BMW'S END USER SERVICES IN THE SOCRATES 2.0 PROJECT

SOCRATES 2.0
FAST SAFE GREEN

BMW GROUP

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The approach taken to realize the Socrates2.0 vehicle prototype is an “Offboard-Routing”, meaning the route for the vehicle is no longer calculated by the internal navigation system of the vehicle, but by an external server. The communication is done via a built-in mobile phone connection. This approach is a common realization which is also already in use in series production vehicles. This is an essential fact, as the prototype was used by normal series production vehicles of customers.

The normal setup was extended by a so called “vehicle app”, which is essentially only an application running on the vehicle’s onboard unit. Those vehicle apps can be pushed to defined vehicles via over-the-air updates and only need to be downloaded by the vehicle to get the prototype ready.

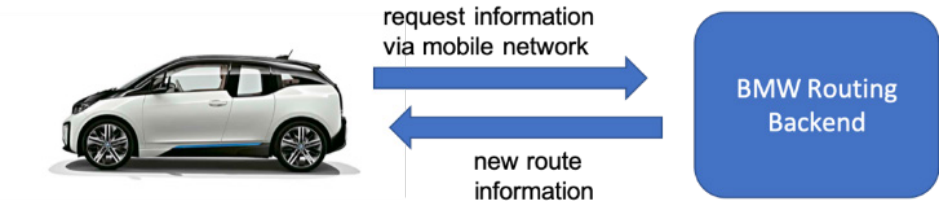


FIGURE 1. BMW VEHICLE – BACKEND INFORMATION EXCHANGE

This described vehicle application is used to send detailed and personized information to a vehicle and display it instantly in the car. The implementation is realized via a pull mechanism, where all information is kept in the backend and vehicles make requests for new information to be displayed. The backend decides conditionally when to release new information. When asking for new information the vehicle transmits its current position, enabling the backend to decide geographically when to send new information.

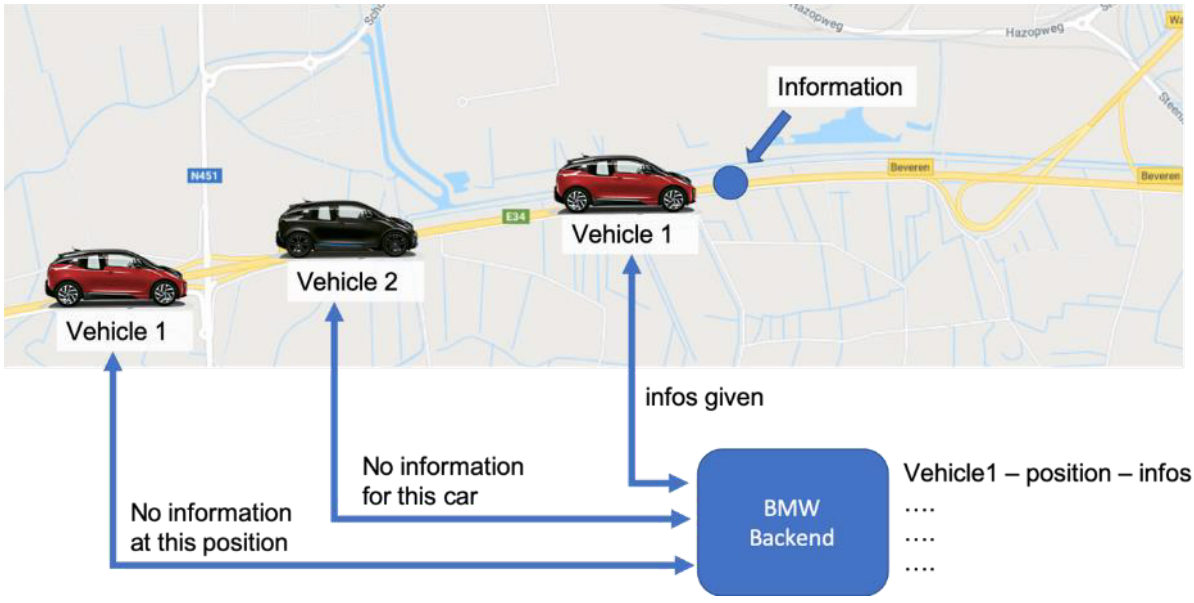


FIGURE 2. VEHICLE APP AND BMW BACKEND COMMUNICATION TRIGGERED BY GEO LOCATION

+This picture above shows how the developed vehicle app and the backend work together. The backend service only gives information to specific vehicles and only if they are near a specific location. Information can also be broadcasted to all vehicles, or can be send to a specific vehicle independent from its position.

The combination of these two services – the router running on backend servers and the vehicle app to display additional information in the car are the two core components used to realize all prototypes and demonstrators in all Socrates2.0 pilot cities.

BMW Backend

The BMW backend itself can be structured into several subcomponents again. The picture below shows those different components.

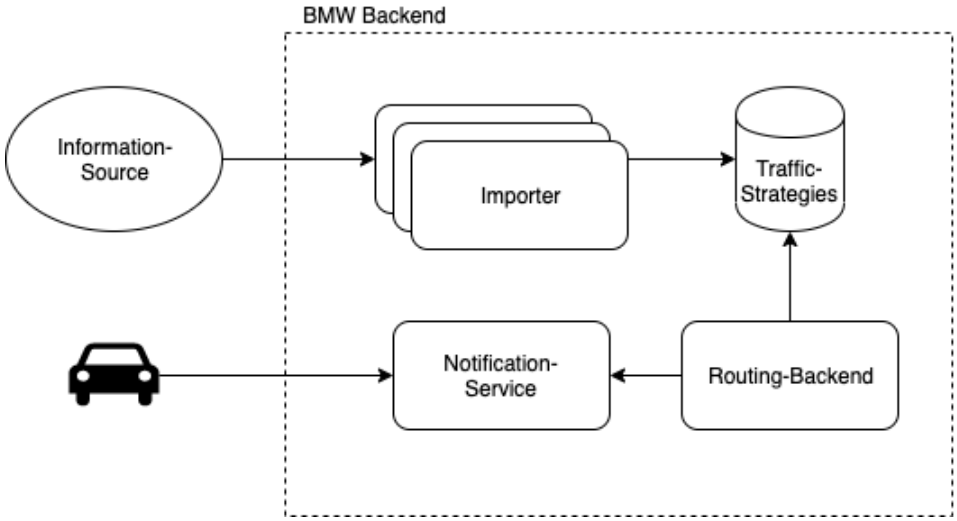


FIGURE 3. COMPONENTS OF THE BMW BACKEND

The importer is responsible for fetching or receiving information from 3rd party information sources, such as intermediaries or authorities. As shown in the picture above there are several importers, as different protocols or publishing strategies are being used. To have a clean and maintainable infrastructure, separate importers have been created for different protocols.

After receiving the information, the importer passes it on to the strategy store. This store holds all currently active strategies, from all different sources in a unified format. The importer can also update or invalidate strategies if this is applicable.

The BMW routing backend checks the strategy store for active strategies. Based on this information it calculates alternative routes and gives information about the intended behaviour for the fleet to the notification service. Whenever there is an active strategy, the routing backend produces a so called “trigger-screen”. The trigger-screen is a message which is sent to the car, via the notification service, to ask the driver, if he wants to take an alternative route. The appearance and content of this trigger-screen is dependent on the strategy.

The notification service is responsible for the communication with the vehicles as they constantly ask if there is any information that should be displayed to the driver. The notification service also receives the answers from the drivers, e. g. when they were asked if they would like to take a strategic alternative route. If they acknowledge, this information is passed on to the routing backend. The routing backend then calculates an alternative route based on the currently active strategies. The details of this route, including information that needs to display to the vehicle are passed back to the notification services. The notification service now creates vehicle specific information screens which are provided along the route.

This overarching architecture has been implemented for all of the Socrates2.0 pilot cities. The notification service and the strategy store could be kept generic from the specifics of the pilot sites. The routing backend was fed with some configuration for each pilot site, but its core logic was independent and identically for all pilot sites.

Whilst most of the components could be used without adaptation for all pilot sites, especially the importer had to be tailored to the specific use case. The fact that the information from many different sources could not be collected in the same fashion, it is still an issue and limits scaling and therefore business opportunities. However, during the implementation of the pilot sites, the usage of standardized protocols and national distribution hubs was always favoured, to ensure a scalability from single suppliers to a larger extent.

In the pilot site Munich the existing MDM-DATEX2 protocol was used, and communicated via the MDM (German Mobility Data Marketplace). But within Socrates2.0 the MDM-DATEX2 profile was enriched with the route cause to improve the interpretation of the strategy. Moreover, the detailed parking lot guidance strategies of the Messe München had been incorporated in the strategies of the public road authority and could be communicated as one.

In Antwerp in contrast, a peer to peer exchange with the Flemish traffic management based on Socrates2.0 specific format was used, to activate a service request.

BMW Frontend

If a service request was activated by the public, the BMW's Service provides the information via a vehicle App. The vehicle App triggers relevant users based on their actual position in pre-defined geofences when to change their route and to follow the strategic one to reduce congestion or how to reach the suggested parking place at the event destination.

A pop-up occurs in the main display if the user passes specific geofence areas in the surroundings the problem area or the event location.

Antwerp Case: If the Flemish Road Authority (Vlaamse Overheid) monitors that the traffic needs a redistribution **to balance the traffic flow** in the two tunnels, the BMW Smart Tunnel Drive Service informs as follows:

- If the user drives in the area of the Antwerp ring, a pop-up offers him/her a toll-free drive through the Liefkenshoektunnel.
- He/she may accept or decline the suggested alternative via Liefkenshoektunnel in the Service App.
  - **If he/she accepts,**
    1. He/she receives a QR-Code by email to his/her registered email address and a notification is shown in the main display that the QR code has been sent to the registered email address.
    2. Pop-ups will advise when to change in direction to the Liefkenshoektunnel.
    3. A pop-up will remember to take a “green arrow” toll booth.
    4. After passing the Liefkenshoektunnel we kindly ask the user to vote the BMW Smart Tunnel Drive Service.
  - **If he/she declines,** he/she follows the initial route via the Kennedytunnel
- If the user accepts, he/she get sent a QR-Code by email to his/her registered email address. And a notification is shown in the main display of the car that the QR code has been sent to his/her registered email address.
- After passing the tunnel the user gets an in car pop-up whether he liked the service (yes/no).

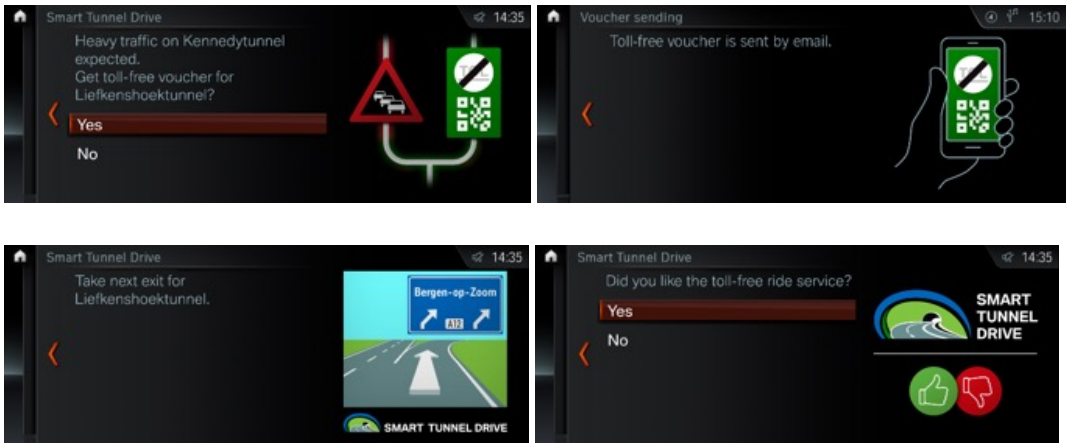


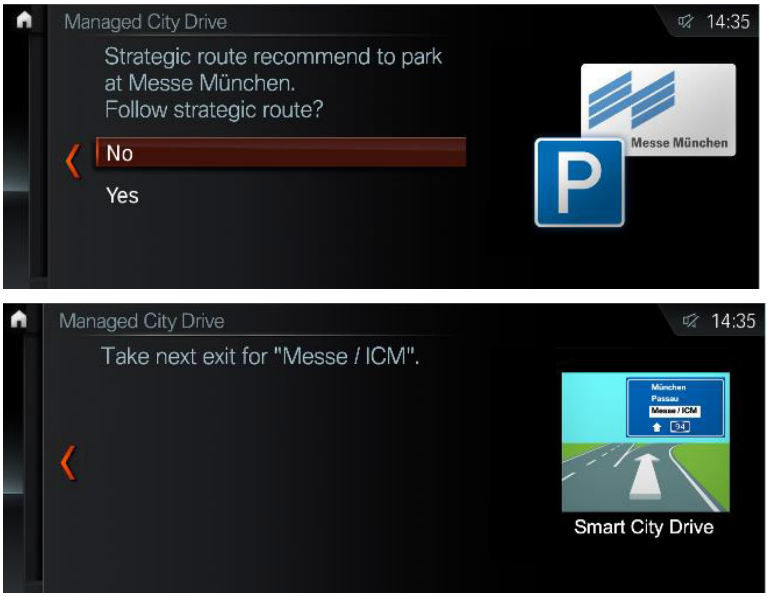
FIGURE 4. CASE B: BMW’S SCREENS SEQUENCE TOWARDS THE LIEFKENSHOEKTUNNEL OF THE IN VEHICLE END USER SERVICE OF THE BMW GROUP

FIGURE 5. EXAMPLE OF THE BMW SERVICE ON THE IN VEHICLE DISPLAY

The in car notification with the QR code included in the pop-up is repeated again when the user is in front of the toll booth. But for scanning the user has to show the QR code on his mobile phone.

FIGURE 6. QR CODE VOUCHER SCANNING AT THE TOLL BOOTH OF THE LIEFKENSHOEKTUNNEL

Munich Case: If there user wants to visit a major event at the Messe München, the BMW' Socrates2.0 Managed City Drive Service checks whether there is a specific strategy active at the MDM. The user is asked whether he/she wants to follow the strategic route advice towards the event area. If he/she accepts, further in car pop-ups occur and guide him/her on the strategic streets towards the preferred parking places as shown in **FIGURE 4**.



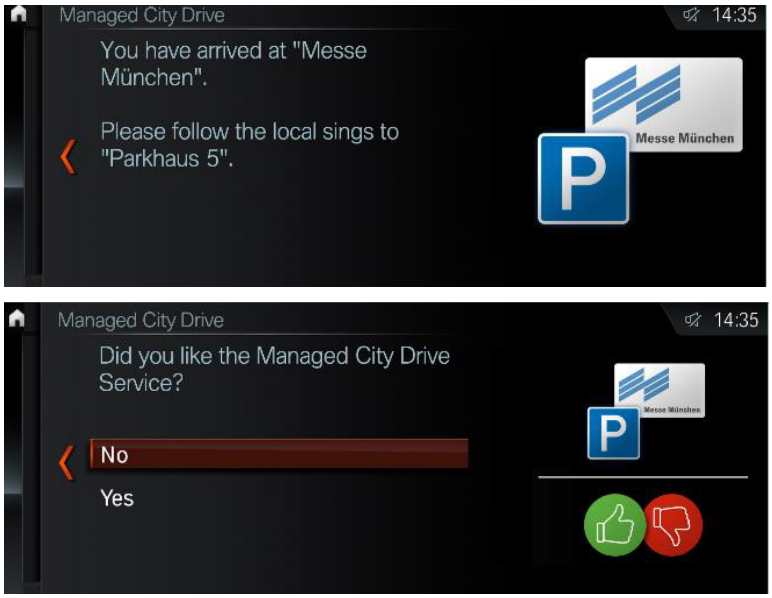


FIGURE 7. SERVICE SCREENS SEQUENCE TOWARDS THE MESSE MÜNCHEN OF THE IN VEHICLE END USER SERVICE OF THE BMW GROUP

FIGURE 8. EXAMPLE OF THE BMW SERVICE ON THE IN VEHICLE DISPLAY

Generating impact and key take aways

Especially the Antwerp Smart Tunnel Drive Service offers a user centric communication channel for traffic management strategies. **The general road authority's information is translated in an individual one, only provided to the user if applicable to him/her.** But also form the individual user's perspective is the service a direct and transparent way to contribute to the road authorities' goal to improve the distribution of traffic over the network.

Compared to traditional solutions, a huge advantage of the developed service is that it allows for the targeting of individual users. BMW as the service provider knows well how and when to address their customers. A service request coming from the public based on their network view should incorporate where, when, and why the traffic has to be spread, maybe enriched by an incentive.

Especially the detailed cause in the road authority's service request is valuable. The more precise the underlying intention is stated the better the service provider know how to process the information in the internal routing system. And it also gives a higher transparency and higher understanding by the user why to follow the advice.

The main task of the service provider is to build out of the service request a high quality service for the users. It is a sophisticated mechanism to decide in each situation again to whom to provide the service. **But this freedom and also responsibility has to remain by the service providers themselves. The road authority's service request for network balancing should focus on the problem state, but not on the routing solution itself.** The routing machine of each service provider works in his specific way. Therefore, it has to be tuned very specifically to the service request and to be aligned with the user interfaces.

The trust in the quality of a route advice by BMW is very high and stated in the pilot questionnaires as main reason to follow the alternative. Dominating aspects to choose the suggested alternative are congestion avoidance and travel time savings. On a distinct lower level but equally stated, the toll-voucher as well as the traffic balancing aspect had been answered by the users. This shows that the users are also willing to contribute to cities' goals even when to accept a detour. The Antwerp Smart Tunnel Drive shows that it is possible to combine and can be stimulated by an incentive. And the feedback of the service providers back to the assessor/ road authority on the amount of targeted users gives control for the public that their key goals are met.

Moreover, detailed arrival and parking strategies by major event organizers are valuable when directly incorporated in the strategies of the public road authority and therefore communicated as one, as done in the Munich pilot. Standardised data exchange is a precondition for upscaling interactive traffic management. But there is currently no generic solution for the exchange protocol for traffic management related information between public traffic management centres and private back offices. Even though **DATEX II is a Europeanwide standard, the regional different ways of filling and using the protocol raise implementation effort and impede faster large scaling.** This also includes improving (the integration of) different forms of georeferencing.