THE SOCRATES$^{2.0}$ PILOT IN CITY OF MUNICH

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1. PREFACE – RELATED REPORTS

This report provides an overview of the Socrates$^{2.0}$ Munich pilot. The focus lies on the description of the use cases, the technical and functional design, as well on the operational period and the analysis of the pilot data.

The evaluation of the Munich pilot and the drawn conclusions based on the analysis is not part of this report, but can be found in the evaluation report of Activity 8.

2. ORGANISATIONAL SET-UP

Based on the use cases and their functional designs defined in Activity 3, two working groups had been set up to elaborate the Munich pilot.

- Smart Destination:
  - Involved partners: BrandMKRS, Be-Mobile BMW, and the Bavarian Road Authority as associated partner
- Road Works
  - Involved partners: Be-Mobile, MAPtm, TomTom and the Bavarian Road Authority as associated partner

In the following chapters a detailed description for each of the two uses cases is given.

3. INTRODUCTION – SMART DESTINATION

In Activity 3 the functional design of the use case Smart Destination has been described and approved by the Socrates$^{2.0}$ steering group in October 2018. In Activity 6 this functional design is elaborated in more detailed. Based on this latter design the pilot was developed.

This document presents the functional and technical designs of the Socrates$^{2.0}$ use case 'Smart Destination' and 'Road Works' in the pilot site Munich. It is a report on the technical design and the changes made on the traffic centre (6.1), the realization of intermediaries (6.2), the changes on back offices (6.3) and end-user applications (6.4) and the system integrations tests (6.5).

The technical architecture of these Use Cases includes sequence diagrams, user stories and interface descriptions. These are elaborated for each cooperation model, based on the functional design as described in Activity 3.

3.1 Use case description – Smart Destination

The Socrates$^{2.0}$ Use Cases Smart Destination deployed in the Munich region are related to two different event locations:

- Allianz Arena
- Messe München

Main problem

The main problem at events at the Allianz Arena and the Messe München is the sub-optimal traffic inflow before and during an event and the sub-optimal parking choice distribution in the area.

- Many road users don't know exactly which exit to take to reach the event area nor where to park best.
- Non-event visitors who drive in the area of the event often do not know that an event takes place and are stressed by the heavy traffic that is generated by the event.

The problems are caused by:

- Visitors have little knowledge about parking location & occupancy
- Routing services do not generally consider parking guidance & occupancy
- Routing services do not generally consider recommendations of road authorities to optimize the inflow

Mission

The mission of the use case is to provide better information for:

- Event visitors with detailed information which route to take and where to park best.
- Non-event visitors, that drive in the area of the event, to inform them on the event related traffic conditions and recommend them to avoid the area.

By means of execution and validation of this use case, it contributes to the overall goals of Socrates$^{2.0}$:

- Testing of public private cooperation and new business models;
- Testing the effectiveness of Traffic Management 2.0 by communicating directly with the end user.

Allianz Arena – local context

Rough sketch of the arrival options from the north:

- A9 (blue)
- A92 (yellow)
- B13 (purple)

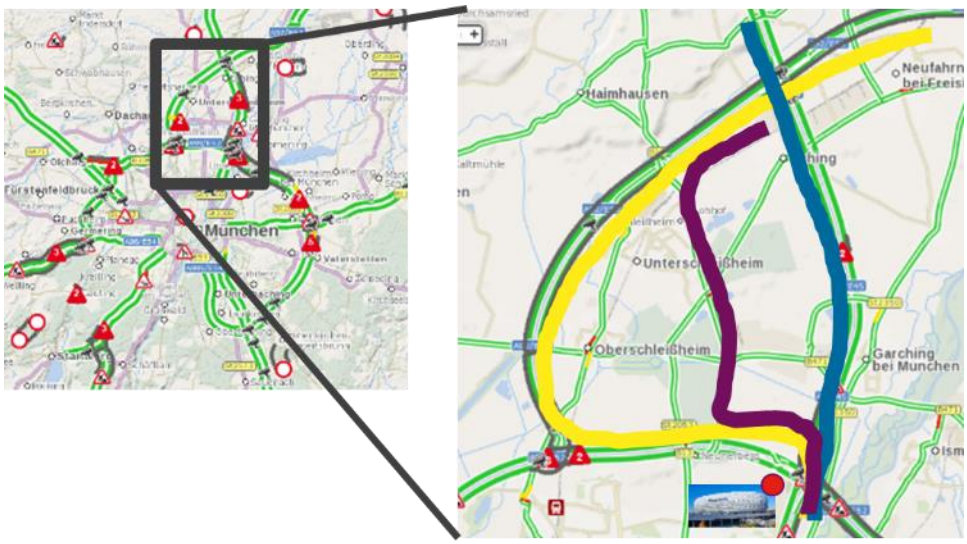

FIGURE 1. ARRIVAL OPTIONS TOWARDS THE ALLIANZ ARENA FROM THE NORTH

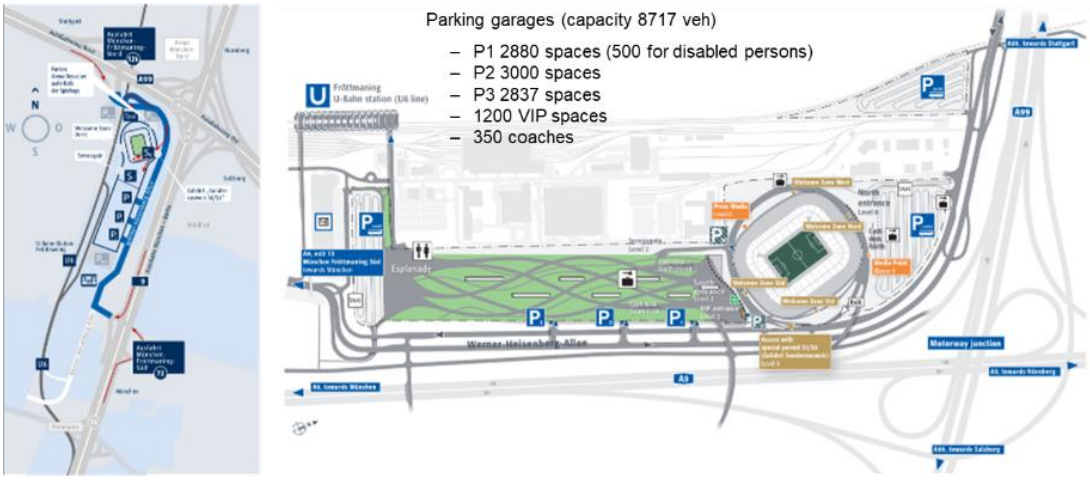

FIGURE 2. OVERVIEW OF THE DIFFERENT PARKING SPACES AT THE ALLIANZ ARENA (SOURCE HTTPS://ALLIANZ-ARENA.COM/EN/MATCHDAY/HOW-TO-REACH-US-AND-PARKING, 12.10.2020)

Messe München / Munich Trade Fair– local context

The Messe München, with roughly 40 fairs focusing on new technologies, consumer and investment goods, belongs to the globally leading fair associations. In addition, there are 14 international leading fairs taking place in Munich.

The fair location Munich has 16 halls with an exhibition area of 80,000 m² before 2018, 2 halls will provide an additional 120,000 m². Moreover, the fair already has Germany's fair locations' biggest outdoor area with 425,000 m².

The Messe München has enough parking spots for cars and busses. At specific events, a guide system lead to them. The visitor is allowed to start parking two hours before and must have left the parking space two hours after the event.

Parking structure 'West': In the parking structure there are 14,000 parking spots. From there, the ICM and the fair building can be directly accessed. The parking structure is only open during the events. Daily fee of 10 €.

Parking structure park & ride 'Messestadt Ost': The parking structure does not belong to the fair site, yet it can be used by visitors. On 1050 spots, one can park for 10 € a day.

Parking spots at North entrance: For 8 €/day, one can park outside.

(source: https://en.instaff.jobs/exhibitions/locations/trade-fair-m%C3%BCnchen, 12.12.2019)

Rough arrival options from the north:

- A99 + A94 (purple)
- A9 + B2R (blue)
- A99 + St2082 (yellow)

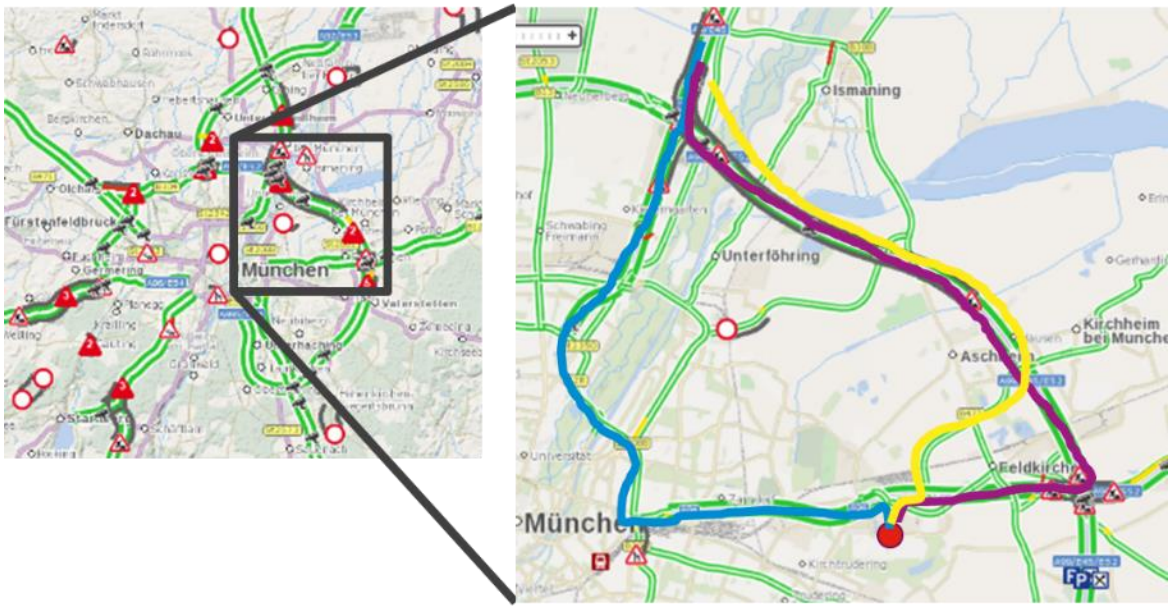

FIGURE 3. ARRIVAL OPTIONS TOWARDS THE MESSE MÜNCHEN FROM THE NORTH

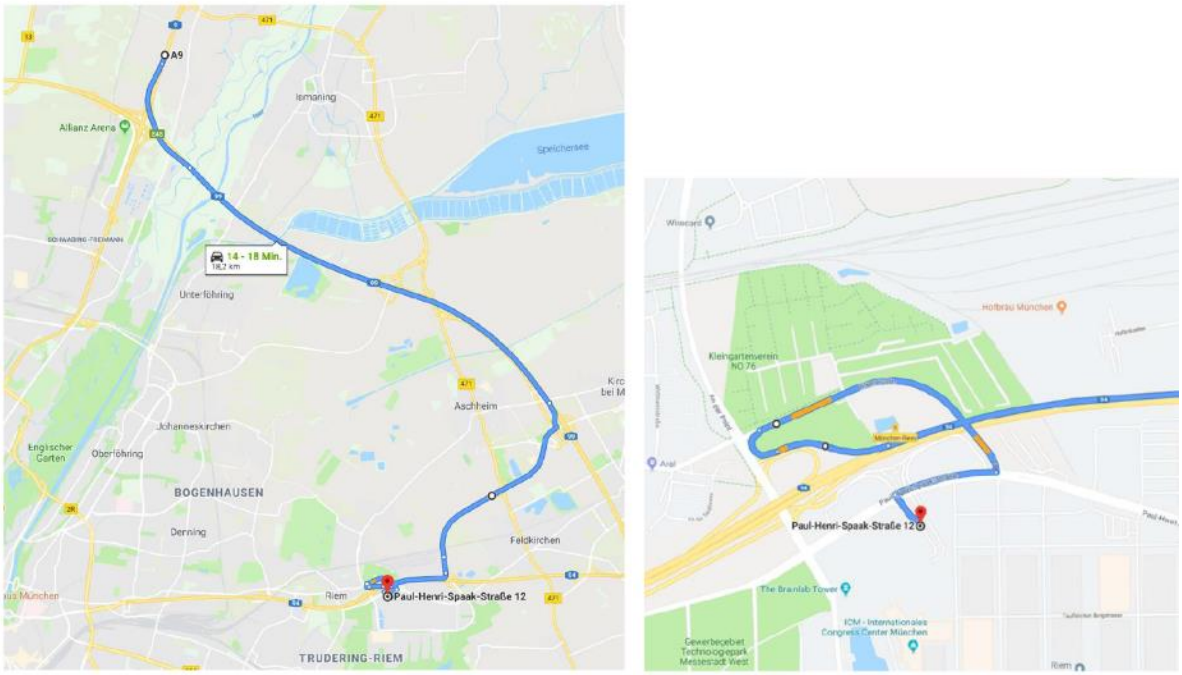

FIGURE 4. EXAMPLE OF A STRATEGY TOWARDS THE MESSE MÜNCHEN FROM THE NORTH

FIGURE 5. OVERVIEW OF THE DIFFERENT PARKING LOTS AT THE MESSE MÜNCHEN (SOURCE HTTPS://WWW.INSTAFF.JOBS/MESSEN/STANDORTE/MESSE-M%C3%BCNCHEN#ANFAHRT, 12.10.2020)

3.2 Functional overview

Changes in relation to Activity 3 – functional design

The table below contains an overview of the changes made during the further development of the Use Case in Activity 6, in relation to the Activity 3 functional design.

FIGURE 6. ACTIVITY 3: PART 3: SOCRATES$^{2.0}$ SERVICES FOR SMART DESTINATION UC

	Activity 3	Activity 6
3.1 System overview		No changes
3.2 Cooperation Model	Cooperation Model 2	No changes
3.3 Roles		No changes
3.4 Intermediary		No changes
3.5 Actors		BrandMkrs, Be-Mobile, BMW
3.6 Pre/post-conditions		Due to the Corona crisis no events with a larger group of visitors/ greater audience take place since 03/2020 till end of 2020. Thus, targeting/ recruiting/ interviewing of real end users was not feasible. A real piloting could not be executed. Compensation via friendly user tests.
3.7 Sequence diagram		No Changes

Staged deployment of functionalities

The operational stage was planned from January 2020 to June 2020. The operational period was extended to end of 2020 due to the Corona crisis and the lack of big events. A detailed description of the deployment and recruitment adaptions is described subsequent.

Allianz Arena

FIGURE 7. DEPLOYMENT AND FUNCTIONALITIES ALLIANZ ARENA

Events	Initially: • Every two weeks at soccer games in the during the soccer league • EURO2020: 16/21/ 26 June + 03 July 2020 ➔ All events are skipped or without an audience due to the Corona Crisis

Below an overview of scheduled soccer games in the Allianz Arena during the pilot phase is shown.

BUNDESLIGA | 9. SPIELTAG SA | 26.10.2019 | 15:30 Uhr	FC Bayern München	15:30	1. FC Union Berlin
CHAMPIONS LEAGUE | 4. SPIELTAG MI | 06.11.2019 | 18:55 Uhr	FC Bayern München	18:55	Olympiakos Piräus
BUNDESLIGA | 11. SPIELTAG SA | 09.11.2019 | 18:30 Uhr	FC Bayern München	18:30	Borussia Dortmund
BUNDESLIGA | 13. SPIELTAG SA | 30.11.2019 | 18:30 Uhr	FC Bayern München	18:30	Bayer 04 Leverkusen
CHAMPIONS LEAGUE | 6. SPIELTAG MI | 11.12.2019 | 21:00 Uhr	FC Bayern München	21:00	Tottenham Hotspur
BUNDESLIGA | 15. SPIELTAG 13.12 - 15.12.2019	FC Bayern München	--:--	SV Werder Bremen
BUNDESLIGA | 17. SPIELTAG 20.12 - 22.12.2019	FC Bayern München	--:--	VfL Wolfsburg
BUNDESLIGA | 19. SPIELTAG 24.01 - 27.01.2020	FC Bayern München	--:--	FC Schalke 04
BUNDESLIGA | 21. SPIELTAG 07.02 - 10.02.2020	FC Bayern München	--:--	RB Leipzig
BUNDESLIGA | 23. SPIELTAG 21.02 - 24.02.2020	FC Bayern München	--:--	SC Paderborn 07
BUNDESLIGA | 25. SPIELTAG 06.03 - 09.03.2020	FC Bayern München	--:--	FC Augsburg
BUNDESLIGA | 27. SPIELTAG 20.03 - 22.03.2020	FC Bayern München	--:--	Eintracht Frankfurt
BUNDESLIGA | 29. SPIELTAG 11.04 - 13.04.2020	FC Bayern München	--:--	Fortuna Düsseldorf
BUNDESLIGA | 31. SPIELTAG 24.04 - 27.04.2020	FC Bayern München	--:--	Borussia Mönchengladbach
BUNDESLIGA | 33. SPIELTAG SA | 09.05.2020 | 15:30 Uhr	FC Bayern München	15:30	Sport-Club Freiburg

FIGURE 8. SOCCER GAMES AT ALLIANZ ARENA (STATUS OCT 2019)

Some important events in the Allianz Arena would have been the soccer matches for EURO2020 planned for the16th / 21st / 26th of June and 3rd of July 2020. Initially it was planned that the Socrates$^{2.0}$ services will also be deployed during these events. But due to the Corona crisis the EURO2020 was shifted to 2021 and therefore no event took place during the pilot phase.

Overall, due to the Corona crisis no events with a larger group of visitors/ greater audience took place from 03/2020 till end of 2020 in the Allianz Arena. Thus, targeting/ recruiting/ interviewing of real end users was not feasible. A real piloting could not be executed. A compensation was made via friendly user tests.

Messe München

FIGURE 9. DEPLOYMENT AND FUNCTIONALITIES MESSE MÜNCHEN

Events	➔ See list below of scheduled trade fairs ➔ Due to the Corona crisis trade fairs are cancelled or without a greater amount of visitors.

Here is shown an overview of major trade fairs at Messe München in 2020 including the number of expected visitors (status Jan 2020): Initially it was planned to provide the Socrates$^{2.0}$ service to users of at least two of these major trade fairs. But due to the Corona crisis all of these events had been skip or limited to a small non-public visitor group.

FIGURE 10. SCHEDULED MAJOR TRADE FAIRS AT MESSE MÜNCHEN IN 2020 (STATUS JAN 2020)

Name	Topic	Start	End	Visitors
Opti	Optics	Fr, 10. Jan 09:00	So, 12. Jan 18:00	28.000
ISPO	Sports	So, 26. Jan 09:00	Mi, 29. Jan 18:00	85.000
Inhorgenta	Jewelery	Fr, 14. Feb 09:00	Mo, 17. Feb 18:00	27.000
Free	Travel	Mi, 19. Feb 09:00	So, 23. Feb 18:00	150.000
Internet World Expo	E-commerce	Di, 10. Mrz 09:00	Mi, 11. Mrz 18:00	20.000
Garten München	Gardening	Mi, 11. Mrz 09:00	So, 15. Mrz 18:00	110.000
Internationale Handwerksmesse	Construction, Crafts	Mi, 11. Mrz 09:00	So, 15. Mrz 18:00	110.000
Analytica	Bio technology	Di, 31. Mrz 09:00	Fr, 3. Apr 18:00	36.000
IFAT	environmental technologies	Mo, 4. Mai 09:00	Fr, 8. Mai 18:00	150.000
Automatica	Robotics, automisation	Di, 16. Jun 09:00	Fr, 19. Jun 18:00	45.000
Intersolar	Solar energy	Mi, 17. Jun 09:00	Fr, 19. Jun 18:00	50.000
expopharm	Medicin	Mi, 7. Okt 09:00	Sa, 10. Okt 18:00	25.000
electronica	Comsumer electronics	Di, 10. Nov 09:00	Fr, 13. Nov 18:00	82.000

3.3 Active partners

Four Socrates$^{2.0}$ partners and one associated partner had been active in the Smart Destination use case in Munich.

Bavarian Road Authority – Role Data provider / Road Authority

The Bavarian Road Authority wants to be a good host for inhabitants and visitors alike. As a public data provider and road authority I want to recommend reliable data to road users which route to choose best towards an event and where to park preferable at the event location or even where to avoid heavy jammed areas due to an event. I want to achieve less traffic jams, less parking search traffic and stress reduction to the road users due to the increase of event specific information. Above all, the use case should contribute to improve the overall traffic flow.

MDM – national data access point

As the national data access point in Germany I receive strategic route and parking lot data, in this case from the Bavarian Road Authority about the Alliance Arena in Munich and the Messe München (trade faire). Thereafter I enrich the data flow and make this information public available in standard European formats. I want to improve the availability, quality and accessibility of public data.

End user Service provider

As a Service provider, I want to receive up-to-date and accurate data on strategic routes and recommended parking lots regarding a specific event in standard formats. I want to provide most accurate guidance and parking information on events to my users, so that they experience a satisfying journey towards their event.

3.4 Generic description of end user services

End user service by BrandMKRS

The BrandMKRS Smart Destination service in Munich aims at providing a routing advice to event visitors. First step is to target and approach users on social media, have them 'opt-in' to register, and provide them with relevant information. Then, at the day of the event, provide the user a route with the best access to take.

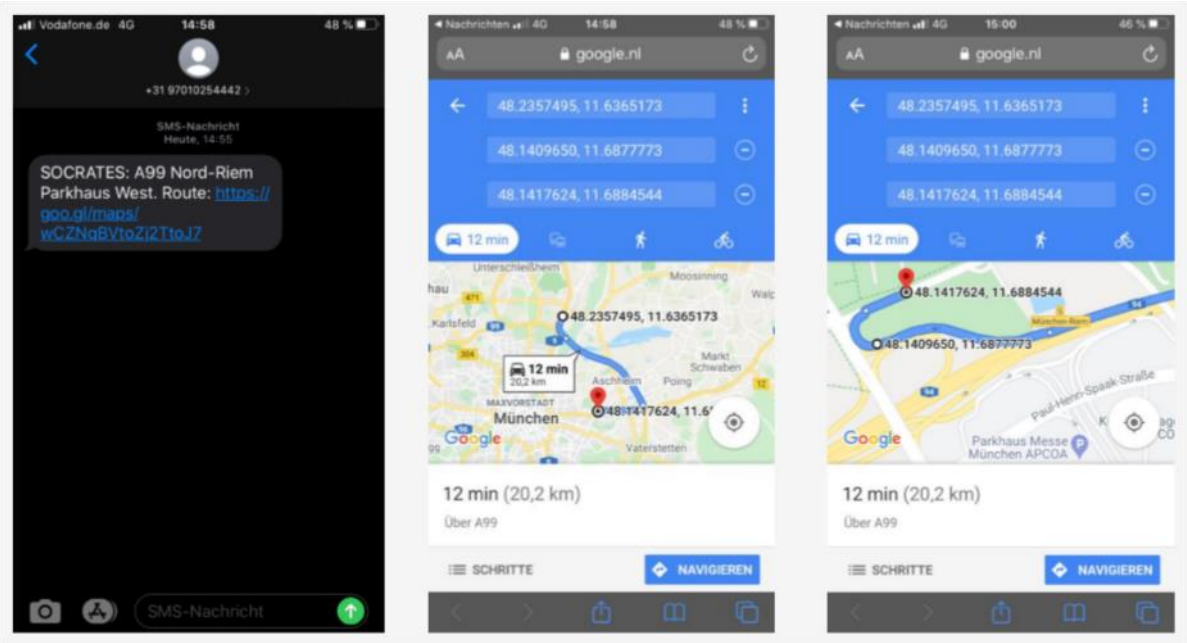

FIGURE 11. SERVICE SCREENS TOWARDS THE MESSE MÜNCHEN OF THE END USER SERVICE OF BRANDMKRS

Service by BMW Group

The approach taken to realize the Socrates$^{2.0}$ 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.

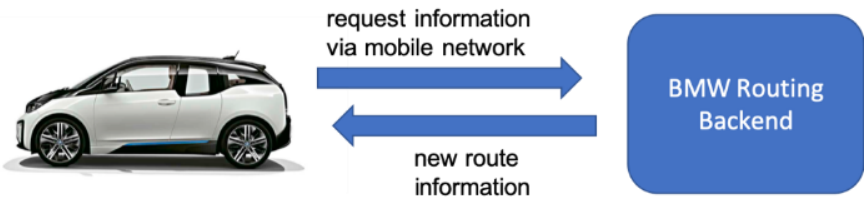

FIGURE 12. BMW VEHICLE – BACKEND INFORMATION EXCHANGE

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.

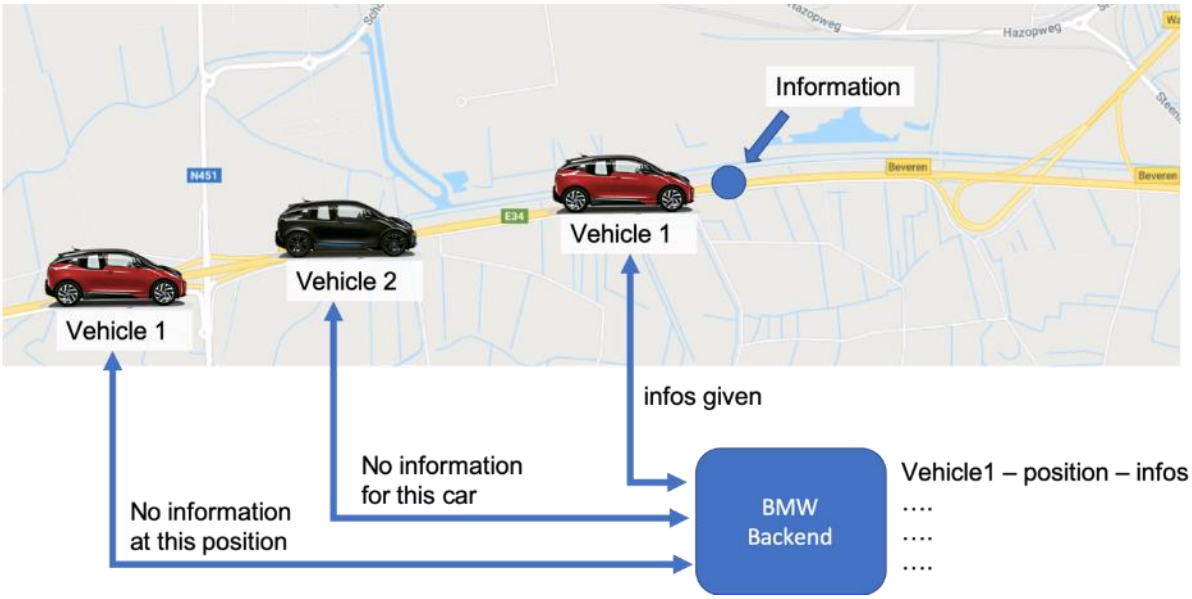

FIGURE 13. VEHICLE APP AND BMW BACKEND COMMUNICATION TRIGGERED BY GEO LOCATION

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 Socrates$^{2.0}$ pilot cities.

BMW Backend

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

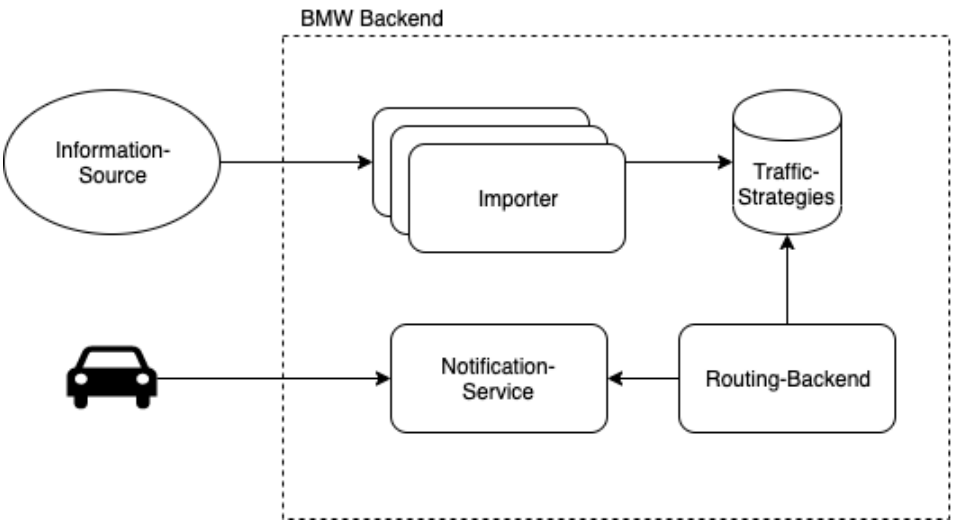

FIGURE 14. COMPONENTS OF THE BMW BACKEND

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 Socrates$^{2.0}$ 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, is not very surprising. 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.

BMW Frontend

The Service of BMW Group provides the information via a vehicle app. A pop-up occurs in the main display if the user passes specific geofence areas in the surroundings of the event and on the strategic route segments towards the event area. This is triggered by the BMW Backend as described before. The user is asked whether he wants to follow the strategic route advice towards the event

area. If he accepts, further in car pop-ups occur and guide him on the strategic streets towards the preferred parking lot as shown in Figure 15.

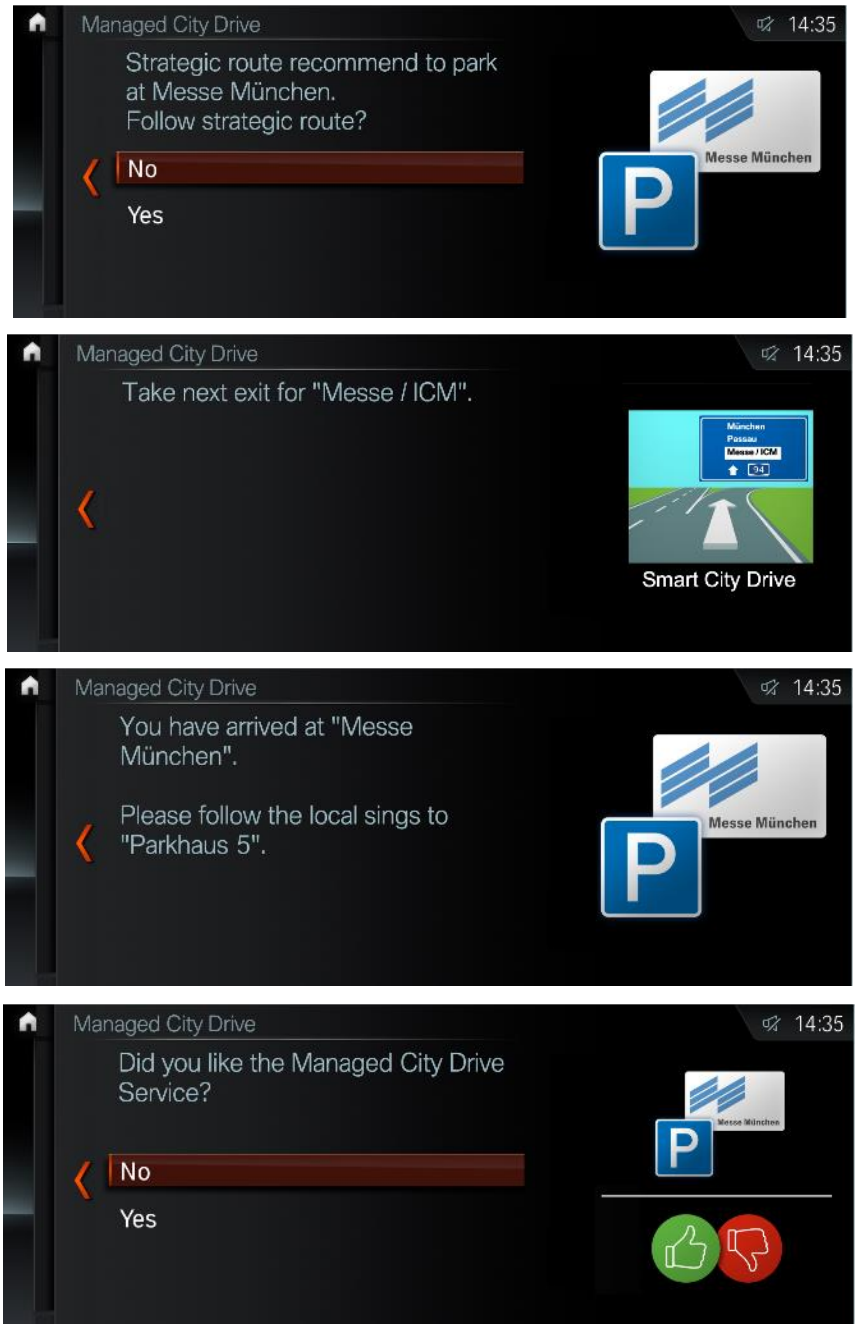

FIGURE 15. SERVICE SCREENS SEQUENCE TOWARDS THE MESSE MÜNCHEN OF THE IN VEHICLE END USER SERVICE OF THE BMW GROUP

FIGURE 16. EXAMPLE OF THE BMW SERVICE ON THE IN VEHICLE DISPLAY

Service by Be-Mobile

The Be-Mobile Smart Destination service for the Messe München aims at providing a routing advice to event visitors via the Flitsmeister navigation driver companion service. The use-case starts for the end-user when she puts in Messe München as destination in the Flitsmeister application.

- The end-user is offered the fastest route to Messe München. In the route choice screen, a pop-up will be shown which asks the end-user whether she would like to have parking guidance.

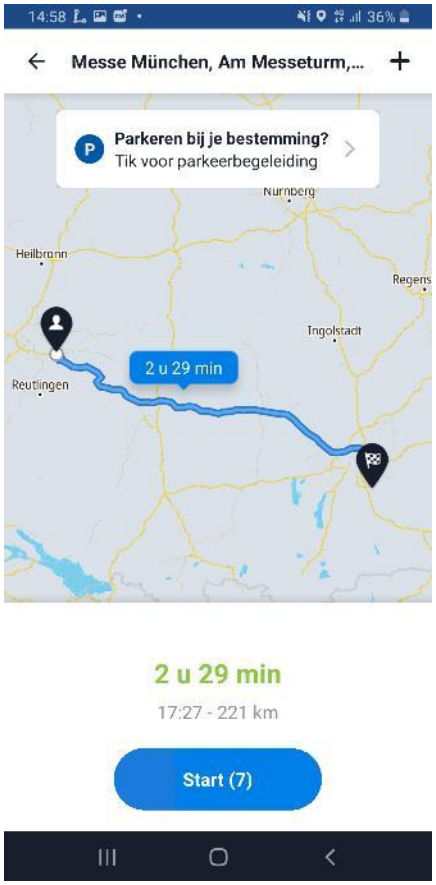

FIGURE 17. EXAMPLE OF THE FLITSMEISTER SERVICE

- If the end-user accepts the parking guidance (by clicking on the pop-up), she will be shown a screen where the parking options will be shown. In the case of an event at the Messe Munchen (i.e. when the SD Munich use-case is active), the presented parking option will be aligned with the parking strategy provided by the MDM.

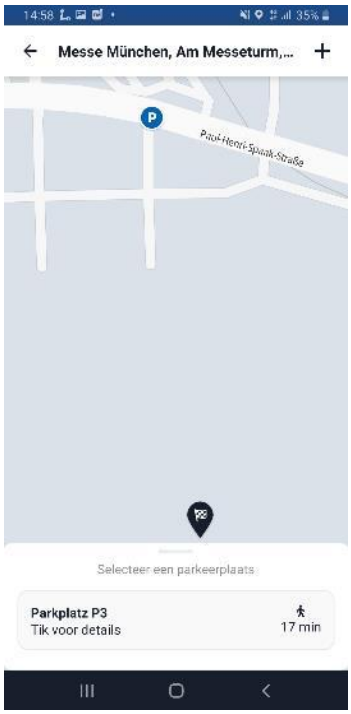

FIGURE 18. EXAMPLE OF THE FLITSMEISTER SERVICE

- If the end-user clicks on the parking, she will be presented with some information (such as travel time from the parking to the Messe Munchen, and parking occupancy). She can then choose to start the route towards that parking.

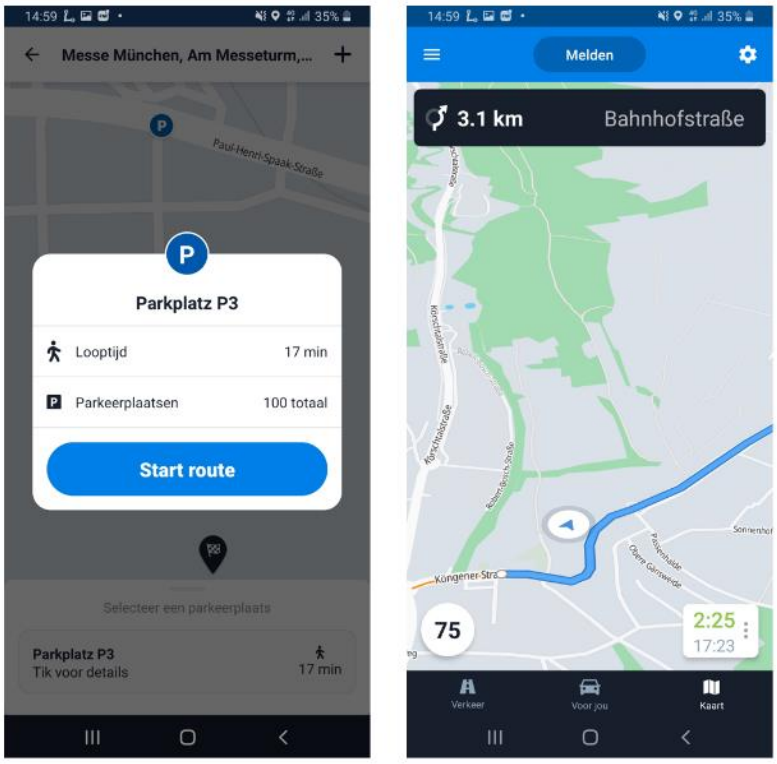

FIGURE 19. EXAMPLE OF THE FLITSMEISTER SERVICE

4. INFORMATION ARCHITECTURE - SD

4.1 Sequence diagram

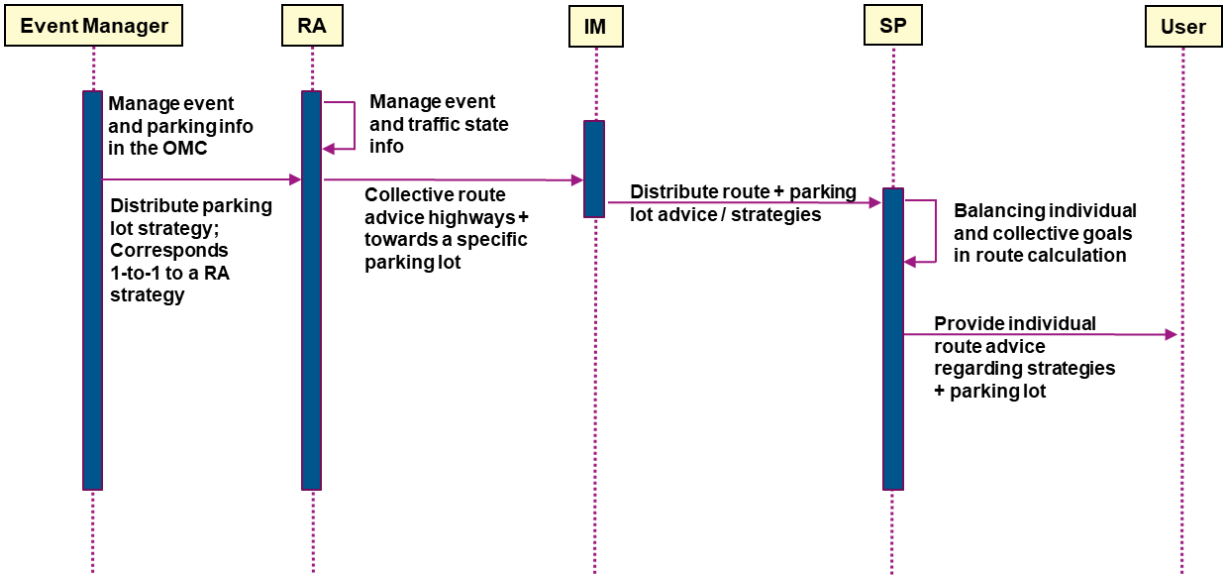

FIGURE 20. SEQUENCE DIAGRAM SMART DESTINATION MUNICH

4.2 Processes and interactions

The information architecture (IA) is an elaboration of the sequence diagram (see 2.1). It describes the processes and interactions between processes. The processes are functional and general conducted by one stakeholder as an internal process. A process receives and collects data, enriches the data and produces information as a product. Information is sent via protocols to other processes in the architecture.

Step 1: Manage Event and Parking Information + distribute strategy

The event manager collects and enriches the parking info and sends it through to the Road Authority. In the Operation Management Center (OMC) a parking operator of the Munich trade fair and an operator of the Bavarian Road Authority is present.

Step 2: Manage Event and Traffic State Info + translate to MDM-DATEX2

The operators in the OMC will have the overview on Traffic State and Parking Info and decide jointly on suitable information and routing strategy. The Bavarian Road Authority executes its traffic measures and translates these to service requests in MDM-DATEX2 format for Service Providers. Within Socrates$^{2.0}$ the Bavarian Road Authority has implemented in the trade fair strategies a one-to-one relation from the main road routes towards the specific parking lot. Thus, in one service request the recommended route and the preferred parking lot is incorporated. Also the cause of the strategy is implemented. No extra connection between the event manager/ OMC parking operator and the intermediary or service provider is needed.

Step 3: Service Request - Distribute road and parking lot advice (via the intermediary MDM)

The Bavarian Road Authority sends out the service request via the German Access Point MDM as an intermediary The MDM-DATEX2 profile used is based on former developments and projects. Exceptions are written in OpenLR.

Step 4: Providing service / type of service (SP)

The Service Providers have a connection to the MDM. If they receive a service request, they adapt it to their service and provide the information to the road users (see chapter 3.4 on end user services).

Step 5: Service activation

Internal process of the service provider: Services providers can accept or decline the service requests. If they accept, the communicated strategy incorporating the preferred parking lot is translated in a recommendation of where to drive for the end user.

5. SYSTEM ARCHITECTURE - SD

5.1 System overview

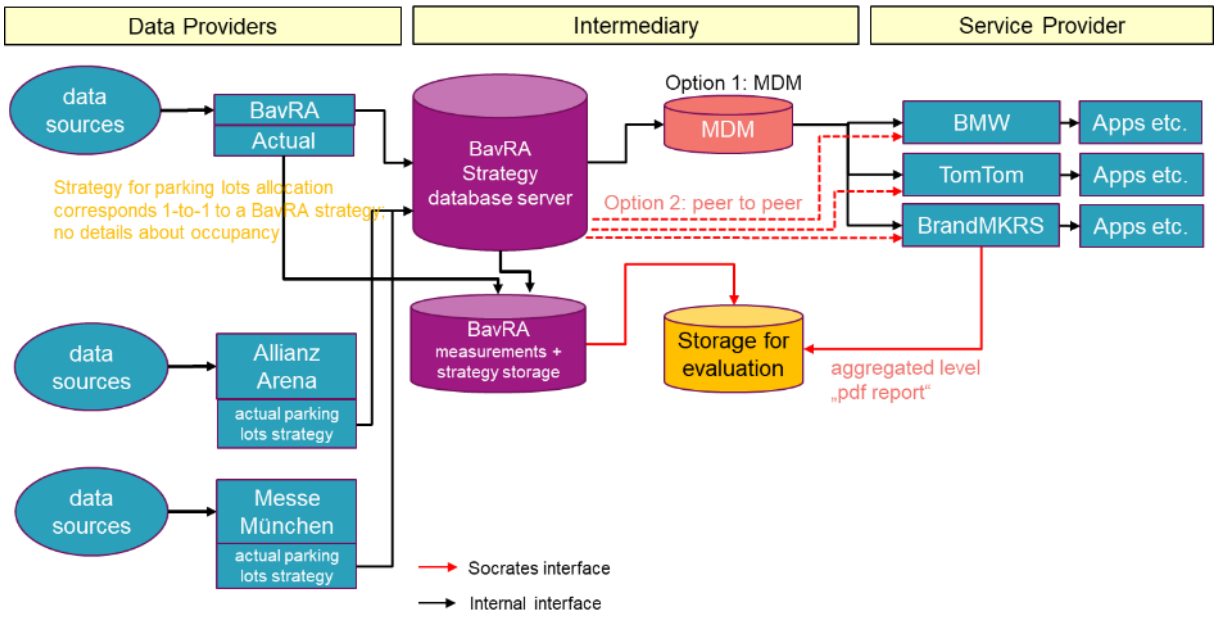

FIGURE 21. SYSTEM OVERVIEW SMART DESTINATION MUNICH

5.2 Interfaces

This section contains detailed information about the interfaces and the information exchanged via these interfaces.

MDM protocol

The existing MDM-DATEX2 protocol is used (MDM: Datenmodell für strategiekonformes Routen Version 01-00-00 – 05|2012) for option 1, the communication via the MDM. A peer to peer exchange (option 2 in Figure 21) was not further elaborated within Socrates$^{2.0}$.

This interface is minimally required to build a functional system. Others can ‘subscribe’ to consume this information as well for own information purposes.

The reason for the measure and related situation is included based on designated fields of MDM-DATEX2.

FIGURE 22. SCREENSHOT OF THE MDM-PORTAL

name	type	definition	comment / example	origin
id	String	An ID	actionPlanIdentifier in MDM	MDM
nameOfRouteManagement	String	A descriptive name		MDM
trigger(s)	OpenLR	Defines geolocations which a route needs to surpass such that a strategy applies to him/her		MDM
route(s)	OpenLR	Original routes. Have several sub-properties such as georeference etc.	Original route where an alternative route has been defined to replace this original route	MDM
alternative route(s)	OpenLR	Alternative routes. Have several sub-properties such as georeference etc.	Alternative route in order to reduce / prevent usage of original route	MDM
additionalManagementTypeEnums	Enum	For each route several reasons can be given	e.g. capacitiesAvailable, extendedGreenPeriod ...	MDM
travelTimeData	Time	Object that describes traveltimes for the routes depending on the vehicle type and possibly including a prediction trend		MDM
weightingAndVehicleClassification	Classification	Describes types of vehicles which are allowed to/should take a specific route		MDM
cause	Enum	Contains the reason	{environmental, manual intervention, traffic conditions, incident, …}	MDM
causeDescription	String	Explanation of the reason towards end users	"Prevent usage of inner-city roads and use the ring road"	MDM
operatorActionStatus	Enum	Status of the operator's action if applicable	{beingImplemented, implemented, beingTerminated}	MDM

complianceOption Enum	Enum	Additional information about the TMP	{advisory, mandatory}	MDM
indicatedEndPoint	*OpenLR*	Gives the end point of the route	E.g. the parking location	*new*
preferredNetworkToBeUsedInOrderToPreventDriversSomewhereElse	*OpenLR*	Needs attention in order to prevent people of driving into the area while the ring road should be used		*new*

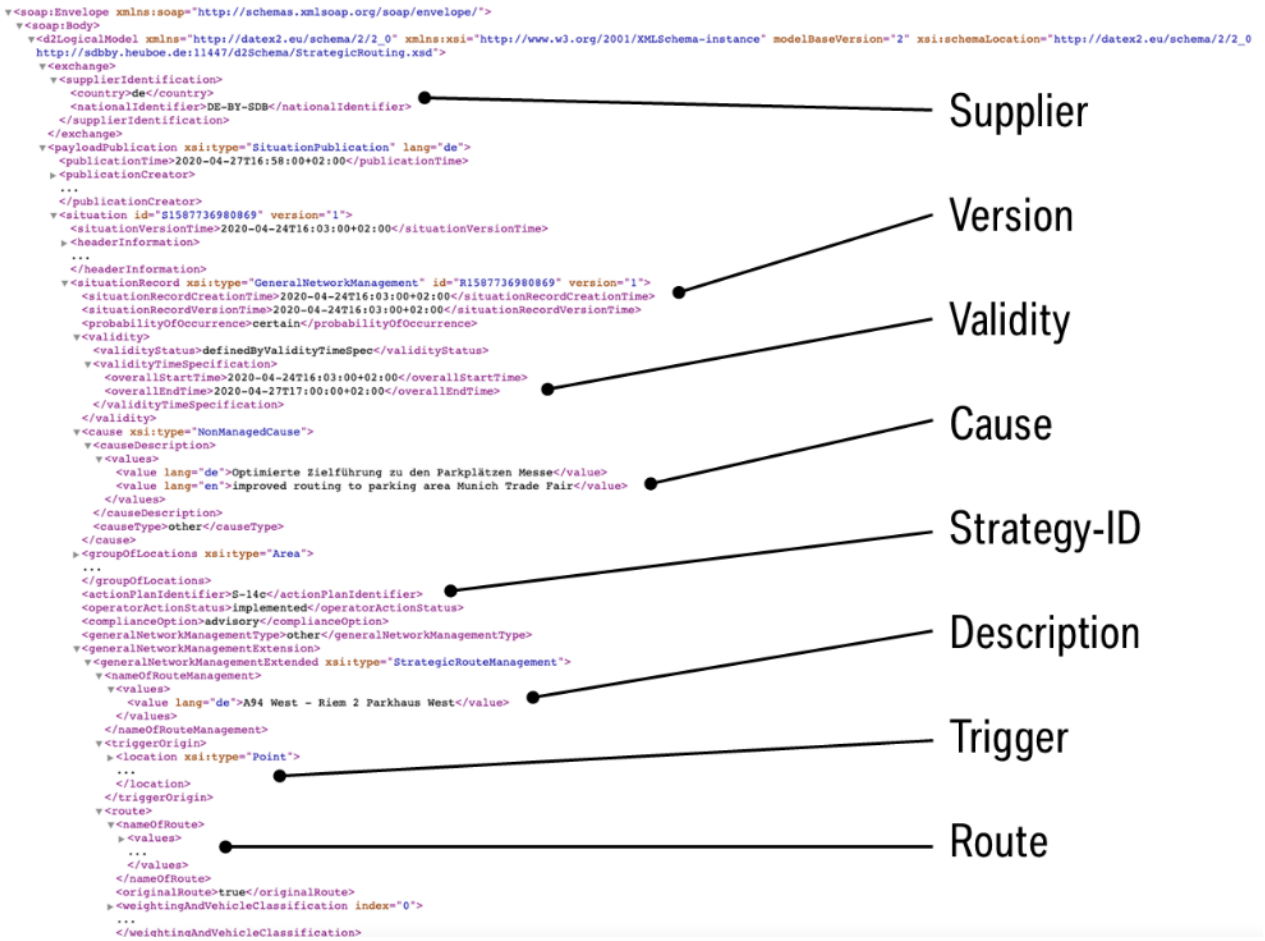

FIGURE 23. EXAMPLES OF THE MDM-DATEX2 PROFILE

Within Socrates$^{2.0}$ the MDM-DATEX2 profile was enriched with the route cause to improve the interpretation of the strategy and a unique strategy ID.

```
- <cause xsi:type="NonManagedCause">
    - <causeDescription>
        - <values>
            <value lang="de">Optimierte Zielführung zu den Parkplätzen Messe</value>
            <value lang="en">improved routing to parking area Munich Trade Fair</value>
          </values>
      </causeDescription>
      <causeType>other</causeType>
  </cause>
+ <groupOfLocations xsi:type="Area">
  <actionPlanIdentifier>S-14c</actionPlanIdentifier>
  <operatorActionStatus>implemented</operatorActionStatus>
  <complianceOption>advisory</complianceOption>
  <generalNetworkManagementType>other</generalNetworkManagementType>
- <generalNetworkManagementExtension>
    - <generalNetworkManagementExtended xsi:type="StrategicRouteManagement">
        - <nameOfRouteManagement>
            - <values>
                <value lang="de">A94 West - Riem 2 Parkhaus West</value>
              </values>
```


FIGURE 24. EXAMPLES OF MDM-DATEX2 PROFILE, ENRICHED OF THE ROUTE CAUSE AND ID

In addition, the different strategies are fixed numbered and stated in the MDM-DATEX2 protocol. Thus, the interpretation of the strategies on the service provider site could be done via a fixed look up table (especially for test cases and as a fall back solution).

FIGURE 25. LOOK-UP TABLE WITH ID AND DESCRIPTION OF ALL STRATEGIES TOWARDS THE MESSE MÜNCHEN

ID (Action Plan Identifier)	Route number PDF	frequently used	Name (Name of Route)
S-09	1		A99 Nord via B471 Aschheim
S-10	2a	x	A99 Nord via Kirchheim
S-11-a	3a	x	A94 Ost - Feldkirchen West Freigelände
S-11-b	3b	x	A94 Ost - Riem Parkhaus West
S-11-c	3c		A94 Ost - Am Moosfeld Parkhaus West
S-12-a	4a	x	A99 Süd - Feldkirchen West Freigelände
S-12-b	4b	x	A99 Süd - Riem Parkhaus West
S-12-c	4c		A99 Süd - Am Moosfeld Parkhaus West
S-13-a	5a	x	A99 Nord-Feldkirchen West Freigelände
S-13-b	5b	x	A99 Nord-Riem Parkhaus West
S-13-c	5c		A99 Nord-Am Moosfeld Parkhaus West
S-14-a	6a		A94 West - Am Moosfeld Parkhaus West
S-14-b	6b		A94 West - Riem 1 Parkhaus West
S-14-c	6c	x	A94 West - Riem 2 Parkhaus West
S-14-d	6d	x	A94 West - Feldkirchen West Freigelände
S-15-a	7a		A9 - Mittlerer Ring Nord - Am Moosfeld Parkhaus West
S-15-b	7b		A9 - Mittlerer Ring Nord - Riem 1 Parkhaus West
S-15-c	7c	x	A9 - Mittlerer Ring Nord - Riem 2 Parkhaus West
S-15-d	7d	x	A9 - Mittlerer Ring Nord - Feldkirchen West Freigelände
S-16-a	8a		A8 - Mittlerer Ring Sued - Am Moosfeld Parkhaus West
S-16-b	8b		A8 - Mittlerer Ring Sued - Riem 1 Parkhaus West
S-16-c	8c	x	A8 - Mittlerer Ring Sued - Riem 2 Parkhaus West
S-16-d	8d	x	A8 - Mittlerer Ring Sued - Feldkirchen West Freigelände

6. INTRODUCTION – ROAD WORKS

6.1 Use case description

The use case Road Works focusses on data quality improvement in the live stream as described and finalized in activity 3 for Road Works use cases. The use case is to be deployed in the following pilot sites;

- Antwerp
- Amsterdam
- Munich

The basis for all Pilot sites is the same and resembles the use case description as for Antwerp. The pilot sites Munich and Amsterdam build upon this basis to both incorporate a pilot site specific detail/extension.

The pilot site Munich will make use of Truck Mounted Attenuators. These TMA are deployed on the road to warn traffic for an oncoming Road works zone and project the people working in the RW-zone. The TMA rely their live location and shown traffic warning to the central system. This information includes location GPS and direction of travel shown (pass left or pass right). This information is included within the available MDM-DATEX2 feed.

In all pilot sites the assessor will investigate the quality improvement and establish the value of the full chain and help in deriving the win-win-win from the lessons learned.

Road Authority: Bavarian Road Administration

As a Road Authority, I want to provide road works data to a service provider offering a service to the end user.

- *I collect roadworks information from various data sources. My staff is in direct contact to the entities executing the work. This is an existing service, nothing new needs to be developed for Socrates$^{2.0}$.*
- *The information is provided to a public endpoint (MDM). The data is provided in MDM-DATEX2 format to the intermediary. The message includes information about start time and end time of the roadworks as well as the location of the roadworks (set of coordinates and textual position information like "between Munich and Augsburg") and if applicable additional information like type of road works (narrow lanes, closed lanes, closed road), reason for the works (bridge maintenance, resurfacing, grass cutting etc.), recommended detour for closed sections, height or width restrictions and phases of the works. This is an existing service, nothing new needs to be developed for Socrates.*
- *I monitor the network and validate the roadworks information based on additional data sources (FCD, direct contact to road maintenance offices). This is an existing service, nothing new needs to be developed for Socrates.*
- *I detect new roadworks or changes in the existing ones. This is an existing service, nothing new needs to be developed for Socrates. Based on this I provide updated information to the public endpoint.*
- *I receive a common roadworks picture from the intermediary in MDM-DATEX2 format. This message includes information about the roadworks (location, time and extend/length), the Universal Unique ID for the roadworks, and a confidence level.*
- *I validate internally against my information the common roadwork picture and if necessary, update my information. A team of editors is in place to receive the feedback and update the information.*

Identified Interface 1: **MDM-DATEX2** between Bavarian Road Administration – Intermediary (From RA to Intermediary only)

- Objects exchanged:
    - Situational record creation time
    - Situational record version

    - Situational record first supplier version time
    - Overall start date
    - location OpenLR
    - Network Management type

Identified Interface 2: **TMeX** between Intermediary – Bavarian Road Administration (From Intermediary to RA only)

- Objects exchanged:
    - Situational record creation time
    - Situational record version
    - Situational record first supplier version time
    - Probability of occurrence
    - Validity status
    - Overall start date
    - location OpenLR

Service provider

As a Service provider, I want to provide most accurate real time information on roadworks to my users, so that they experience a satisfying journey.

- *I collect roadworks information from various data sources. This is an existing service, nothing new needs to be developed for Socrates.*
- *I monitor the network and validate the roadworks information based on additional data sources. This is an existing service, nothing new needs to be developed for Socrates.*
- *I detect new roadworks or changes in the existing ones. This is an existing service, nothing new needs to be developed for Socrates.*
- *Roadworks information are part of the incident feed that we provide to our customers through an API. The data is provided in MDM-DATEX2 format to the intermediary. The message includes information about start time and end time of the measure as well as the location of the roadworks*
- *I receive a common roadworks picture from the intermediary in MDM-DATEX2 format. This message includes information about the roadworks, the trackable ID for the roadworks, and a confidence level.*
- *I validate internally against my information the common roadwork picture and if necessary update my information and/or algorithms.*

Identified Interface: **JSON** between TomTom– Intermediary

- Objects exchanged:
    - Situational record creation time
    - Situational record version
    - Situational record first supplier version time
    - Probability of occurrence
    - Validity status
    - Overall start date
    - location OpenLR or WGS84
    - Network Management type

Intermediary

As an Intermediary, I want to provide most accurate real time information on roadworks to the Service providers and road authorities by fusing their data, so that they can provide the most accurate data to their end systems.

- *I collect roadworks information from various sources. This is an existing service for road authorities, and a new service for Service Providers.*

- *I monitor the data and fuse data where needed and/or extend the data sets.*
- *I detect newly reported Road Works and add them to the data set with a new UUID.*
- *Based on input from service providers I add a probability for the Road Works information.*
- *I produce a Common Road Works Picture which is provided to Service Providers and Road Authorities and the Assessor.*

Identified Interface: **TMeX** between Intermediary – Use Case partners
Format of interface supplied is either JSON or XML. By choice of partners

- Objects exchanged:
  - Location of event (openLR & WGS84)
  - Unique Event_ID
  - Version (new version when features of traffic event change, e.g. extra lane closed).
  - description of traffic event
  - Freetext (textual description of traffic event)
  - Heading (direction of traffic event)
  - Location Wgs84
  - Starttime (YYMMDDHHMMSSZ (UTC))
  - Endtime (YYMMDDHHMMSSZ (UTC))
  - Probability
  - Number of sources reporting event
  - Detection method (Manual, System, User Input)
  - Quality Index

Assessor

The assessor shall determine the rate of quality improvement based on the delivered data per SP and RA and the fused result. Assessment shall be done based on data completeness, timeliness and probability rate. For this the user feedback loop will be used where possible.

6.2 Functional overview

They aim of the use case has been to determine whether fusion of different RW sources can help in creating a current view of Road Works as established in Activity 3. In order to do this, within Activity 4 a data harvesting and fusion process has been built by MAPtm. This process gets with a set interval data from all providing partners and fuses the data into a harmonized view of current roadworks. This fusion is mainly done on the aspects of time and space and where possible on descriptive information as well. During this fusion and harvesting process the goal has also been to 'wash' the data and rid it of identifying elements with which the providing source can be identified in the current data view provided to all partners as a result of this fusion process.

Within Socrates 2.0 the use case 'Road Works' as deployed within the pilot sites Antwerp, Munich and Amsterdam focusses on creating a common ground truth. This common is generated on data from all partners and shared with all partners providing data. Data is retrieved from the various partners and data providers within the project. These partners are TomTom, HERE, Be-Mobile and the government bodies Bäyerisch Verkeersambt (Germany), Vlaamse Overheid (Belgium) and NDW (The Netherlands). The data is retrieved from these parties in their current form. On the providing side, all systems have been left unchanged. For the use case implementation, and the stated research questions, it was explicitly chosen to not alter current data provisions from the partners. Partially to save time but mostly to establish to what the added value could be in the current environment.

First goal was to combine the retrieved data from the partners and provide a new message set with actual roadworks and provide a quality indication to the road work messages based on combining the same messages of a Road Works from the different partners. The content of the combined message set was aligned with the partners within Socrates. The message set was built upon the TMex principals, for data exchange, developed within the project.

If successful a next step would be a fusion of Road works based on multiple notifications of the same roadwork by the partners. This fusion would not only combine on time and location information but would also combine all available detail information and meta data for the provided Road Works into a 'most complete data set'. It must be stated that 100% completeness is only achievable in theory.

6.3 Active partners and roles

Two Socrates$^{2.0}$ partners and one associated partner are active in the Road Works use case in Munich.

FIGURE 26. PARTNERS AND ROLES IN THE MUNICH ROAD WORKS USE CASE

Partner	Role in use case
Bavarian Road Authority (associated partner)	Data provider / Road Authority
MAPtm	Intermediary
MAPtm	Assessor
TomTom	End user Service provider

6.4 Description of end user services

There where no, identifiable end user service specifically made or facilitated for the resulting data. The data has been processed, viewed and analysed and where possible integrated in current Road Works services delivered in many ways from the separate Service Provider's and the Road Authority to the road user.

7. INFORMATION ARCHITECTURE - RW

7.1 Sequence diagram

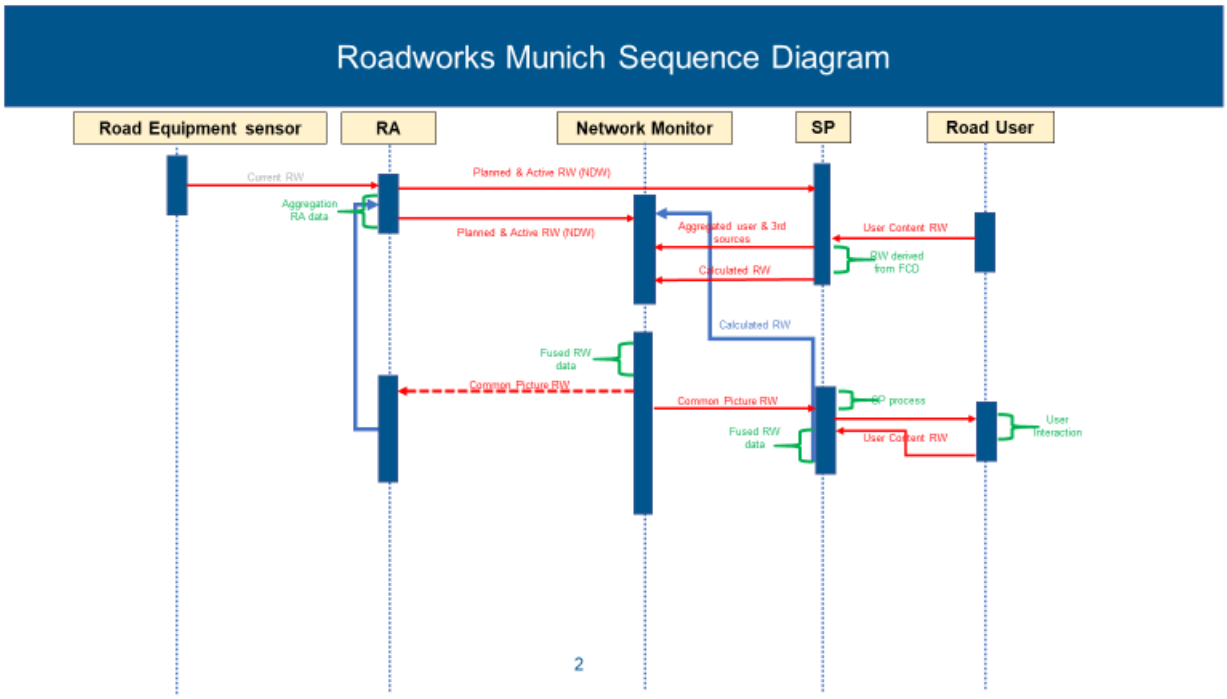

FIGURE 27: SEQUENCE DIAGRAM ROAD WORKS MUNICH

7.2 Processes and interactions

MAPtm – NETWORK MONITOR

- STEP 1: All data providing partners gather data from their underlying sources. For SP's this is from their APP's, in-car systems and third party supplying data sources. For the Road Authority this from their planning system and from road side safety equipment deployed at Road Works sites.
- STEP 2: Network Monitor receives all data by pulling the data from the SP's and RA. All data is stored in a centralised system and harmonised in preparation for the fusion process. Included in the harmonisation step is making sure data is not easily linked back to their providing sources.
- STEP3: Data is fused based on common fields and when matches are found with a limited discrepancy.
- STEP4: The fused data is made available on a REST API which, per request response with a XML or JSON formatted current view of active Road Works.

7.3 Data storage for evaluation

MAPtm – NETWORK MONITOR

For evaluation purposes the fused data (API response) is stored per time interval, being ruffly 15 minutes without 'partner labelling information'.

8. SYSTEM ARCHITECTURE – RW

8.1 System / Application overview

From the fusion process data is injected into the existing MDM-DATEX2 feed that is being provided by the Bavarian TMC within the pilot site. From the fusion process a new container is appended to the MDM-DATEX2 structure per updated Roadworks object within the existing feed. The old and updated information will coexisted alongside each other. Based on the probability rate a user of the feed can determine on his own business rules if and what part of the data will be used in their end systems. For objects that are new for the data feed, a roadworks light container will be appended to the existing feed as a new Roadworks object. Use-case users (SP's and RA's) do not have to amend their receiving systems for roadworks. Determining which roadworks info to take from the datasets can be done on their own terms.

8.2 Interfaces

FIGURE 28: INTERFACE ALLSITES-RW-CM3, INFORMATION CAN BE PULLED

Scope	name	INT1	INT2	type	definition	requirement	comment
Space	location OpenLR	x	x	openLR		Need	Optional
	location WGS84	x		POINT(x,y,z)		Optional	Optional
Time	Situational record creation time	x	x	DATETIME	versioning		
	Planned Start datetime for RW	x	x	DATETIME	Start time of Road works	evalution storage	Changes logging in boekhouding IM situationRecordFirstSupplierVersionTime
	Actual start datetime for RW		x		Reported Start time	evalution storage	Changes logging in boekhouding IM situationRecordVersionTime
	Detected datetime for RW		x		This is NOT a start time	evalution storage	Changes logging in boekhouding IM situationRecordObservationTime
					versioning is needed		
Meta	Situational record version	x	x	VARCHAR			
	Network Management type	x	x	VARCHAR	?	copy from datexII?	
	Situational record first supplier version time	x	x	VARCHAR	?	copy from datexII?	
	Probability of occurrence		x	INT		already available	certain/probable/riskOf certain is definitief (change van starttime)
	Probability rate		x	INT		Combine with probalitiy? Define the field!	Added to profile
	UUID		x	UUID	Unique ID	Traceability	
	Type of Roadworks		x	TEXT or INT	moving, stationary, long-term		
	lanes closed/available	x		TEXT or INT	status of lane availability	0 = open, 1 = closed, sequence number for lane postition on road	>Groupoflocation boom of > impact
	Narrow Lanes	x		TEXT or INT	lanes wit reduced width	optional	> OperatorActions - RoadorCarriageWaytManagement
	Reduced speed					Do we need this? Can we get this from a different datexII container for this location?	SpeedManagement
	one lane traffic control	x		TEXT or INT	Temporary Traffic Light Signals in use or Traffic Warden	TLC for controlling one lane traffic	GeneralNetworkManagement > trafficManuallyDirectedBy
	Counterflow traffic	x		TEXT or INT	Traffic is divert to the other side of the road		alternating traffic over one lane
	Detour information					Copy from input. Avaliable in antwerp/munich?	ReRoutingManagement (in NL verplicht om andere route op te geven als gebruikt wordt)
	Passable for emercency services						RoadOrCarriageManagement > useOfSpecifiedLanesAllowed (wegafgesloten voor alles behalve) (validity aangeven met period)
	Changed Traffic Situation	x		?	Road Layout has changed	for changes in longer term RW	
	Author	x		TEKST or INT	Alert created by	dependable on whether this is allowed	Source

For all pilot sites (Amsterdam, Antwerp, Munich) the Road Works URL-endpoints are formatted in a unified structure;

https://roadworks.maptm.nl/{pilotsite}/{responseformat}/

The variables within the URL are:

- *PILOTSITE*: This can either be; Amsterdam, Antwerp, Munich
- *RESPONSEFORMAT*: This can either be; TMEX or JSON.

Road Works data identified in the fusion process to not be within the provided RA MDM-DATEX2 feed will be injected into the existing and supplied MDM-DATEX2 feed and rebroadcasted with an extra

container for added information from the Socrates$^{2.0}$ project. Original and updated/added information will co-exist in this feed.

FIGURE 29: EXAMPLE OF A RW FEED


```
[
    {
        "s20_tmexid": 136514,
        "s20_creationtime": "2019-12-17T18:30Z",
        "s20_updatetime": "2019-12-17T18:30Z",
        "s20_endtime": null,
        "s20_version": 1,
        "s20_isactual": true,
        "roadname": "Camera Obscuralaan",
        "locationdescription": "Camera Obscuralaan",
        "directiondiscription": "Construction work:Camera Obscuralaan, between Klaasje Zeve
nsterstraat and Oranjebaan",
        "impactdelay": null,
        "location_wgs84": "LINESTRING(4.87716 52.303272,4.876755 52.302063)",
        "location_fordisplay": "POINT(4.87716 52.303272)",
        "alertccountrycode": null,
        "alertctableid": null,
        "alertcttrafficcode0": null,
        "alertcdescription0": null,
        "alertcduration0": null,
        "alertcdirection0": null,
        "alertcttrafficcode1": null,
        "alertcdescription1": null,
        "alertcduration1": null,
        "alertcdirection1": null,
        "planned_startdatetime_rw": "2019-12-17T18:14Z",
        "actual_startdatetime_rw": null,
        "detected_datetime_rw": null,
        "situationalrecordversion": null,
        "generalnetworkmanagementtype": null,
        "situationalrecordfirstsuppliertime": null,
        "number_ofoccurences": null,
        "probability_ofoccurences": "Probable  ",
        "probability_rate": null,
        "type_ofroadworks": "CONSTRUCTION",
```

```
        "numberoflanesrestricted": null,
        "numberofoperationallanes": null,
        "originalnumberoflanes": null,
        "roadclosed": false,
        "temporaryspeedlimit": null,
        "onelanetrafficcontrol": null,
        "counterflowtraffic": null,
        "detourinformation": null,
        "passableforemercencyservices": null,
        "changedtrafficsituation": null,
        "author": "Socrates  "
    },
    {
        .....
    }
]
```


Every data feed of the partners was aligned with dataset (TMex) for the Road Works that was agreed upon and where useful information was added if one of the partner's data feed had specific useful information. **Error! Reference source not found.** shows the contents of the RW-TMex message. As the table shows the list of fields is rather straight forward without nesting information in (sub)containers. Many data fields are already available in varying degrees within the data feeds provided as sources for this use case.

FIGURE 30: TMEX MESSAGE SET

Response field	Name	Type	definition	Comment
s20_tmexid		VARCHAR	Socrates 20 uuid	
s20_creationtime		Integer	First creation time	Within framework
s20_updatetime		timestamp	Last update time	Within framework
s20_endtime		timestamp	Detected end time	Within framework
s20_version		timestamp	Version of message	Within framework
s20_isactual		boolean	Message is current	
roadname		VARCHAR	Streetname	
locationdescription		VARCHAR	descriptive text for location information	
directiondiscription		VARCHAR	orientation of RW	
impactdelay		Integer	Time lost due to RW	best guess value
-	*location OpenLR*	*openLR*		
location_wgs84	location WGS84	Linestring		
location_fordisplay	location for display (WGS84)	POINT		
alertccountrycode	from alertC when available	VARCHAR		
alertctableid	from alertC when available	Integer		
alertcttrafficcode0	from alertC when available	Integer		
alertcdescription0	from alertC when available	VARCHAR		
alertcduration0	from alertC when available	VARCHAR		
alertcdirection0	from alertC when available	VARCHAR		
alertcttrafficcode1	from alertC when available	Integer		
alertcdescription1	from alertC when available	VARCHAR		

alertcduration1	from alertC when available	VARCHAR		
alertcdirection1	from alertC when available	VARCHAR		
planned_startdatetime_rw	Planned Start datetime RW	timestamp	Start time of Road works	
actual_startdatetime_rw	Actual start datetime RW	timestamp	Reported Start time	
detected_datetime_rw	Detected datetime RW	timestamp	This is NOT a start time	
situationalrecordversion	Situational record version	Integer		
generalnetworkmanagementtype	Network Management type	VARCHAR		
situationalrecordfirstsupplliertime	Situational record first supplier version time	VARCHAR		
number_ofoccurences	Number of data suppliers reporting the same RW	Integer	Number of sources reporting some RW	
probability_ofoccurences	Probability of occurrence	VARCHAR	rate for RW are to be seen on the road	
probability_rate	Probability rate	REAL	rate for trueness of RW info	
type_ofroadworks	Type of Roadworks	VARCHAR	moving, stationary, long-term	
numberoflanesrestricted	lanes closed/available	Integer	status of lane availability	When available
numberofoperationallanes	Number lanes opened for traffic during RW	Integer	Number of lanes available	When available
originalnumberoflanes	Number of lanes opened for traffic during normal operation	Integer	Number of lanes available in normal situation	
not available currently, planned for future incorporation	Narrow Lanes	TEXT or INT	lanes wit reduced width	
roadclosed		boolean	Road closed due to road works	
temporaryspeedlimit	Reduced speed	Integer		
onelanetrafficcontrol	one lane traffic control	boolean	Temporary Traffic Light Signals in use or Traffic Warden	
counterflowtraffic	Counterflow traffic	boolean	Traffic is divert to the other side of the road	
detourinformation	Detour information	VARCHAR		
passableforemercencyservices	Passable for emercency services	boolean		
changedtrafficsituation	Changed Traffic Situation	VARCHAR	Road Layout has changed	
author	Author	VARCHAR	Alert created by	

Data harmonisation

During the matching stage of de data feeds of the partners towards the TMex message set, it was striking how much the shape and the contents differed per feed, provider and even between sites (e.g. DATEX2). So, for every feed for every site the code to retrieve and convert to the Socrates dataset (TMex) was rewritten and adapted. Feeds differ in complexity, from a compact and straightforward dataset with actual road works to complex DATEX2 data sets including not only actual roadworks but also planned or even past events. Moreover, the naming and coding (e.g. containers or not) of the fields differs per feed. This is also regarding TMC and DATEX2 standardised fields as well.

Differences in georeferencing

- TMC is not harmonic over all sites. The implementation of the TMC principle divers per site/country and thus has had its particularities per site.
- Documentation for TMC is only available for paying members of TISA. Beyond that a current TMC table must be retrieved from the relevant governing bodies and isn't available as open data everywhere. Though, payment is never required for obtaining the TMC tables.
- Service Providers use different geospatial projections. But in most cases provided alternative projections within the feed.
- The Flanders data feed is provided with only TMC as geospatial reference.
- Relying solely on TMC geospatial referencing limits the area where RW can be reported as TMC is not covering all roads (e.g. local and residential roads). This difference is especially visible between Public and Private sources.

Differences in data provision

- DATEX2 has proven not harmonic over all sites
- Detail information is not consistent added
- Update intervals are not always clear and never in sync.
- DATEX2 feed from NDW was too large for a stable feed. To get a good performance Extra RAM memory was allocated on the NDW side and we used a cut out from the region of Amsterdam.

9. OPERATIONAL PILOT

9.1 Recruitment

Initially the operational period was planned from January 2020 to June 2020.

The Road Works use case went live in December 2019. But a targeting and recruitment of specific users was not necessary.

For the Smart Destination use case a targeting of user groups started in autumn 2019. In parallel, starting from November 2019 till October 2020 friendly users tested the different development steps.

9.2 Impact of Corona - SD

Because of the Corona crisis big events like soccer games and trade fairs had been skipped from end of March 2020. Therefore, the Munich Socrates2.02.0 operational period was extended to end of 2020. The hope was that some bigger events may be possible in autumn 2020 again. Realising in summer 2020 that no big events will be realistic in 2020 in Munich, no further effort had been spent in recruitment.

To get feedback, live tests with friendly users had been executed, as described following.

10. ANALYSIS - SD

The tests for the Use Case Smart Destination in Munich had been organized as follows.

Participants:

- Bavarian Road Authority
- BrandMKRS
- BMW
- Be-Mobile

Structure:

- Testphase 1: provide strategies on the MDM (functional design)
    - Strategies towards the Allianz Arena and the Messe München are made be available on the national access point MDM by the Bavarian Road Authority.
    - Even in times of no event is taken place in the Allianz Arena or the Messe München, the “base” strategy is active and processed to the MDM by the Bavarian Road Authority.
- Testphase 2: internal service set-up (functional design)
    - Service Providers process (synthetic) strategies within their own system and adapt their route/ guidance advice accordingly.
    - Friendly users are partly used to gain detailed feedback.
- Testphase 3: Access MDM (integration test)
    - Service Provider establish a connection to the Munich strategies on the MDM.
- Testphase 4: independent chain tests (integration test)
    - Service Provider access the strategies on the MDM, process them in their system and generate the user advice. Because the base strategy is always active and available on the MDM, this chain test could be done independently by each partner.
    - Friendly users are partly used to gain detailed feedback.
- Testphase 5: Live Tests (joint integration test)
    - Even if there is no event taken place (due to the Corona Crisis), the Bavarian Road Authority activates different strategies in a scheduled way. This is done live via the Munich Traffic Management Centre, so that also the road side signs (VMS) are adapted and in parallel the activated strategies communicated to the MDM.
    - The live test focus only on the Messe München strategies.

- The Service Provider access the strategies on the MDM, process them in their internal System and send out an advice to some friendly users.

The following aspect should be checked by the different tests:

- Are the strategies described correctly in the MDM-DATEX2 Format?
- Are the strategies available on the MDM?
- Do the messages arrive at the service providers?
- Do the correct messages arrive at the service providers?
- Can the messages be processed by the service providers?
- How does the generated information to the user look like?
- Is the generated information correct (time, location) and understandable by the user?
- Does this information correspond to the strategy that was send out by the BayRA?

11. FINDINGS AND RELATED EVALUATION REPORT

The evaluation of the Munich pilot and the drawn conclusions based on the analysis is not part of this report, but can be found in the evaluation report of Activity 8. Here just the main findings:

A learning from the pilot site Munich is, that standardization should not be underestimated. 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.
A one-way communication of public traffic management strategies is only a first step towards interactive traffic management. An important condition for future large scale implementation is the availability of such data, both standardized and through a national access point.

Another insight from pilot site Munich is that service providers need the cause of a traffic management strategy (insight into the reason why) to point out the additional value of the service to the user. Make data as the public traffic management strategies available is no guarantee that service providers can process it beneficial for the user. The win-win-win must be further elaborated for this.