SETTING THE STAGE FOR THE DEPLOYMENT OF INTERACTIVE TRAFFIC MANAGEMENT

SOCRATES 2.0

FAST SAFE GREEN

SOCRATES2.0 is co-funded by the European Commission

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Also available:
“Annex: Design per pilot site”

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TABLE OF CONTENTS

1 Introduction ... 3
1.1 SOCRATES$^{2.0}$ in nine activities ... 4
1.2 What's new in SOCRATES$^{2.0}$? ... 5
1.3 SOCRATES$^{2.0}$ framework on public-private traffic management ... 5
1.4 SOCRATES$^{2.0}$ vision ... 5
1.5 Reading guide ... 6

2 Setting the stage for the deployment of interactive traffic management ... 7

3 Basics for the pilot designs ... 10
3.1 Pilot site inventory ... 11
3.2 Use cases per pilot site ... 13
3.3 Cooperation models ... 14
3.4 Intermediary design ... 16

4 Specification of the data interface: TMex ... 19

5 Pilot designs ... 22
5.1 Functional design ... 23
5.2 System overview ... 24
5.3 Description of intermediary roles ... 25
5.4 Partner distribution ... 26
5.5 Factsheets on the pilot designs ... 27

6 Evaluation ... 28
6.1 Ex-ante evaluation ... 29
6.2 Evaluation approach ... 30

7 Conclusion ... 33
7.1 What has been achieved in Activity 3? ... 34
7.2 Recommendations and learnings on specific elements of Activity 3 ... 35
7.3 What's new in the pilot designs? ... 37
7.4 Recommendations and learnings from the approach ... 37
7.5 Next steps: Technical design and validation of the pilot designs ... 38

List of contributors ... 39

1. INTRODUCTION

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In the European project SOCRATES$^{2.0}$, eleven public and private organisations have been challenged to try different ways of working together to realise smart traffic and navigation services. The partners have selected and developed three types of services, which will be tested by 9,000 users in the regions of Amsterdam, Antwerp, Copenhagen and Munich. These services include smart route advice (for example in case of events), actual speed and lane advice, and local warnings (for example on environmental zones and road works). The pilots will take place in 2019 and 2020 and include 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.

The SOCRATES$^{2.0}$ main learning objectives are to gain insights on how to organise the collaboration between public and private parties, and what key elements are necessary to assure scalability and success of use cases.

1.1 SOCRATES$^{2.0}$ in nine activities

The SOCRATES$^{2.0}$ project consists of nine activities and follows a V-model approach. First, a common framework was defined (Activity 2), which was then specified for the four pilots (Activity 3). This report is the reflection of 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).

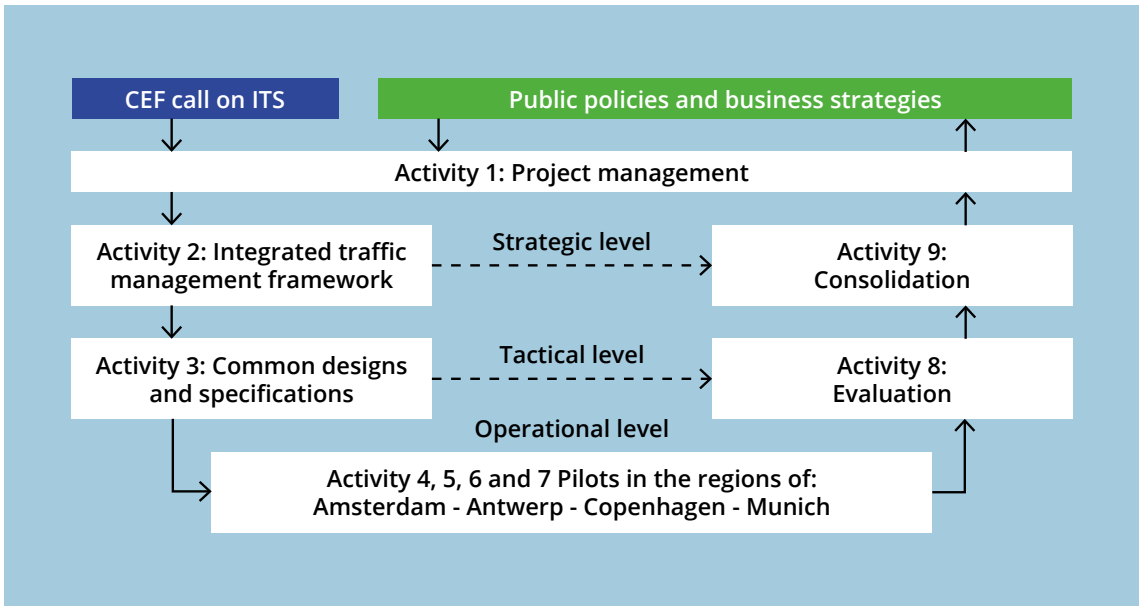

Figure 1: V-model approach.

1.2 What's new in SOCRATES$^{2.0}$?

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 better services for road users, all parties involved – 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.

1.3 SOCRATES$^{2.0}$ framework on public-private traffic management

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. 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*. The elaboration of different models for cooperation was mainly covered in SOCRATES$^{2.0}$ Activity 2.

1.4 SOCRATES$^{2.0}$ vision

The vision of the SOCRATES$^{2.0}$ partners is that cooperation will lead to a win-win-win situation for all actors in the traffic management eco-system: the road user, the road operator (Traffic Management Centres) and service providers. To reach the win-win-win situation, some basic concepts and common agreements were elaborated.

The partners in SOCRATES$^{2.0}$ wanted to establish something new and not just to improve an existing concept of cooperation. To do so, they recognised that a paradigm shift should be made from 'managing and influencing traffic' to 'supporting people on their travel from A to B'. To bring this vision to the pilots in the ongoing deployment work, two statements are adopted as the *agreed base*:

- Active involvement of the customer (road user) and the communities, pre-trip, on-trip and post-trip
- Move from managing traffic to supporting individuals

As a result, the vision does not just focus on technology or the traffic management process but is elaborated along four elements: customer, community, technology and cooperation.

The essence of each element is captured into four 'slogans', summarizing what is new behind this concept, compared to contemporary traffic management. See Figure 2.

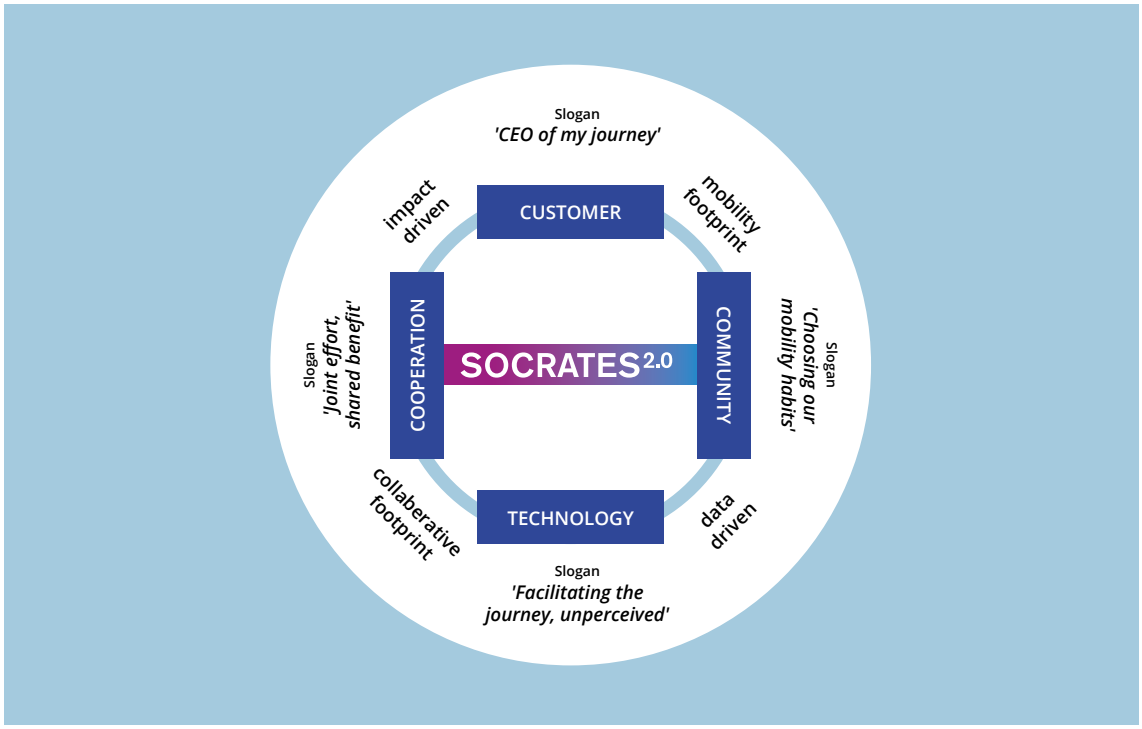

Figure 2: The four elements of SOCRATES$^{2.0}$ and their slogans.

1.5 Reading guide

The goal of Activity 2 was to develop an optimal framework for cooperation between the public and private partners, as a basis for a European deployment of interactive traffic management. As a result, a theoretical framework was created, describing options for cooperation on a strategic level.
Activity 3 covered the tactical level by specifying the framework for the four pilots. This report describes the approach and the results of Activity 3.

Chapter 2 introduces a guideline for stakeholders engaged in (similar) deployment projects for interactive traffic management. Chapters 3-6 describe the sub-steps to take when it comes to preparing pilot deployments. These sub-steps form the milestones of the mentioned guideline. Chapter 7 concludes on the results of Activity 3 of the SOCRATES$^{2.0}$ project and gives an outlook on activities 4-7.

2. SETTING THE STAGE FOR THE DEPLOYMENT OF INTERACTIVE TRAFFIC MANAGEMENT

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Before the individual pilots could be further specified, some common agreements had to be made on a tactical level. This included an explicit concept for interactive traffic management, eventually resulting in functional designs for each envisioned pilot site and use case.

Such a concept is an important base when preparing pilot deployments. This way, a common understanding on how a pilot site is deployed can be gained, considering both ***(a)*** a common mission and vision, as elaborated in Activity 2, and ***(b)*** the individual realisation of each pilot site and each use case, as elaborated in Activities 4, 5, 6 and 7. The concept includes some organisational, functional and technical aspects, touching on the roles of partners and their products and services, as well as the interfaces between those products and services.

We believe that a coordinated elaboration of these aspects leads to successful cooperation deployments, not only in the SOCRATES$^{2.0}$ pilots, but in any comparable project. This way, the outcomes of Activity 3 can be seen as a guideline for stakeholders engaged in (similar) deployment projects.

The mentioned aspects have been elaborated in dedicated Focus Groups within Activity 3. As an outcome from these Focus Groups, some sub-steps could be identified when it comes to preparing pilot deployments. The sub-steps form the milestones of the mentioned guideline. They are introduced below and are described in more detail in the subsequent text chapters:

- **Make an inventory of the pilot site**
  - Describe local prerequisites and conditions
  - Identify individual partner assets in terms of data availability, existing management strategies etc.
    > See 'Pilot site inventory', chapter 3.1

- **Select a use case**
  - Decide which use case is deployed at which pilot site
  - Discuss what is useful and feasible in the particular context
    > See 'Use cases per pilot site', chapter 3.2

- **Specify a cooperation model**
  - Explore concepts, characteristics and ambitions of different cooperation models
  - Assign a suitable type of a cooperation model to each pilot deployment
    > See 'Cooperation models', chapter 3.3

- **Specify an intermediary**
  - Explore potential functions and roles of intermediaries
  - Assign a suitable type of an intermediary to each pilot deployment
    > See 'Intermediary design', chapter 3.4

- **Specify a data interface (TMex)**
  - Define a concept to exchange data between different parties, including potential data protocols and data platforms
  - Explore requirements, prerequisites (such as existing data standards) and technical solutions for such an interface
    > See 'Specification of data interface', chapter 4

- **Provide a functional design**
  - Describe a functional architecture for each pilot deployment
  - Identify system functions and their interactions
    > See 'Pilot Designs', chapter 5

- **Plan the evaluation**
  - Describe evaluation goals
  - Define research questions and analysis methods
    > See 'Evaluation', chapter 6

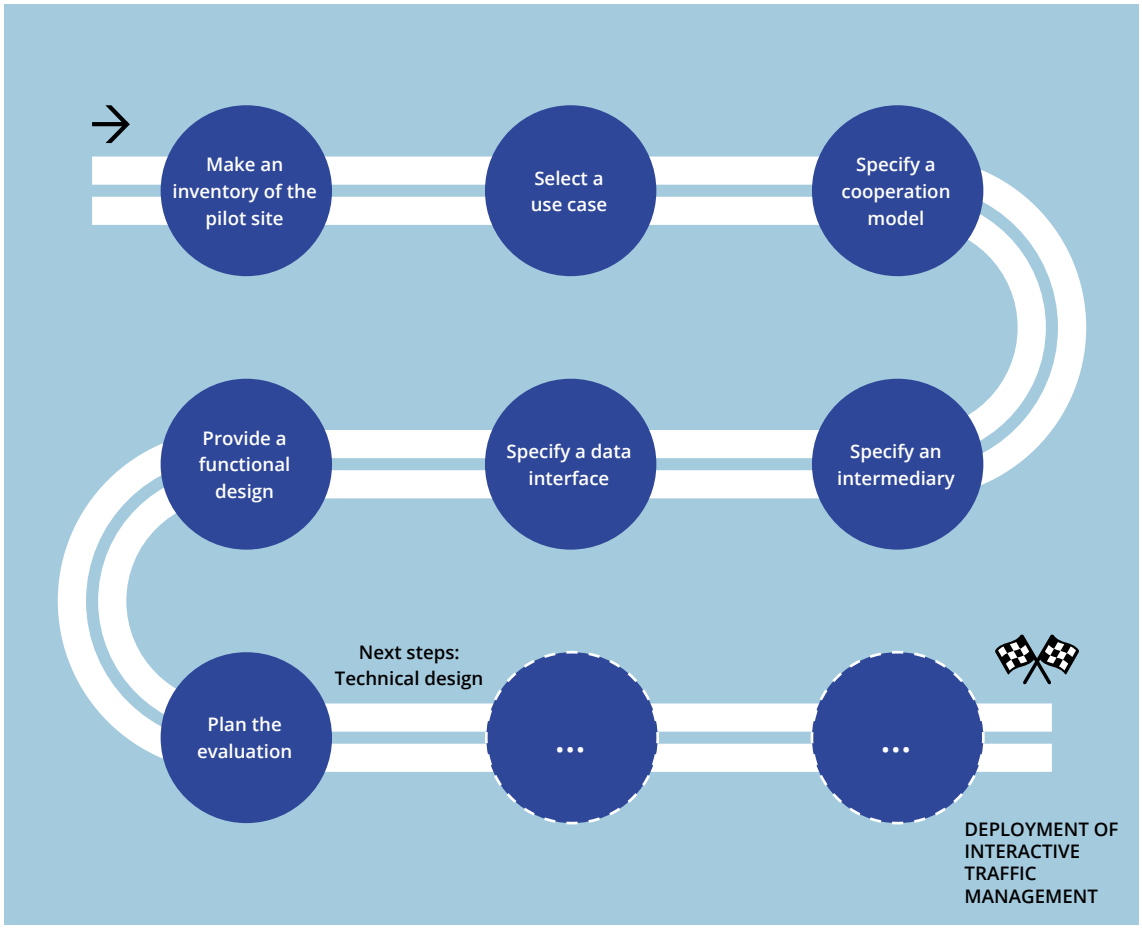

Figure 3: Preliminary step-by-step plan to the deployment of interactive traffic management.

3. BASICS FOR THE PILOT DESIGNS

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3.1 Pilot site inventory

It is important to get familiar with the different characteristics of each pilot site, to adapt the pilot deployment to local conditions and constraints. To have an overview on these conditions, a survey was initiated among pilot site partners, asking the following questions:

- What is the geographic boundary of the pilot site and which roads should be part of the use case in pilot site?
- What are the current problems at the pilot site network in relation to the services in the use case?
- Which services are deployed in the pilot site that are similar to services in the use case?
- Which partners are involved in these services?
- Which wishes for improvement do you have in relation to the use case in the pilot site?

The outcome of the survey was a first preparation step for the individual pilot designs.

As an example, an important aspect for the 'Optimising network traffic flow' use case was the road network situation. For the Amsterdam deployment, the following map was used as an input.

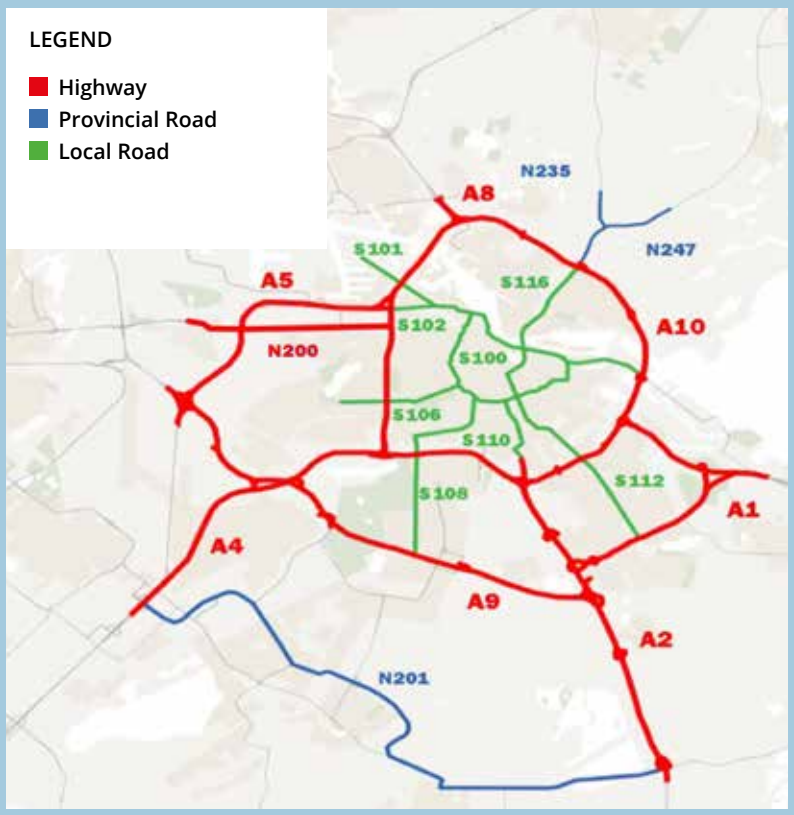

Figure 4: Road network situation overview, pilot deployment 'Optimising network traffic flow, Amsterdam'.

Another important prerequisite for the pilots is the current availability of data. This was also explored by a survey, asking for the availability per pilot partner on 85 different data types, which have been clustered in the following seven categories:

- Dynamic Traffic/Road Status data
- Static road data
- End User/Traveller data
- Vehicle Data
- Multi-modal data
- Parking data
- Other

Eventually, this data survey allowed a 'gap analysis', showing discrepancies between data required for the envisioned use cases (SOLL situation) and the actually existing data (IST situation).

An example for such a gap analysis for the use case 'Optimising network traffic flow' is shown in Table 1. The required data sets are listed in the lines, whereas the availability status per pilot site is marked in the columns. The purple colored fields indicate the most critical data gaps, which need to be clarified within the next steps.

		Amsterdam			Copenhagen			Munich			Antwerp		
Data	Data description	Yes	Partly	No	Yes	Partly	No	Yes	Partly	No	Yes	Partly	No
Traffic flow	Actual road usage	4	2	2	2	0	2	1	0	3	2	0	2
Events	Current road status: Abnormal traffic, Incident, Hazard, Activity (construction, event)	4	4	1	1	1	2	2	0	2	3	0	1
Delay	Actual delays (in seconds/ minutes) due to abnormal traffic	6	1	2	1	0	2	1	0	3	2	0	2
Traffic volume	Current intensity per road segment	1	4		0	1	3	1	0	3	1	0	3
Average traffic speed	Current speed per road segment	7	2	0	3	0	1	3	0	1	4	0	0
	Current density per road segment	0	2	6	1	0	2	0	0	3	1	0	2
Route	Route of road user	1	0	7	0	0	4	0	0	4	1	0	3
Road capacity	Capacity of roads (or maximum performance: product of intensity and speed)	0	1	8	0	0	4	0	0	4	1	0	3
Location	Location of individual vehicle	2	0	6	1	0	4	1	0	4	2	0	3
Heading	Direction of individual vehicle	3	0	5	2	0	3	2	0	3	3	0	2
Speed	Speed of individual vehicle	3	0	5	2	0	3	2	0	3	3	0	2

Table 1: Gap analysis for data in use case 'Optimising network traffic flow'.

3.2 Use cases per pilot site

One of the elements of the SOCRATES$^{2.0}$ vision is that the road user should be in the centre of attention. This guided the elaboration of the (sub) use cases to be deployed in the pilot sites Amsterdam, Antwerp, Copenhagen and Munich:

1. Smart routing
   - Optimising network traffic flow
   - Smart destination
2. Actual speed and lane advices
   - Lane information
3. Local information and hazardous warnings
   - Road works warning
   - Environmental/areal information and constraints

The selection of use cases to be tested per pilot site was done in several consecutive steps:

- A provisional choice for use cases per partner at the beginning of Activity 3
- A survey on 'preferred' use cases per partner and per pilot site
- A final decision on use cases in a common workshop

This way, a coordinated, common decision-making was possible, taking into account both individual partner perspectives (such as business interests) and overarching project goals (such as a complete and balanced coverage of use cases across the entire project).

The final selection is shown below.

	PS Amsterdam	PS Copenhagen	PS Munich	PS Antwerp
Optimising network traffic flow				
Smart destination				
Lane information				
Road works				
Environmental / areal info				

Table 2: Overview of selected use cases to be tested per pilot site.

3.3 Cooperation models

One of the main objectives of SOCRATES$^{2.0}$ is to design, operate and evaluate a cooperation framework for interactive traffic management by road authorities, service providers and car industries. Therefore, the project introduced and discussed different cooperation models and intermediary roles. A first selection of options for cooperation models and intermediary roles was defined in Activity 2. The next steps were to define and elaborate different cooperation models and intermediary roles and to determine what cooperation and intermediary models are applied and tested in the use cases (services) in the respective pilot sites. The SOCRATES$^{2.0}$ pilots aim to experiment with different cooperation models and intermediary roles, to learn the effects of different options.

Cooperation model matrix

The cooperation models were defined in the form of a matrix, looking at three dimensions regarding the exchange of traffic management strategies:

- **Level of commonality:** Is there a commonly agreed plan for coordinated actions or common insights, a so called 'common truth'?
- **Level of detail:** At what level of detail do we want/need a commonly agreed 'truth'?
- **Level of commitment of the stakeholders:** Are stakeholders free to use the agreed plan/basis or do they commit themselves to a set of needed actions to achieve the common goals?

	• No joint approach • Exchange info	• Joint approach • Common insights	
	No coordinated services	No coordinated services	Coordinated services
Situational: status sensors, actuators	Monitoring with own instruments	Share data, jointly set up CSP and optional improve own monitoring	Joint development CSP and all agree to use it
Operational: actions, measures	Independent choice and deployment of measures	Share actions and measures and optional improve own measures and actions	Joint development, choose and deploy coordinated measures and actions
Tactical: approach, TM services, motivation	Independent development and choice of tactical approach	Share approach and motivation and possibly improve own approach and motivation	Joint development, choice and deployment of coordinated approach
Strategical: policy, priorities, objectives	Independent development and deploy of policy framework	Share policies and prios and possibly improve own policy and prios	Joint development and deployment of policies

● 1. Level of commonality ● 2. Level of detail ● 3. Level of commitment

Table 3: Cooperation model matrix.

As a part of defining the pilot designs the partners had a ('bottom up') discussion on the role of stakeholders and how they could cooperate. These options were elaborated with theoretical ('top down') options and finally resulted in recommendations for the use cases.

	• No joint approach • Exchange info	• Exchange info • Common insights	• Joint approach • Common insights • Coordinated services
Situational	CM1	CM3	CM5
Operational			
Tactical	CM2	CM4	CM6
Strategical			

Table 4: Six cooperation model options.

Discussing the cooperation options more in detail resulted in six elaborated cooperation model options – see Table 4.

CM1 & CM2: In both models, only information is exchanged between the partners. What to do with that information is totally up to these stakeholders. They are likely to have more information than before and they can use that to optimise their service.
The difference between CM1 and CM2 is the level of detail of the information that is exchanged: situational & operational (traffic conditions, VMS messages active etc.) versus tactical & strategic ('reduce inflow' tactic is deployed, strategic goals of government etc.).

CM3 & CM4: In both models information is shared, and from that information a common picture of the current or expected situation is derived. Partners have the same 'picture' in front of them, however what they do with this information is for each partner to decide for itself.
The difference between CM3 and CM4 again is the level of detail of the information that is exchanged: situational & operational versus tactical & strategic. An example of CM4 could entail that partners develop common goals and KPIs and individually assess their potential to contribute (impact) to this. This cooperation can also be the basis for an impact driven business model, where partners are incentivised (rewarded) to contribute to commonly agreed goals and KPI's.

CM5 & CM6: In both models information is shared, and from that information a common picture of the current situation is developed. Partners have the same 'picture' in front of them, and in this case, they actually coordinate what actions are taken on both public and private side. The idea is that they can strengthen and complement each other instead of sending contradictory messages. And they can have positive impact on each other's (and/or common) goals and KPIs in a coordinated manner. Also, in this case the cooperation can be translated into an impact driven business model.
Once more, the difference between CM5 and CM6 is the kind of information that is exchanged: situational & operational versus tactical & strategic.

Per pilot design is determined which cooperation model fits best. The outcome is shown in Table 5 below, and is based on balancing ambition, legacy and learning opportunities for the project.

	PS Amsterdam	PS Copenhagen	PS Munich	PS Antwerp
Optimising network traffic flow	CM6	CM3		CM4 and CM1
Smart destination	CM3 and/or CM6	CM3	CM2	
Lane information				CM1
Road works	CM3		CM3	CM3
Environmental / areal info	CM1	CM3		

Table 5: Overview of cooperation models to be tested.

3.4 Intermediary design

The various use cases and coordination models each ask for certain roles to be fulfilled by stakeholders. The project, therefore, explored the options for an 'intermediary': a facilitating actor or function for the interaction between public and private service providers in delivering traffic management services. This enables truly interactive traffic management, the overarching goal of SOCRATES$^{2.0}$. In short, the framework[1] presented the following options for an intermediary:

- No intermediary: Each public or private service provider arranges its own interactions
- Multiple public or private intermediaries: Each public or private service provider can decide which intermediary service to subscribe to
- One intermediary for public service providers: public TMC's align on traffic management measures, while private service providers operate independently
- One intermediary 'trusted party': Each service provider acts as an integrated part of the intermediary (multiple parties (public and private) come together and implement different roles of an intermediary. The resulting services are offered as trusted party services)
- One intermediary 'orchestrator': Each public or private service provider is connected to the intermediary which provides instructions to all services/systems/users.

As a part of defining the pilot designs the partners specified this concept further into tasks and functions, how these could be grouped and how data/information flows should be designed. This enabled the partners to organise more detailed discussion on distribution of roles between types of stakeholders (public authorities, private service providers and others) and how roles can be allocated to the consortium partners.

[1] Report 'Proposed Cooperation Framework and bottlenecks', May 2018, Deliverable Activity 2, SOCRATES2.0.

Intermediary functions
Several intermediary functions were identified and described. Based on needed expertise, different intermediary functions were clustered, resulting in the following four different clusters of intermediary roles:

- Strategy Table
- Network Monitor
- Network Manager
- Assessor

Each of these intermediary roles is described in general terms and is used as a reference for detailed description when applied to specific use cases and cooperation models.

Strategy Table
The Strategy Table is the meeting place (counsel, assembly) to establish and monitor strategic cooperation between public and private parties. It focuses on joint or coordinated approaches for the implementation of use cases and services. Public and private strategic goals and roadmaps are brought to the Strategy Table and through a joint process promising win-win-win business cases are described.
Both individual and common goals are identified and translated into measurable KPIs. Public and private services with potential impact on the KPIs are identified and generally described. The impact of the services to the KPIs is reported regularly to the Strategy Table, allowing an agreed period of time to revise performance and achievement of the individual and collective goals or KPIs. 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.
The Strategy Table is facilitated by a facilitating partner and will have participants with a mandate from the public and private parties they represent.

Network Monitor
The Network Monitor collects data from road authorities and private data providers and determines the common current (and if possible predicted) state for a pre-defined use case related network and indicators. In this process the Network Monitor can perform data handling services such as quality assessment, data completion and fusion of different public and private sources according to use case and business requirements. The Network Monitor distributes the network common state to other intermediary roles and other agreed parties.

Network Manager
The Network Manager combines KPIs (desired state of network) with current (or predicted) network state and defines the problem statement. Furthermore, he identifies potential effective measures to solve the problem based on available public and private services. The Network Manager distributes services requests and receives feedback on the performance of the deployed services and uses it to improve the corresponding scenario.

Assessor
The Assessor collects, validates and reports the impacts (value) of public and private services to the defined KPIs. If defined, the Assessor can also be responsible for implementation and management of a reward system based on the reported impact of services to specific KPIs. The Assessor is most necessary in impact driven cooperation models.

Combinations of cooperation model and intermediary design
The types of and need for intermediary roles is one of the elements to be studied within SOCRATES$^{2.0}$. With this objective in mind it is valuable to experiment different combinations of cooperation models and intermediary roles over the pilot sites and use cases. After all, one of the SOCRATES$^{2.0}$ main learning objectives is to gain insights on how to organise the collaboration between public and private parties, and what key elements are necessary to assure scalability and success of the use cases.

Also, note that not all intermediary roles are necessary in all of the cooperation models. Where the focus of cooperation is based only on the exchange of information (CM1 and CM2) some intermediary roles do not necessarily add value to the use case. For a cooperation based on creating common data insights only (CM3 and CM4) the Network monitor seems necessary and an Assessor would also be beneficial. Also, not each task per role needs to be deployed. The most advanced and complex cooperation models require all four intermediary roles.

Definition	CM1	CM2	CM3	CM4	CM5	CM6
Exchange of situational/operational data	yes	no	yes	no	yes	no
Exchange of tactical/strategic data	no	yes	no	yes	no	yes
Create ONE common truth	no	no	yes	yes	yes	yes
Create ONE common approach	no	no	no	no	yes	yes
Need for a Strategy Table?	no	no	no	no	yes	yes
Need for a Network Monitor?	no	no	yes	yes	yes	yes
Need for a Network Manager?	no	no	no	no	yes	yes
Need for an Assessor?	no*	no*	yes	yes	yes	yes

* Yet to be considered for project evaluation.

Table 6: Characteristics of the different cooperation models.

4. SPECIFICATION OF THE DATA INTERFACE: TMEX

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SOCRATES$^{2.0}$ is based on the strategy as developed by the TM$^{2.0}$ initiative[2]. One of the objectives of SOCRATES$^{2.0}$ is to define a prototype TMex protocol and to test this in a large scale, operational environment. TMex covers all tactical information (including the level of smart routes) to be exchanged between traffic centres and back offices, both for traffic information and for traffic management information. TMex is based on European or regional developed standards based on DATEX II.

The future cooperation framework leads to a new concept and functional design. The concept describes the data driven collaboration function that transforms TM1.0 into TM2.0. All partners identify how they use their (upgraded) products in order to fulfil parts of the value chain within this concept. The outcome is processed in the functional design of the pilots. Based on this, the TMex interface is specified, such that the same interface can and will be used by all partners in the test-site(s). The TMex interface provides the interface between traffic centres and intermediaries and between intermediaries and back offices. TMex' architecture is based on the requirements for data exchange between service providers and traffic centres.

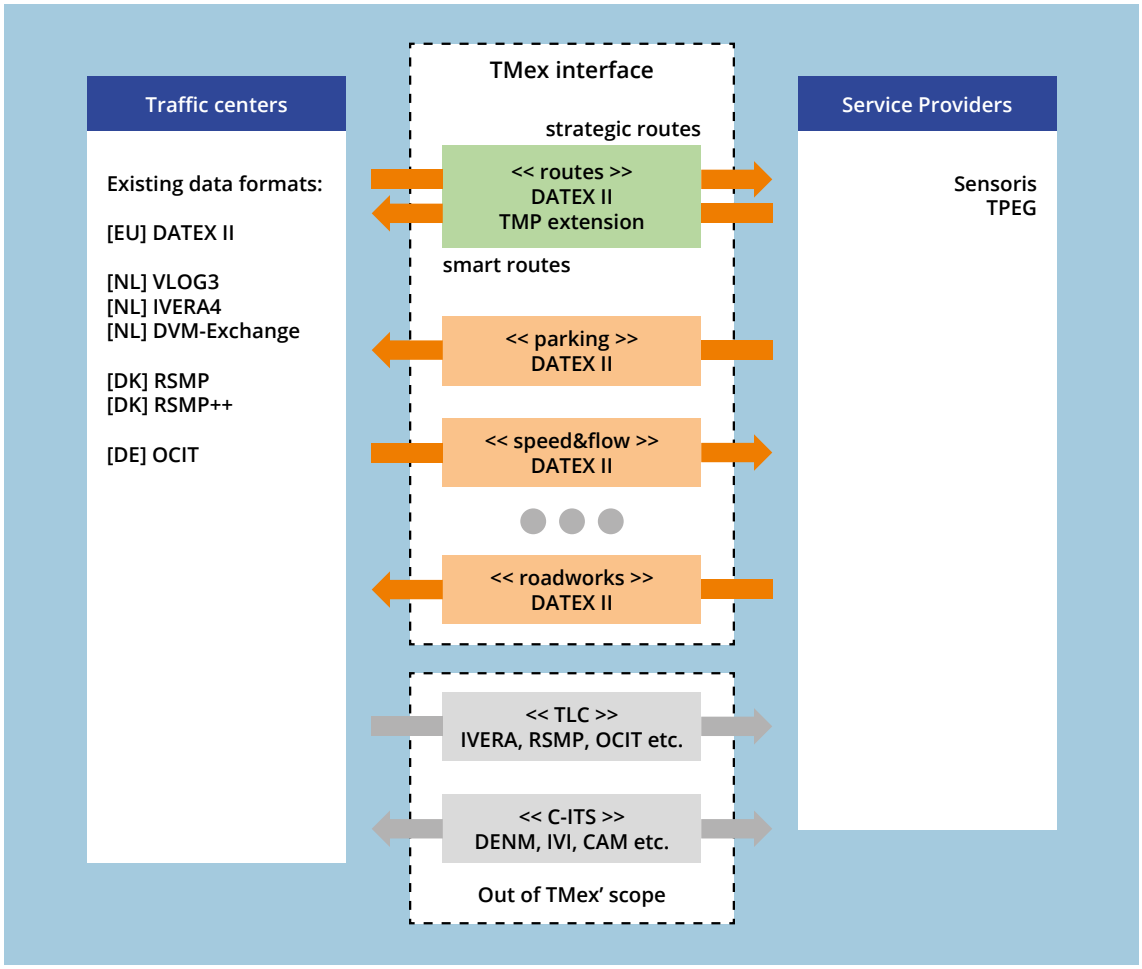

Figure 5: Overall architecture of the TMex interface positioning in the SOCRATES$^{2.0}$ context.

[2] http://tm20.org/

TMex in SOCRATES$^{2.0}$ will be flexible and aligned across the four pilots to make sure that the cross-border interoperability is ensured to allow a future proof implementation. The project will deliver the proposals for the DATEXII standards, new extensions for traffic management plans and new elements in such a way that it can be discussed in the according standardisation bodies in Europe.

Prototype TMex specification

As a part of Activity 3 the project delivered a first TMex specification based on assumptions, ideas and requirements from SOCRATES$^{2.0}$. Also, the project elaborated the steps to take, aimed at actual implementation in order to achieve a final specification.

TMex is not a protocol as such, but a collection of APIs within a catalogue using a standardized approach. The TMex interface is the user shell around the TMex API catalogue and offers the first stop to go when looking for SOCRATES$^{2.0}$ related traffic data and information. The API catalogue shall be a searchable, web-based portal.

We have seen that traffic management plans, routes and geo-fences are missing in DATEX II. Besides the API catalogue and existing DATEX II data formats, within SOCRATES$^{2.0}$ the DATEX II extension for traffic management plans, routes and geo-fencing will be part of the deliverables. The project will take a layered approach to deliver these data formats. The routes are intended to be used for the strategic routes from road authority to service provider and for smart routes from service provider to road authority. These routes form the base for almost all traffic management plans and as no standard has been defined yet, SOCRATES$^{2.0}$ will establish this standard.

The project identified data sources that are part of the use cases and pilot sites and determined what data sources should be handled by TMex and what data sources shouldn't. TMex will cover most of the data exchange requirements within the use cases and pilot sites in SOCRATES$^{2.0}$, however for every situation the data exchange situation and possibilities should be evaluated and the most practicable approach should be chosen. The DATEX II community will be involved in order to get an aligned proposal that covers the SOCRATES$^{2.0}$ requirements and can be used throughout the protocol.

5. PILOT DESIGNS

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5.1 Functional design

A functional design is a detailed description of pilot set-ups. A core element of it is a functional architecture, providing blueprints for the pilot sites to support planning and implementation.

Functional designs were elaborated by individual teams for each pilot deployment. They were asked to describe the designs in a common template, consisting of the following items:

1. Context & Mission of pilot deployment
   1.1 Local context
   1.2 Existing services
   1.3 Available data
   1.4 Problem statement
   1.5 Mission of use case
2. Existing services for pilot deployment
   2.1 Identification of use case levels
   2.2 System overview (including system components & relations)
   2.3 Roles & actors
   2.4 Cooperation model
3. SOCRATES$^{2.0}$ services for pilot deployment
   3.1. System overview (including system components & relations)
   3.2. Cooperation model
   3.3. Roles
   3.4. Intermediary
   3.5. Actors
   3.6. Pre-conditions, post-conditions & sequence diagram

These items were elaborated step-by-step within the individual teams. By reflecting the results in regular meetings with the entire project team, a consistent and a common understanding for each pilot description could be reached, even if all pilot deployments eventually show different characteristics.

Major elements of the functional design descriptions are explained below.

5.2 System overview

One major element of the functional design descriptions was the 'system overview', showing the interactions between the various elements, actors, data streams and interfaces. Usually, two system overviews were created: one for the existing conditions and one for the envisioned pilot design.

An example for such a system overview is shown below, here for the pilot deployment 'Optimising network traffic flow, Amsterdam'.

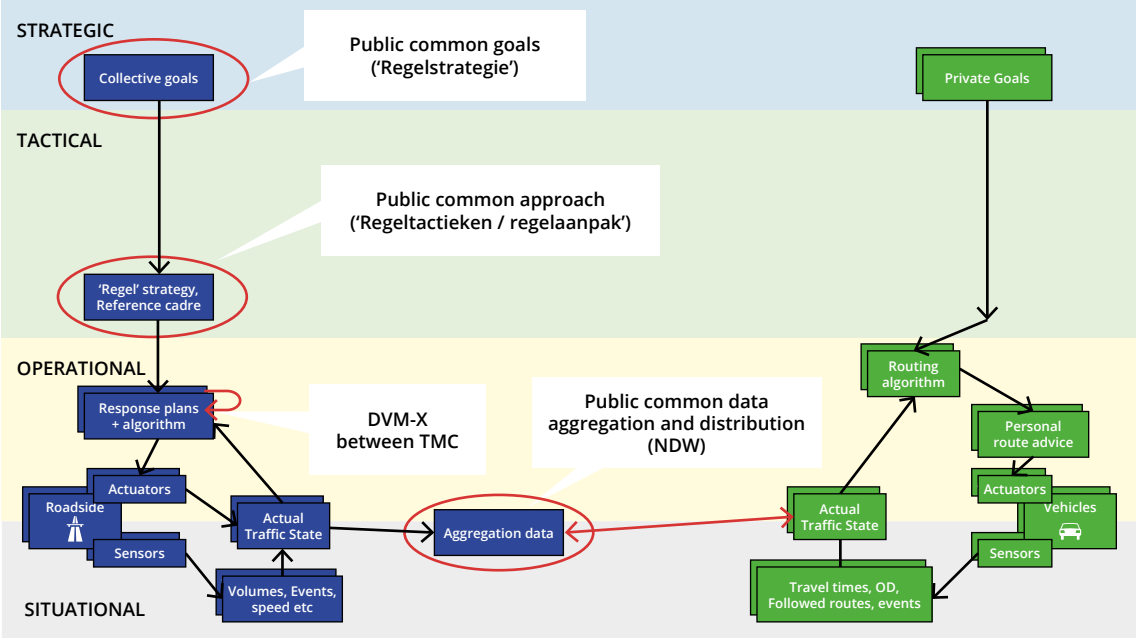

Figure 6: System overview, pilot deployment 'Optimising network traffic flow, Amsterdam', existing conditions.

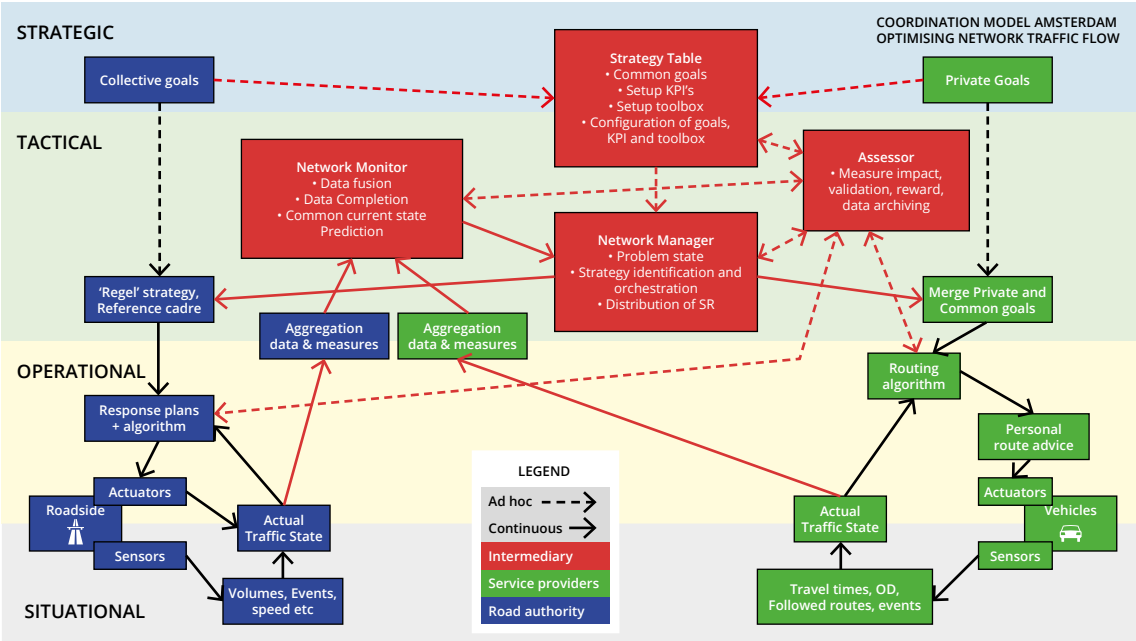

Figure 7: System overview, pilot deployment 'Optimising network traffic flow, Amsterdam', pilot design conditions.

5.3 Description of intermediary roles

Comparing Figures 6 and 7, it is obvious that exchange between road authorities (elements shown in blue) and the service providers (elements shown in green) are mainly facilitated by the intermediary (elements shown in red).

There are four possible roles of the intermediary which have been introduced before:

- Strategy Table
- Network Monitor
- Network Manager
- Assessor

The corresponding roles were further described for each pilot deployment, including aspects for each role such as:

- Assignment of a main partner as a design leader
- Assignment of supporting partners
- Objective
- Approach and timeline
- Interfaces and input/output
- Risks and mitigation

The role descriptions were again documented in common templates, as shown in Figure 8.

Functional Design <<use case>>

<<function>>	**<<part of role>>**
<<responsible partner>>	**<<supporting partner(s)>>**
<<description of function>>	
<<description of interfaces and output/input>> ☐ ☐ ☐	
<<links, mitigation>> ☐ ☐ ☐	
<<timeline, approach>> ☐ ☐ ☐	

Figure 8: Template for description of intermediary roles.

5.4 Partner distribution

As a final step of the pilot design, a final distribution of partners per role and per pilot deployment was agreed upon.

Potential roles include the four intermediary roles (see above) as well as specific actors such as service providers, traffic managers and data providers. These roles are described in Table 7.

Strategy Table	Create win-win-win / Align public and private goals / Define KPI's / Setup toolbox / Monitor (& redefine) strategic goals and KPI's
Network Monitor	Collect aggregated data from public and private data providers / Fuse data / Predict state of the network / Assess data quality / Respect data agreements
Network Manager	Configuration of KPI's / Create problem state / Identify an effective scenario to solve the problem / Send service requests / Evaluate and improve scenario
Assessor	Validate partner impact / Report on impact and KPI / Virtual rewarding / Data archiving
End user Private service provider	Receive and assess service requests / Activate routes / Measure own impact and inform Assessor
Public traffic manager	Receive and assess service requests / Activate routes / Measure own impact and inform Assessor
Data provider	Providing relevant data

Table 7: Description of intermediary roles.

This partner distribution forms the commitment of individual partners when continuing with the realisation of the pilots, as elaborated in Activities 4, 5, 6, and 7.

There are different levels of partner commitments, such as:

- Lead partner: one per role
  - Responsive to the role
  - Specify / organise the role
  - Monitor timely performance of all tasks
  - Contact for transition manager
  - Perform one or more tasks
- Supporting partner:
  - Support the lead in specifying and organising the role
  - Perform one or more tasks
- Participating partner:
  - Perform one or more specific tasks within a role

The partner distributions were again documented in common templates, as shown below.

Role	Lead	Supporting	Parcticipating
Strategy Table			
Network Monitor			
Network Manager			
Assessor			
Role	Participating Partners		
End user Private SP's			
Public RA's			
Data Provider			

Table 8: Template for partner participation per pilot deployment.

5.5 Factsheets on the pilot designs

Essential information on the design of each pilot deployment in SOCRATES$^{2.0}$ has been compiled as factsheets, and are available as a seperate annex of this report. The factsheets reflect the following:

- What problem is addressed with this use case?
- When will this use case be successful? What goals do we want to achieve?
- Expected win-win-win
- What cooperation model is being tested?
- What intermediary roles are defined?
- How does the service work?
- End user services will be provided by ...

6. EVALUATION

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6.1 Ex-ante evaluation

The project plan agreed upon the accomplishment of an ex-ante evaluation. This ex-ante evaluation aims to concretise the results formulated by the partners. The ex-ante evaluation can also be used as a framework for the evaluation of the SOCRATES$^{2.0}$ pilots.

The ex-ante evaluation was carried out in two steps. In the first step, the evaluation framework defines the aspects to research. Possible research questions that were formulated in different documents, were collected and sorted in the updated framework. In the second step, each of the research aspects is elaborated and the upfront expectations (expected outcomes/effects) are presented.

As the necessary plans for the pilot sites were still being developed (among others the selection of use cases), some upfront expectations are formulated in terms of 'insight into …' (qualitative description). The ex-ante evaluation will not extendedly elaborate on the research aspect 'technical conduct' because this aspect is in principal up to the service providers. Furthermore, this evaluation does not include expected outcomes / effects on the safety of road users in relation to the use of devices while driving.

The evaluation framework exists of six research aspects, as shown in Figure 9.

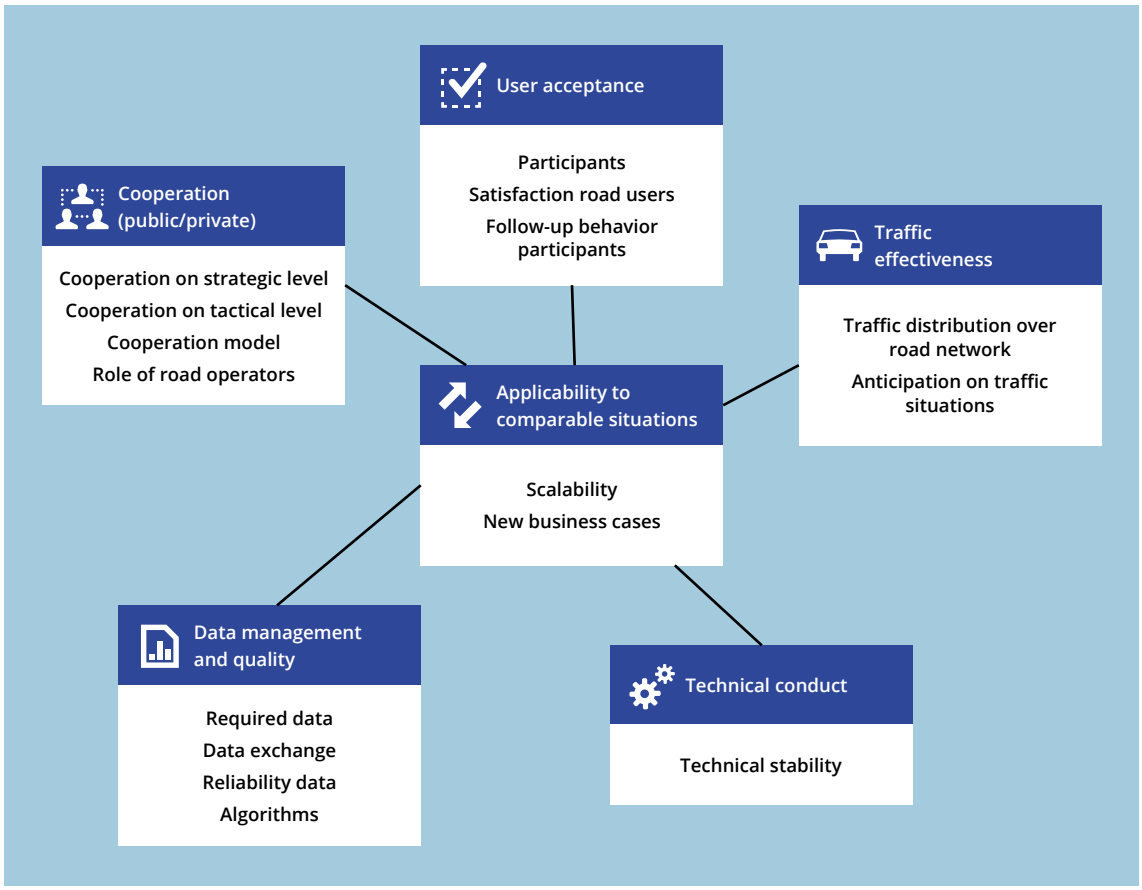


Figure 9: Evaluation framework SOCRATES$^{2.0}$.

In Activity 2, the partners of SOCRATES$^{2.0}$ assembled a shared vision on interactive traffic management. The shared vision provides the main objectives, key research questions and leading principles on a strategic level. The vision elaborates along four elements and gives guidance to define use cases and the scope of tests to be performed at the various pilot sites. The four elements are (1) the customer; (2) community; (3) technology; and (4) cooperation.

The ex-ante evaluation focusses on the four elements with the following research aspects. The ex-ante research questions are connected with the use cases and four elements of SOCRATES$^{2.0}$. The findings of the evaluation will be elaborated from the perspective of the goals of SOCRATES$^{2.0}$ and will provide an answer if the objectives are achieved and to what extent.

The four elements of SOCRATES$^{2.0}$	**Ex-ante research aspects**
Customer	User acceptance (Participants - Satisfaction road users - Follow-up behaviour participants).
Community	Traffic effectiveness (Traffic distribution over road network - Anticipation on traffic situations).
Technology	This is mostly the necessary intermediary technology (Fusion, completion, prediction, cop, service request management). Technical applicability and scalability of the complete chain of the cooperation framework. Data management and quality (Required data/available data - Data exchange, also TMex - Reliability data - Algorithms, fusion, completion, prediction).
Cooperation	Cooperation between governments and private parties (Cooperation on strategic level- Cooperation on tactical level - Cooperation model - Role of road operators). This is mostly the necessary intermediary functions and responsibilities and deriving win-win-win. Applicability to comparable situations (Scalability - New business cases).

Table 9: SOCRATES$^{2.0}$ elements and evaluation research aspects.

6.2 Evaluation approach

Goal of the evaluation is to provide answers to the evaluation/research questions by means of collecting, analysing and evaluating measured data. And it will provide proof of the actual operators of the SOCRATES$^{2.0}$ concept. The ex-post results are compared with the expectations from the ex-ante to judge the actual performance and impact against the expected one'.

The project evaluates the results and learning experiences in four pilot sites and for different use cases. To gain in-depth learning experiences and underpin statements, a comparison analysis is executed between the four pilot sites and different use-cases (cross pilot level).

The project considers a flexible research approach as essential, because the evaluation depends on various choices within the development process. Such as the design of the four pilots and use cases, the selection of participants, the logging of data, the choice of cooperation model, etc.

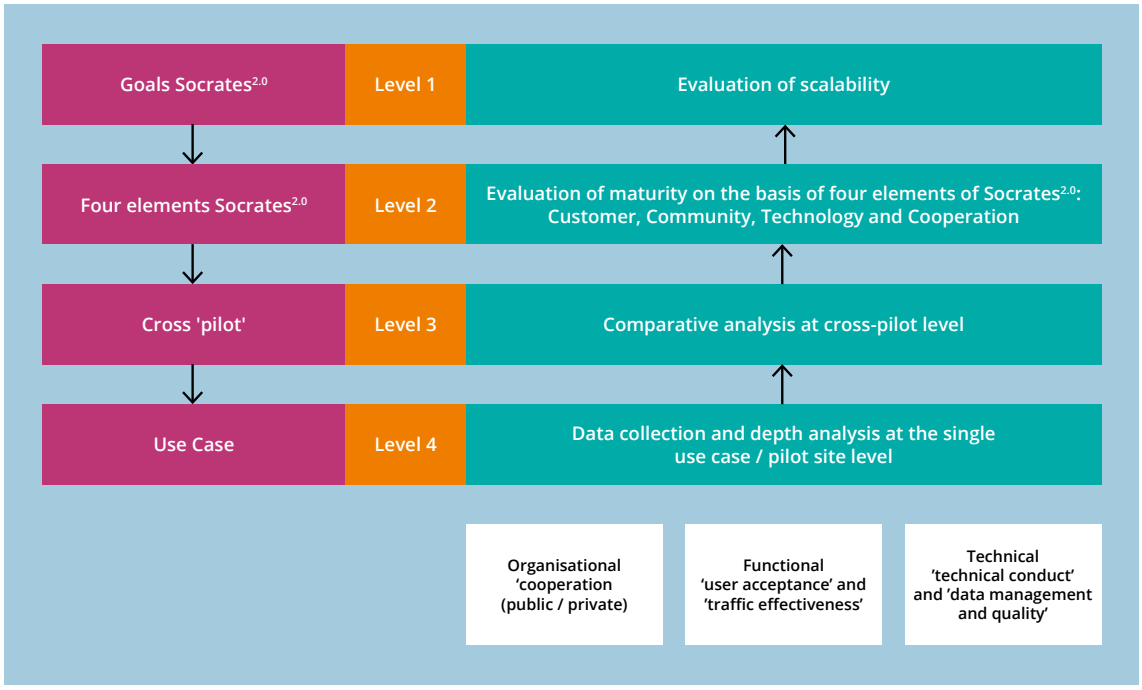


Figure 10: SOCRATES$^{2.0}$ evaluation principles.

The performance measured on organisational, functional and technical level will be combined in a synthesis to allow these individual performance analyses to learn from each other. This means that the results of the performances are the basis level of evaluation done. Within the synthesis these results will be connected together and thus allow us to look at what SOCRATES$^{2.0}$ has realised, how much of the set objectives and goals have been met as well as answering the questions mentioned below.

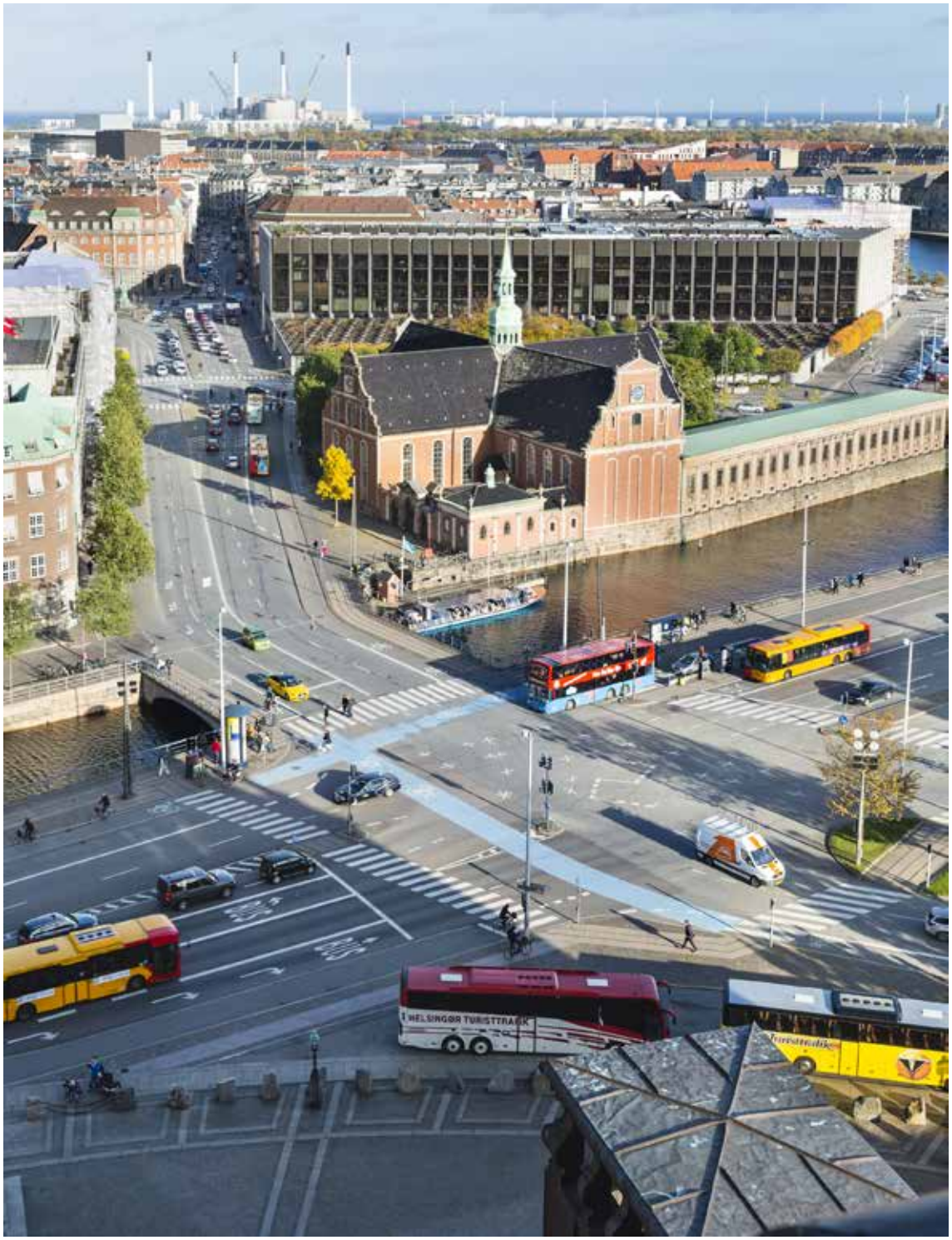
For this synthesis step we will built on the following aspects as explained in Figure 10.

- **Level 1:** This level is based on the two overarching goals from SOCRATES$^{2.0}$ that will be reported upon.

  Goal 1: *To design, operate and evaluate new and extended traffic management measures and mobile/in-car services for road users; based on a close cooperation of road authorities, service providers and car industries.*
  Goal 2: *To design, operate and evaluate a cooperation framework (at strategic, tactical and operational level) for interactive traffic management by road authorities, service providers and car industries.*

- **Level 2:** Following these goals we will evaluate the maturity of the four elements from SOCRATES$^{2.0}$ as defined in the Socrates Vision, Activity 2.
- **Level 3:** A comparative analysis at cross-pilot level.
- **Level 4:** This is the use case level per pilot – where most of the performance results will be used directly. This will be related to the goal of the use cases in the pilot sites as well as the stated success factors.

7. CONCLUSION



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7.1 What has been achieved in Activity 3?

Based on the common 'Framework for cooperation in traffic management', defined in Activity 2, the common approach was specified for the four pilots in Activity 3. This included an explicit concept for interactive traffic management on a tactical level, eventually resulting in functional designs for each envisioned pilot site and use case.

Besides the (functional) designs of the pilot sites, Activity 3 also resulted in presenting a progressive guideline for stakeholders engaged in (similar) deployment projects for interactive traffic management.

To realise the pilot designs dedicated Focus Groups were established that elaborated on some organisational, functional and technical aspects, touching on the roles of partners and their products and services. The Focus Group(s) also elaborated on the interfaces between those products and services. As an outcome from the mentioned Focus Groups, some sub-steps could be identified when it comes to preparing pilot deployments. The sub-steps form the milestones of the aforementioned guideline. The concept of this guideline is shown in the figure below.

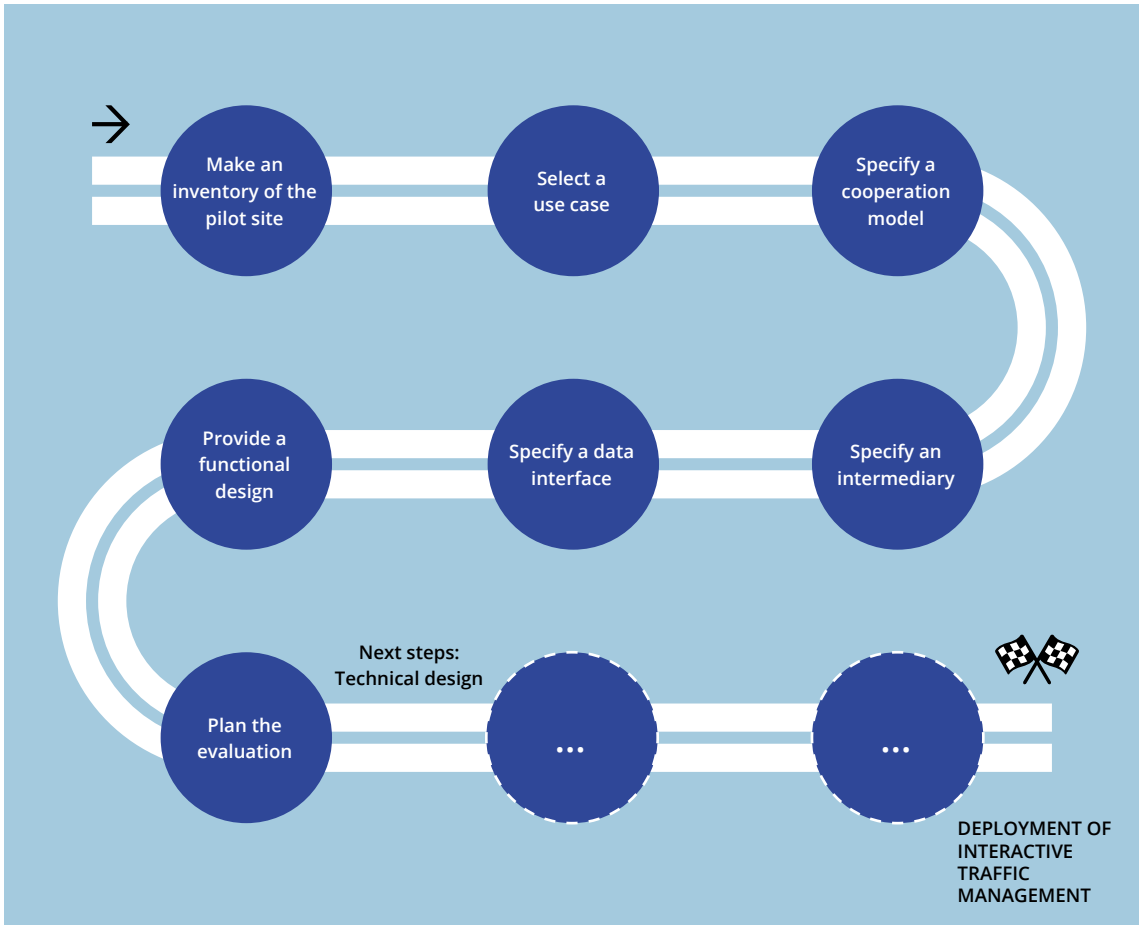

Figure 11: Preliminary step-by-step plan to the deployment of interactive traffic management.

7.2 Recommendations and learnings on specific elements of Activity 3

We believe that the approach taken in Activity 3 is a role-model when preparing deployment projects for interactive traffic management, not only in SOCRATES$^{2.0}$. The processes and outcomes described in the previous chapters form the milestones of a guideline, which will lead to successful deployment of interactive traffic management.

In SOCRATES$^{2.0}$ there will be many pilot deployments, which all have different characteristics. On the other hand, a common framework and approach behind each pilot will help find some consistency and comparability among all deployments, eventually also supporting interoperability and scalability.

In the work of Activity 3, some elements have been specified to establish such a common approach. Looking at these elements, the following success factors and recommendations were identified:

Coordination models

As introduced in Activity 2, cooperation models describe the level and intensity of cooperation of different partners. Based on partner inputs and pilot site conditions, the cooperation models have been elaborated in more detail and clustered in six types of models.

This way it was possible to find a common understanding on the preconditions and impacts of each cooperation model. The cooperation models have been described in a universal way, allowing to adopt them in any deployment environment.

In the present stage of SOCRATES$^{2.0}$, it was important to finally decide which cooperation model will be applied per deployment, and to prepare the partners to take on corresponding roles within the chosen cooperation context.

As an important learning from the pilot deployments, we would like to explore how the different cooperation models work out in practice, and which models meet the overarching goals best.

Intermediary

Intermediaries are the prerequisite to facilitate the envisioned data cooperation, building a data bridge between road authorities and the service providers, and being integrated into data eco-systems which are already in place.

Activity 2 has already laid out some basic concepts for Intermediaries. Based on this, Activity 3 was able to deepen and expand on the functionalities of an Intermediary. In particular, different options how to place the Intermediary within an existing data eco-system, as well as potential roles of an Intermediary have been defined.

These definitions are also described in a universal way, to be potentially re-used in other deployment environments.

As for the cooperation models, we expect to learn from the pilot deployments, how the different Intermediary types work out in practice.

As each Intermediary type has a different impact on the cooperation, it is essential to relate the choice of an Intermediary type to the choice of cooperation models and use cases.

Eventually, for each deployment within SOCRATES$^{2.0}$, a relation of a specific uses case, cooperation model and intermediary type needs to be defined.[3] Such relations are fundamental decisions of Activity 3, setting the tactical stage for the upcoming pilot realisations.

TMex

We expect that big amounts of data of different kind will be exchanged within the pilot deployments. To handle that exchange in an efficient and interoperable manner, a commonly agreed data exchange concept seems to be promising.

In SOCRATES$^{2.0}$, the TMex concept was developed for this reason. TMex describes exchange concepts regarding data interfaces, data protocols and data platforms. These concepts should be applied for all deployments, regardless their specific data environments.

Of course, the concrete data eco-systems will be defined by each deployment individually. However, TMex is understood as a minimum, overarching solution, which is adoptable and expandable to any deployment. This way, the TMex approach will allow scalability and transferability, also beyond the SOCRATES$^{2.0}$ project.

An important aspect of TMex at this stage is to allow flexibility for different data domains and to different data actors. An important building block for this is the TMex API catalogue, which can be seen as a modular system, providing a 'single access point' for relevant data sets.

Another important aspect is to build on existing approaches, such as DATEX II, to avoid 're-inventing the wheel'.

Pilot designs

As the pilot deployments are expected to be realised and tested very soon, the pilot designs of Activity 3 aimed to provide a good starting point to build on during the subsequent Activities 4, 5, 6, and 7.

This way, each pilot team is provided with a basic design to be further elaborated in their individual pilot settings. In particular, the provided functional designs will be translated into a complete architecture (information, application and technical architecture).

[3] In the internal SOCRATES$^{2.0}$ wording, each deployment was named as 'Use Case/Cooperation Model/Intermediary combination'.

One important feature of the presented pilot designs are the 'system overviews', elaborated for each pilot deployment and showing the interactions between the various elements, actors, data streams and interfaces. As basic structures of the pilots are defined here, the pilot teams can quickly start to detail and to implement the individual elements.

At the present stage of SOCRATES$^{2.0}$, it was important to specify the pilot details in a sufficient, but not too extensive manner:

- The basic design elements, such as the mentioned system overviews, should make sure that the underlying tactical decisions (e.g. on the Cooperation Models) are reflected well in a technical context. Further, a common understanding on potential functions and roles among project partners is supported this way.
- On the other hand, the presented design elements allow enough room for specifications to be made in the individual pilot settings.

Another prerequisite is to assign specific partners to different responsibilities and roles of the upcoming pilots. This way, the coordination tasks of the individual pilots will be eased by already having clear partner commitments and organisational structures.

7.3 What's new in the pilot designs?

In short, we can summarize the new elements in the pilot designs as follows:

- Sharing public & private strategy and goals, common KPI's (Strategy Table)
- Exchanging public & private data and information (Network Monitor)
- A joint 'current (and predicted) state' on the network (Network Monitor)
- A joint 'current state' on roadworks (user feedback and service provider data is fused with roadworks information from the road authority) (Network Monitor)
- Public / private network management (Network Manager)
- Request for network management services to service providers (Network Manager)
- Looking for an 'impact driven' business model (Assessor)

7.4 Recommendations and learnings from the approach

There are also some recommendations on the general approach. A basic concept was to combine the technical design work (in individual teams) with an overarching support of all partners (by providing harmonized tools and enabling regular exchange). As a result, our approach was based on the following success factors and recommendations:

- As the topics may become quite complex, it is useful to break down the approach into sub-steps. In SOCRATES$^{2.0}$, focus groups were installed and various sub-deliverables were produced, which in total form the 'big picture'.

- To reach the final designs, a step-by-step and iterative elaboration is recommended. This way, there is an evolution from 'rough' to 'detailed', allowing some flexibility and agility during the design process.
- To achieve a consensus on high-level agreements (e.g. on a suitable cooperation model), parallel top-down and bottom-up approaches seem promising, taking into account both overarching and individual perspectives.
- A harmonized approach to describe the pilot set-ups will help to find consistency and a common understanding on the approach. To support this, general templates to gather information (e.g. functional design templates) and a common wording to describe certain aspects (e.g. for the intermediary roles) were used. In a later stage, these general descriptions can be further detailed when applied to specific deployments.
- Even if a harmonised design approach is recommended across all pilots, it is still crucial to consider and respect local conditions as well as individual perspectives of partners. This has been achieved by an initial pilot site inventory and reflected as a pre-condition for each pilot design.
- Many details were elaborated in individual groups for each pilot deployment. However, regular reflection of the results with the entire project team is helpful, to track the individual progress and to learn from each other's experiences.
- Finally, regular exchange with the overarching project structure (Project Management Meetings, Steering Group meetings) helps to make sure that common project goals are met during the Activity runtime.

7.5 Next steps: technical design and validation of the pilot designs

Now that the pilot designs are ready, the next step in the SOCRATES$^{2.0}$ project is to validate the pilot designs in the four pilot sites Amsterdam, Antwerp, Copenhagen and Munich (Activity 4, 5, 6, and 7). To do so, the functional designs need to be translated into technical designs and (changes to the) sub-systems need to be realised. Activity 4, 5, 6, and 7 will also involve the recruitment of beta users, who will use the modified end-user application. The pilot designs will be evaluated in Activity 8. The results will be used to update the framework and complete the guideline (Activity 9).

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