) to advise the road user, they need to decide on common goals (KPI's) and confront them with the current (or predicted) traffic state and identify effective measures to solve (potential) problems. The Network Manager provides these functions. By executing assessment of impact partners can then determine what measures are effective and create impact.

The Strategy Table is the meeting place, or council, that establishes and orchestrates strategic cooperation between public and private parties (figure 4). It focuses on finding common goals of both public and private partners, which then are being translated into KPI's, network / link goals and indicators, and measurable target and deviation values. Additionally, a service toolbox has been developed. It consists of a collection of public and private services that can be activated to achieve the established goals. Examples of public services: increase traffic output at link level by adjusting green times of traffic light controllers, decrease traffic input at link level by adjusting ramp metering. Examples of private services: avoid a certain link or re-routing traffic via a specific route. When necessary and agreed, the Strategy Table will also define guidelines and principles for ranking and/or rewarding the level of impact delivered by public and private parties.

During the operational phase of the pilot, operational values will be collected through monitoring; this is done by the Assessor. At frequent intervals, the collected data will be confronted with the common established KPI's and this may result in adjusted KPI's and target values.

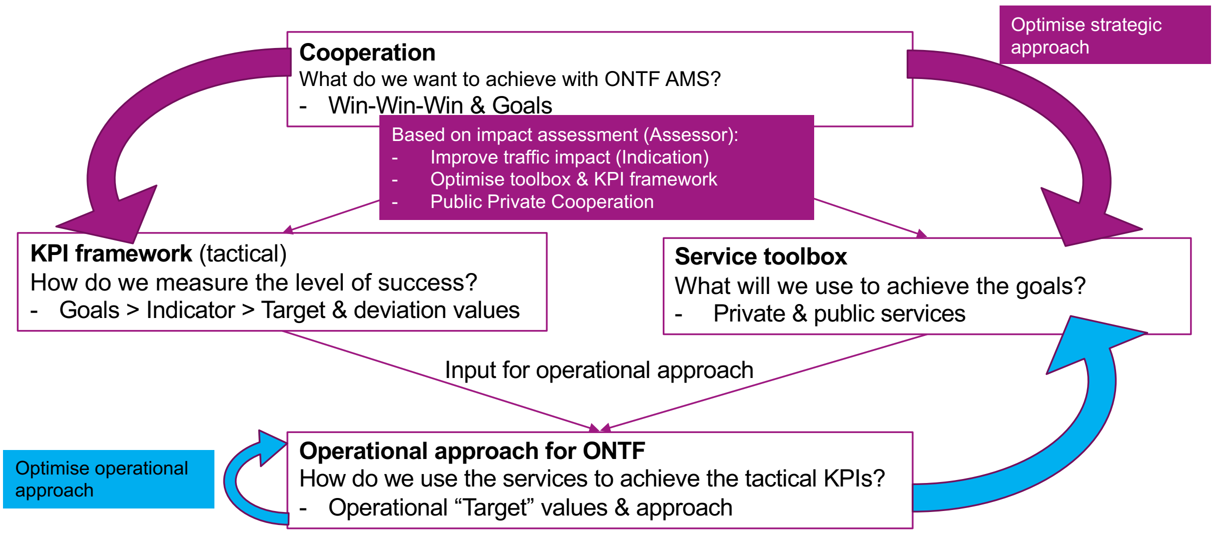


Figure 4: Orchestration of Cooperation through the Strategy Table

Pilot ONTF Amsterdam

In the Optimising Network Traffic Flow (ONTF) Use Case of Amsterdam uses the network of the Amsterdam Metropolitan Region. It consists of the main 118 network links, as displayed in figure 5.

Figure 5: The SOCRATES$^{2.0}$ network links of the ONTF use case Amsterdam

In the Amsterdam region and as part of this ONTF use case, there are three TMC's in operation (Rijkswaterstaat – RWS, Province of North-Holland PNH, Municipality of Amsterdam – A'dam), four Service Providers active (Be-Mobile, BrandMKRS, BMW, TomTom) and all four Intermediary roles implemented (Strategy Table coordinated by MAPtm and NDW, NDW acts as Network Monitor, Rijkswaterstaat and Technolution together act as Network Manager and MAPtm acts as Assessor). During the preparation phases, all systems were (re)designed, build/adjusted, reconfigured, connected and implemented at operational level in order to construct one integrated ecosystem. Figure 6 displays the high-level information architecture of the ecosystem.

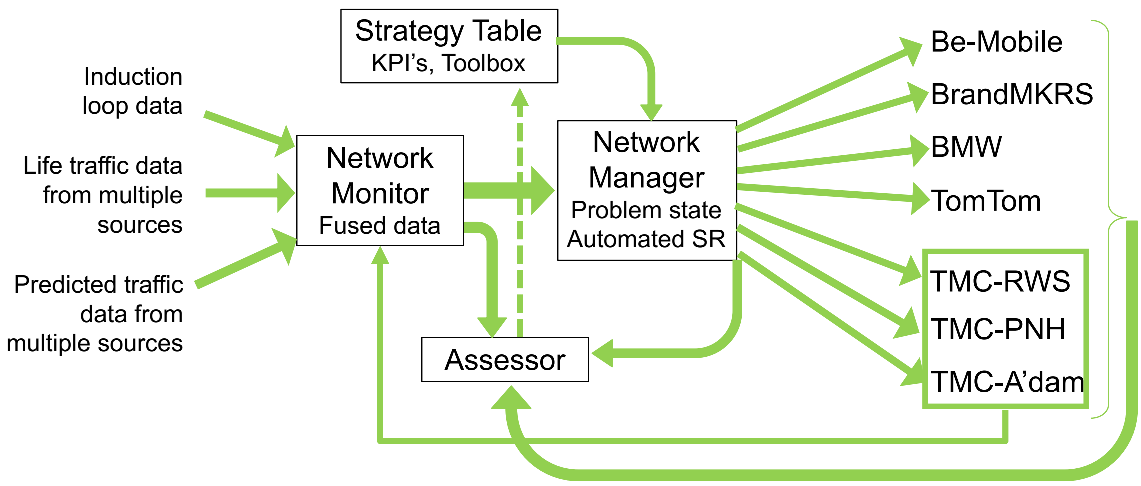
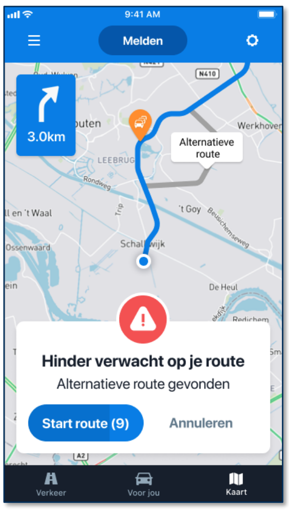


Figure 6: High-level information architecture ONTF Use Case Amsterdam

Starting at the left side of figure 6, several input sources are used. Sources consist of ‘regular’ induction loop data (volume, speed), FCD (Floating Car Data) based traffic information (travel times, speed, volume, delays), and multiple prediction sources (15-minutes look-ahead predictions of volume, speed). Additionally, activated traffic management measures by the TMC’s are used as input data. The input sources are fused and completed within the Network Monitor, providing the current and predicted network traffic state of the Amsterdam Region network. This is forwarded to the Network Manager and the Assessor.

The Network Manager uses the activated traffic management measures, and the current and predicted network traffic state to calculate the Problem state, based on the Level of Service of each network segment. The Problem state is generated within the boundary conditions coming from the Strategy Table (KPI’s and the Toolbox). Once the Problem state is known, the Network Manager automatically generates Service Requests. Service Requests are available in two types, either an ‘avoid’-SR or ‘reroute’-SR type. An ‘avoid’-SR means that services should be activated to avoid a specific network link, while ‘reroute’-SR means that services should be activated to rerouted traffic following a specific route (made up of several network links). The Service Requests are forwarded to the (private) Service Providers, the (public) TMC’s and the Assessor.

The Service Providers receive the SR’s in their backend systems and digest, filter and map them to establish which individual end users are eligible to receive a specific service. The service is then sent out to the end-user’s device and displayed as an advice or recommendation. The end-user then decides to either follow the advice or ignore it (for examples see figures 7a and 7b). Service providers can stimulate travellers to follow their advice by providing incentives. For each service request, follow up behaviour is monitored and forwarded to the Assessor.



PROCEDURE

1	NMa: “**AVOID** Link X”
2	FM: Identify all ongoing **trips A that will pass** Link X
3	For those trips: Calculate **fastest alternative route B**
4	If travel time B – travel time A < +15 minutes: **Offer to re-route** via B (**showing different messages depending on cause**)
5	User **accepts** offer: **New route B** which avoids Link X
6	User **rejects** offer / does nothing: **Route A** via Link X is kept

Figure 7a: HMI-screenshot and Procedure of Be-Mobile / Flitsmeister

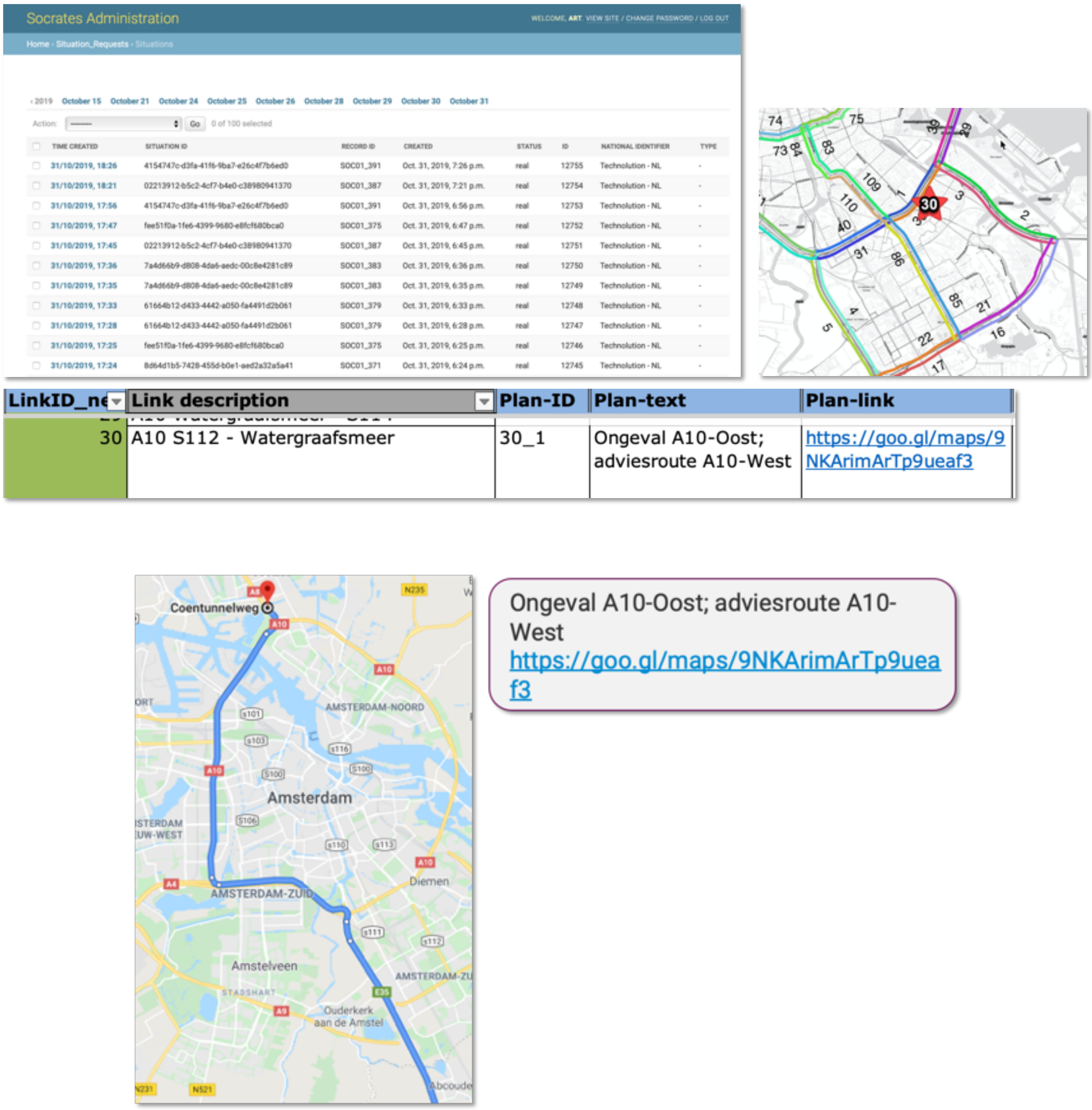


Figure 7b: Back-end systems (top) and HMI screenshots (bottom) of BrandMKRS / Livecrowd

The TMC's also receive SR's in their Traffic Management System. The operator can either acknowledge a SR or discard it. When acknowledged, accompanying services (a selection of one or more traffic management measures) are activated, e.g. the display of a message on a Dynamic Panel, adjustment of green times of traffic lights, the activation of ramp metering, etc. This information is then forwarded to the Network Monitor and the Assessor.

The Assessor collects a vast amount of data; information on the current and predicted state, activated measures, sent out Service Requests, reached and impacted fleet vehicles and also KPI's and toolbox information. This information is used to establish – on regular intervals – the impact of each partner in the total ecosystem. The results will be used to assess if adjustments of the KPI's and / or Toolbox are necessary and in how far the cooperation of the participating partners is successful.

Conclusions

Shortly after submission of the abstract, traffic flow patterns in the Amsterdam region dramatically changed due to the COVID-19 pandemic. Since the organisation was in place, technical chains were up and ready and all systems set to receive evaluation data and the first batch of end users were recruited, we were at that moment gathering the first result data. However, data gathered was insufficient to draw (first) conclusions on a functional level. This is, at the moment of writing the final version, still the case – data acquisition has been postponed, although traffic conditions are more or less recuperating. So, this month new end user recruitment and data acquisition will commence again.

On the organisational level, the first conclusions are that the use of intermediary functions are essential in the complex set up with several road authorities, data providers and service providers. This results in far less agreements than would have been the case if every road authority would have to come to agreement with every data provider and every service provider. The use of the Strategy Table, the Network Monitor, Network Manager and (independent) Assessor are essential in this many-actor context.

On the technical level, the first conclusions are that the use case design did undergo some changes during the implementation due to new insights. Agreement on and interpretation of interfaces costs more time than anticipated, especially the interpretation of it by all parties involved. Additionally, the development and implementation of a new central (traffic management) system should, if possible, be avoided during the execution of such a project. Furthermore, the use of prediction is heavily depending on more or less normal traffic circumstances; prediction algorithms have been calibrated / trained on these normal conditions, so if these conditions do not longer hold, the quality will be affected.

On the functional level, we have to acquire additional data during the remainder of this year before any conclusions can be drawn. Hopefully (and probably), during the next ITS congress we can provide additional conclusions.

Acknowledgements

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