Conférence Européenne
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ANACONDA

Results from the stakeholder requirements analysis

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Author(s) this deliverable:

Isabela Mocanu, AIT Austrian Institute of Technology, Austria

Philippe Nitsche, AIT Austrian Institute of Technology, Austria

Simon Ball, Transport Research Laboratory, UK

Jean Hopkins, Transport Research Laboratory, UK

Kerry Malone, TNO, the Netherlands

Aroen Soekroella, TNO, the Netherlands

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Executive summary

Cooperative Intelligent Transport Systems (C-ITS) share information and data using either Vehicle to Infrastructure (V2I) and/or Vehicle to Vehicle (V2V) communication. The systems can provide advice, warnings or take actions with the objective of improving safety, sustainability, efficiency and comfort, thus contributing to a road authority's objectives. However, to keep up with the fast development of C-ITS, road authorities are confronted with various challenges, such as determining the role that the road authority must play in the interaction between automotive manufacturers and information providers, investing in a cost-beneficial way in roadside infrastructure to support the information provision between vehicles and infrastructure and positioning of road authorities across CEDR countries towards C-ITS and others.

The "Assessment of user Needs for Adapting COBRA including ONline DAtabase" (ANACONDA) project builds on the success of the previous COBRA project and aims to position COBRA+ as the default tool for decision-making support for deployment of C-ITS (Cooperative Intelligent Transport Systems) for National Road Authorities (NRAs). The COBRA+ tool builds on the strengths of the original COBRA tool. COBRA is a decision support tool in the form of a spreadsheet that enables NRAs to compare the costs and monetised benefits of cooperative systems (CS) in various contexts to support investment decisions under different deployment scenarios. The new COBRA+ tool will be enhanced with new functionalities, greater geographic coverage and more flexibility and therefore updated to meet the requirements of users who, having made use of the COBRA tool, have a clear idea of what may be improved and enhanced.

This deliverable presents the approach taken in ANACONDA for assessing the user requirements for the COBRA+ tool, as well as for an additional online tool that will be developed within the project: the COBRA+ Monitor. In addition, an initial list of use cases for potential implementation in the COBRA+ tool is also described. A starting stage in developing the user requirements involved a stakeholder workshop with representatives of the NRAs and the Amsterdam Group held in November 2015. Further consultations were held through surveys and additional meetings with members of the PEB and of the CEDR ITS Group.

Based on the results of the workshop, for the COBRA+ tool, a four-step process was undertaken for obtaining the user requirements that involved classification and prioritisation of requirements, as well as an evaluation of the feasibility of implementation. This resulted in 35 user requirements for the COBRA+ tool that were categorised as:

- "Must haves" refers to the user requirements that were deemed the most important to the successful development and acceptance of the COBRA+ tool;
- "Nice to haves" refers to the user requirements that although somewhat important, they are either too difficult to implement or not critical to the success of the tool; or
- "Not feasible within this project" refers to the user requirements that are either too difficult to implement or outside of the scope of this project.

Following additional rounds of feedback, 24 user requirements were classified as "must haves" and will be implemented in the COBRA+ tool. The list includes updating the cooperative services and bundles, adding more countries, extending the road network in the model, increasing the tool flexibility, optimising the outputs, updating the assumptions of communication platforms and many others.

Similarly, based on the consultations with the project stakeholders and their requirements, a proposal was developed for the COBRA+ Monitor. The COBRA+ Monitor is intended to

monitor the use of ITS and deployment of C-ITS by users of COBRA+ and will have the structure of a website providing information on the C-ITS deployments being considered in the areas covered by the COBRA+ tool:

- The COBRA+ Monitor is intended to monitor: plans for deployment of C-ITS; implementations of C-ITS; impacts of C-ITS; and use of the COBRA+ tool.
- It should promote information sharing between countries to learn from each other.

Lastly, an initial list of potential use cases considered for implementation in the COBRA+ tool was developed, through the stakeholder consultations. The use cases correspond to corridors or parts of the European road network that have been committed to deployment of cooperative ITS services. More European corridor projects are active than the number of use cases that will be analysed in detail in ANACONDA. Therefore, a choice of use cases will take place. The use cases currently under consideration are:

- NordicWay – a pilot project for deployment of C-ITS on a road corridor through Finland, Norway, Sweden and Denmark;
- UK Corridor London-Dover – a project for deployment of C-ITS on the A2/M2 road corridor between London and Dover;
- C-ITS Corridor Rotterdam-Vienna – a project for the introduction of C-ITS on a road corridor between Rotterdam, Frankfurt/M. and Vienna; and
- SCOOP@F – a pilot project for the deployment of C-ITS at five specific sites with different types of roads: Ile de France, “East Corridor” between Paris and Strasbourg, Brittany, Bordeaux and Isère.

The next steps include the development of COBRA+, the COBRA+ Monitor and further specification of the use cases. As stakeholder involvement is paramount to the success of the project, a second ANACONDA workshop will be held in May 2016, where draft versions of the tools will be presented to national road authorities and other relevant stakeholders.

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1 Introduction

The trans-national research programme "**Call 2014: Mobility and ITS**" was launched by the Conference of European Directors of Roads (CEDR). CEDR is an organisation which brings together the road directors of 25 European countries. The aim of CEDR is to contribute to the development of road engineering as part of an integrated transport system under the social, economic and environmental aspects of sustainability and to promote co-operation between the National Road Administrations (NRAs). The Mobility and ITS call has three sub-themes, one of which is, "The business case for connected and co-operative vehicles". The ANACONDA project falls into this theme.

The ANACONDA project builds on the COBRA (COoperative Benefits for Road Authorities) project which developed the spreadsheet-based COBRA tool for NRAs to use to examine the business case for deployment of Cooperative Intelligent Transport Systems on their roads. The ANACONDA consortium will continue this support to NRAs by:

- Extending the number of countries, functionality and C-ITS covered by the original COBRA tool
- Assisting CEDR countries in the preparation and use of updated tool, COBRA+
- Developing the COBRA+ Monitor, an online tool for the monitoring of C-ITS implementations by CEDR members
- Developing a roadmap for transition to C-ITS-equipped motorways.

The ANACONDA project builds on previous work performed by the consortium which developed and built the original COBRA tool, which included investigation of impacts, deployment issues and modelling.

This report presents the user requirements for the new COBRA+ tool and the COBRA+ Monitor, as well as the potential use cases that will be investigated with the tool. The requirements were collected through various methods that included a stakeholder workshop with NRAs of the Netherlands, Belgium, Austria, England and Germany, as well as complementary face-to-face discussions and surveys.

After a step-wise process that included classification, prioritisation, feasibility assessments and additional consultations with selected stakeholders, the final list of user requirements that will be implemented into the COBRA+ tool was reached. Similarly, a set of initial requirements collected for the COBRA+ Monitor resulted in an updated proposal for the structure of the COBRA+ Monitor. Using the input from the first stakeholder workshop, an initial analysis of use cases, the services they encompass and the proposed network for deployment are examined.

The deliverable starts with a description of the multi-step process of attaining the final list of user requirements that will be implemented into the COBRA+ tool. Chapter 3 describes the requirements for the COBRA+ Monitor and the proposed structure of this online tool. Chapter 4 presents an initial analysis of the use cases to be investigated, while Chapter 5 describes the next steps planned in the project.

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2 User requirements for the COBRA+ tool

2.1 Introduction

COBRA+ aims to become the default tool for decision-making support for deployment of vehicle to infrastructure C-ITS systems, encouraging and facilitating national road authorities to get more value from cooperative systems (C-ITS).

The COBRA+ tool builds on the strengths of the original COBRA tool. COBRA is a decision support tool in the form of a spreadsheet that enables NRAs to compare the costs and monetised benefits of C-ITS in various contexts to support investment decisions under different deployment scenarios. COBRA+ will be enhanced with new functionalities, greater geographic coverage and more flexibility and therefore updated to meet the requirements of users who, having made use of the COBRA tool, have a clear idea of what more is needed in the decision-support tool.

This chapter describes the procedure of obtaining the user requirements for the COBRA+ tool, as well as presenting the final list of requirements that will be implemented later in the project.

2.2 Methodology

The methodology to obtain the user requirements consisted of four main steps, as illustrated in Figure 1. The first step was the process of collection of requirements, which was performed through the organisation of a workshop, as well as a survey, where representatives of National Road Authorities (NRAs) and other experts (i.e. members of the Amsterdam Group) participated. The second step was the grouping of the requirements into distinct classes or categories, e.g. usability, data etc. As the workshop generated ample feedback and input that was translated into user requirements, the third step consisted of a prioritisation exercise, in which the requirements were rated according to several criterion. Finally, a feasibility analysis, in which each requirement was evaluated in terms of feasibility of implementation, was performed. This last step was conducted in order to take into account the time and resource limitations existing in the project. The list of classified and ranked requirements was also presented to the project officer, the members of the PEB and of the CEDR ITS Group for feedback and approval.

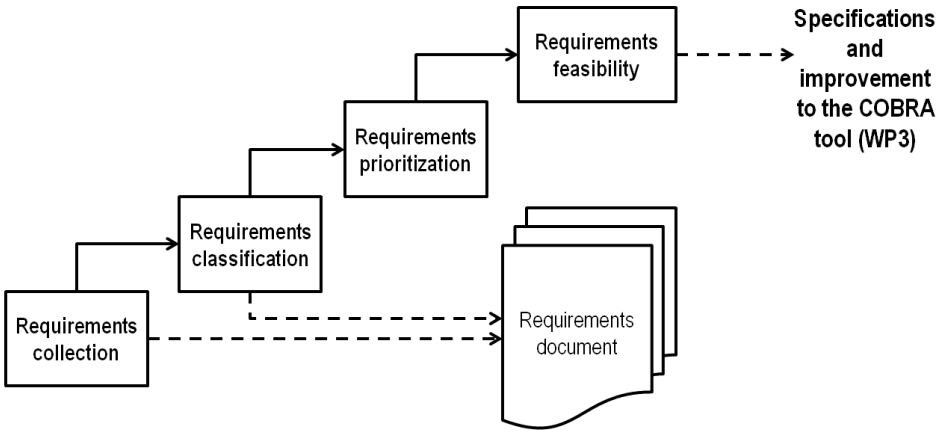

Figure 1 Methodology of user requirements analysis

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2.3 Requirements collection

The collection of user requirements was performed by means of a stakeholder workshop, where National Road Authority (NRA) representatives and members of the Amsterdam Group were invited to view the current version of the COBRA tool and provide feedback. A list of the participants is included in 7. The aim was to demonstrate the current status of the tool and to investigate their needs and requirements for the tool's adaptation. The participants were divided into two working groups and their inputs were collected, in order to identify:

- What are the current opinions on the tool? (e.g. ease of use, list of C-ITS services, list of bundles, benefits, communication platforms, etc);
- What requests for tool adaptations do they have? (e.g. country-specific priorities and strategies, infrastructure requirements, additional cooperative services / bundles of interest, technology choice, etc); and
- What are the general limitations of the tool as experienced by the users?

As not all participants were experienced users of the COBRA tool, the workshop started with a presentation of the current version of the tool. The participants then had the opportunity to express their first impressions. The topics initially brought forth in the workshop were new potential Vehicle to infrastructure (V2I) bundles and services, the user interface, the outputs of the COBRA tool and increased functionality. This was followed by a more interactive discussion on the needs and requirements, in which the workshop participants were split into two working groups.

In addition, a more detailed understanding of the COBRA+ Monitor, as well as the use cases to be investigated in the project were discussed. A lively debate and discussion showed the necessity for the active involvement of NRAs in the development and activities of the ANACONDA project. Chapter 3 and Chapter 4 present the findings on the COBRA+ Monitor and the use cases, respectively.

The user needs and requirements were collected by means of notes and minutes and presented briefly at the end of the workshop.

After the workshop, an initial grouping and filtering of the requirements for the COBRA+ tool was conducted by the project consortium. Different requirements were clustered into one when the requirements were similar or would yield the same result. A small number of requirements were excluded as they were outside the project scope.

2.4 Requirements classification

The next step of the requirements analysis for the COBRA+ tool was the classification step, in which the collected requirements were grouped into five distinct classes. Figure 2 shows the different classes that were defined for the COBRA+ requirements. A complete list of the classified requirements can be found in 8.

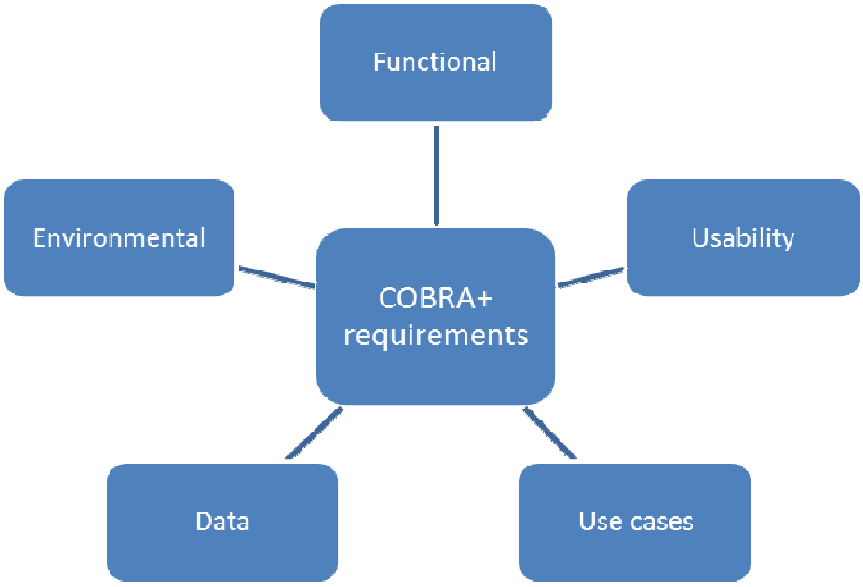

Figure 2 Classes of COBRA+ user requirements

Functional requirements

This group of requirements comprises statements of basic functions that the system should provide, how the system should react to particular inputs and how the system should behave in particular situations. Functional requirements may be calculations, technical details, data manipulation and processing and other specific functionality that define what a system is intended to accomplish. The system in this case is the COBRA+ tool.

Usability requirements

Usability is a non-functional requirement, i.e. a quality attribute, how the functional requirements are presented or visualised to the user. A system can have adequate functionality, but inadequate usability because it is too difficult to use. The purpose of usability requirements is to guard against that.

Data requirements

Data requirements help the COBRA+ developers understand how data will be gathered and used, so that they can plan and build a database with functionality that supports the information flow. Moreover, new data required to be collected should be identified, including national data, information on existing C-ITS and road infrastructure or forecast data e.g. on penetration of technology.

Environmental requirements

Environmental requirements specify the environments in which the system is expected to operate in an effective manner. Examples for environmental requirements are the operating systems under which the COBRA+ tool must function, which hardware and interfaces it must be prepared for, who accesses or administers the tool, or if there is an online connection required etc. It must be noted that no environmental requirements were collected during the workshop. Nevertheless, the COBRA+ user guide will specify the environmental conditions under which the tool would function optimally.

Use cases requirements

Use cases requirements define how to meet the physical and cognitive needs of the intended

users of COBRA+[1]. Users should be able to comfortably and effectively use the tool to accomplish the goals that it has been designed to support. By defining who will be using the tool interface and the environment in which it will be used, use cases requirements can be specified. The tool's functionality and usability might differ among use cases. Hence, the need to investigate the use cases to understand what is needed for tool functionality, usability and data needs.

2.5 Requirements prioritisation and implementation feasibility

The next step in reaching the final list of requirements for the COBRA+ tool was multi-step and included a prioritisation exercise that was performed with regard to importance versus difficulty of the requirements. The consortium carried out an implementation feasibility assessment in which the requirements were investigated through an estimation of the resources and data sources needed for implementation.

The prioritisation exercise was conducted by rating the importance and difficulty of each collected requirement, on a scale of 1 to 5. For rating the importance, the scale ranged from 1 – "not at all important" to 5 – "extremely important". Similarly, the difficulty scale ranged from 1 – "no difficulty" to 5 – "extremely difficult".

Assessing the feasibility of implementation of each requirement meant performing an expert estimation of the resources needed (i.e. number of hours) as well as the input necessary (e.g. data from stakeholders, etc.). The results of the exercise can be observed in the last two columns of Table 1.

Furthermore, a more detailed understanding and description of each requirement was undertaken to help in the selection. This resulted in a list of user requirements that were categorised as "must have", "nice to have" and "not feasible within this project".

- "Must have" refers to the user requirements that were deemed the most important to the successful development and acceptance of the COBRA+ tool;
- "Nice to have" refers to the user requirements that although somewhat important, they are either too difficult to implement or not critical to the success of the tool; or
- "Not feasible within this project" refers to the user requirements that are either too difficult to implement or outside of the scope of this project.

The results of these two assessment exercises can be observed in Figure 3. In the graph, each numbered point represents a specific user requirement. The "must have", "nice to have" and "not feasible within this project" requirements are highlighted green, amber and red, respectively. Table 1, Table 2 and Table 3 identify all the requirements by number.

To ensure the end user acceptance of the COBRA+ tool, the three lists of requirements were subjected to an additional round of consultations that included the Project Officer, various PEB members and the CEDR ITS Group members. Their feedback and inputs were taken into account and the assessment was revised, providing the final lists.

Table 1 presents the final list of 24 "must have" user requirements that will be implemented in the new COBRA+ tool. It must be noted that while the initial assessment yielded that all these requirements will be implemented, although the consortium will endeavour to do so, the successful implementation of all of them cannot be guaranteed. Table 2 and Table 3 present the list of requirements that were assessed as "nice to have" and "not feasible within

[1] NB The terminology 'use cases' has a different meaning here in this context to that as in Section 4

this project". The requirements in Table 2 and Table 3 will not be implemented in this project, although the model will be developed flexibly in order to accommodate their implementation in the future.

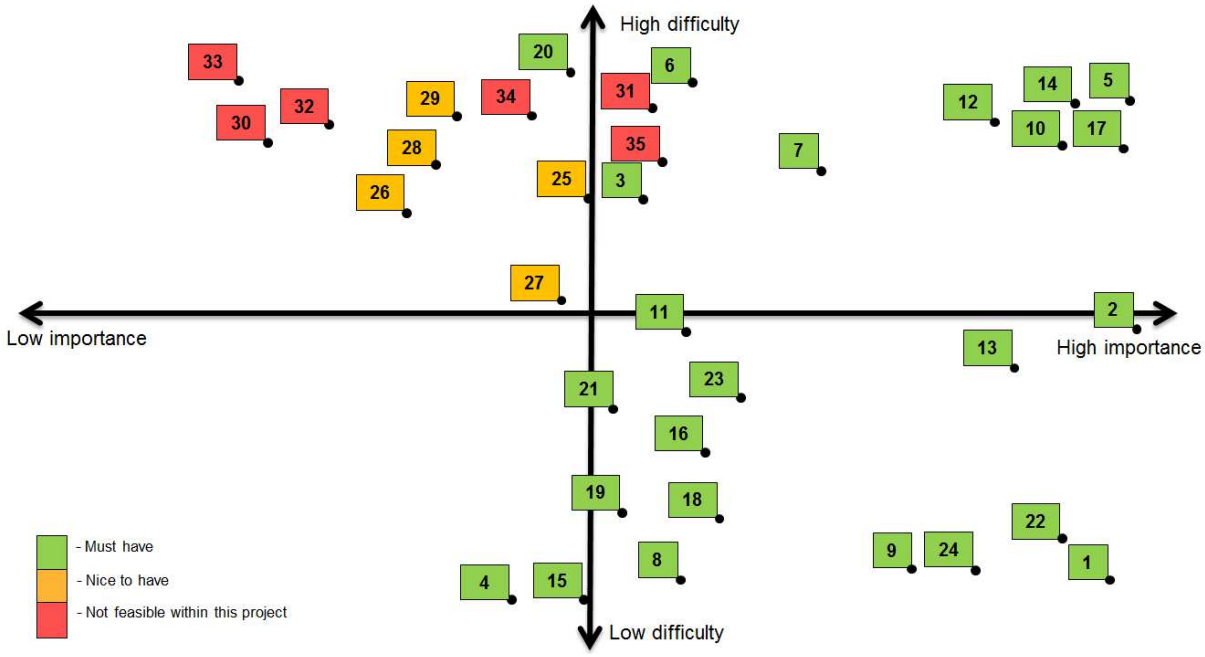

Figure 3 Feasibility assessment of COBRA+ user requirements

Table 1 "Must have" – requirements for the COBRA+ tool

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
1	Bundles	Functional	The COBRA+ tool should provide the option of choosing between individual C-ITS services or bundles according to NRAs' priorities.	Very important; a proposal would be to provide the option of choosing individual services and various pre-defined bundles in the tool.	medium	✓ (for pre-defined bundles)
2	Bundles	Functional	The C-ITS services and corresponding bundles should be updated according to the state of the art (and in turn – cost and impact data); The C-ITS Platform categories of services should be taken into account.	The tool should contain the most up to date cooperative services.	medium	✓
3	Bundles	Functional, Data	The C-ITS services within the COBRA+ tool should be updated to consider ITS Directive Priority Action C, "Safety-related Universal Traffic Information".	Comment: Priority Action C does not specify services; a specification will need to be made, although it will most likely not be possible to include all services, but rather a subset.	medium	✓
4	Bundles	Use cases	The COBRA+ tool should take into account road operator services.	This could be done by reviewing the road operator services in the NL, Austria and England and decide which ones to incorporate into the COBRA+ (as services / as bundles / use cases).	low	✓
5	Country data	Functionality, Data, Use cases	More countries should be included in the COBRA+ tool.	Five countries will be included (Austria, England, Germany, the Netherlands and Sweden); support will be provided for the data collection for other countries outside the five.	high	✓

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
6	Country data	Functionality, Data	For each country, the road network to be included should be defined and agreed with CEDR. This could be the network operated and managed by the NRA (e.g. the SRN in England, etc.) or alternatively the TEN-T Comprehensive network, dependent on availability of data. These networks will be predominantly motorway, and may include some non-motorway roads, but no 'urban' roads.	Urban roads will not be included, due to difficulty in gathering the data necessary to include urban roads. However, the tool will provide the possibility of including this road category, beyond the project end, when data may be available.	high	✓
7	Country data	Usability	The tool could offer the opportunity to the user to input very country-specific data into the COBRA+ tool, such as road-specific congestion, even if data is not available at the moment.	The tool already contains country-specific data such as kms of road, accidents, environmental impacts, etc. There are limitations to including more input data, as very detailed country data is very difficult to collect; the same applies to country-specific impact data. Nevertheless, the tool would offer the possibility to input this data, when available.	medium	✓
8	Modifying input data	Usability	The user should have the option of changing and adjusting life cycle costs in the COBRA+ tool, if desired; for example the life span of wireless beacons.	This can already be performed in the tool; the user guide will be expanded to explain how this can be achieved.	low	

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
9	Modifying input data	Usability	The flexibility of the tool should be enhanced for: modelling of communication platform penetration curves, extension of hotspot curves, choice of key assumptions and costs.	This is important and already possible in the tool to some extent on 'hidden' sheets. The tool will be adapted so it is possible to view and modify more input data and the user guide will be updated to reflect this.	low	
10	Overlap with existing infrastructure	Functional	The user should have the ability to influence situational variables, as different levels of existing infrastructure exist across NRAs. Specifically, the user should be able to define the extent of existing infrastructure and the overlap with C-ITS. This should also be made more visible and obvious within the tool.	This is important; the functionality is already in the model for NL and England for the current bundles. Differences between countries can lead to differences in effects (costs and benefits) of C-ITS implementation. These differences include: presence of legacy systems, problem size, level of deployment, etc.	high	✓
11	Platforms	Functional	The COBRA+ tool should include a Cellular Public & Private business model where the whole service is provided by the private sector, so that part of the services are paid by the public sector.	Such a business model is already included in the tool and will be revisited.	medium	
12	Platforms	Functional	The assumptions on whether to include new communication platforms in the COBRA+ tool should be revisited (i.e. "Wireless + cellular" (hybrid), 4G, 5G). Take into account that the assumptions may change over time; e.g. 2017 assumptions may be different from 2025 assumptions.	This is important and will be addressed.	high	

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
13	Platforms	Functional	The assumptions regarding existing communications platforms (in the model – "wireless beacons" and "3G cellular communication") that are currently in the COBRA+ tool should be revisited.	This is important and will be addressed.	medium	
14	Platforms	Functional	Within the COBRA+ model, the aftermarket should be included in the scenario that involves the wireless beacons communication platform (aftermarket should not be restricted to cellular).	Very important. Within the current version of the tool, the aftermarket is combined only with cellular platform; need to investigate the combination of aftermarket with wireless beacons – the penetration curve might be difficult to develop.	high	✓
15	Time horizon	Usability, Data	The user should have the option of choosing shorter time horizons, as NRAs could have different horizons for investments.	Data is available; not too difficult to implement.	low	
16	Outputs	Functional	The tool should provide output in comparable common units – i.e. cost/km.	No new data is necessary; easy to implement.	low	
17	Outputs	Functional, Data	The COBRA+ tool should provide as an output the cost of a corridor project.	Deployment of C-ITS will most likely be on corridors (national or transnational), such as C-ITS Corridor.	high	✓

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
18	Outputs	Functional	The COBRA+ tool should include a do-nothing scenario in the output page	The current 'do nothing scenario' is implicit within the tool with the forecasts for reduction in fatalities and increase in travel time etc. Extra graphs will be included to make this more explicit on the output page. Validation by the NRAs of the assumptions for the 'do nothing' scenario will be sought and further input will be required from the NRAs on which 'do something' scenarios they wish to test.	high	✓
19	Outputs	Usability	The COBRA+ tool should present more clearly the benefit to cost ratios, i.e. stating explicitly the BCR in 2030. Consider using templates from the C-ITS Platform WG1 report for output graphs.	The benefit to cost ratio data will be presented more clearly.	low	

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
20	Outputs	Usability	The output page should focus on the NRAs; with the possibility of considering other stakeholders if possible.	It is proposed that the output page will focus on NRAs as this is the primary focus of the tool. Considering other stakeholders would require including both costs and benefits to the other groups of stakeholders. An exercise could be performed to assess whether the costs and benefits for other groups of stakeholders can also be quantified. This activity requires the identification of the relevant costs and benefits of different stakeholders, not only NRAs; it is currently estimated that the benefits on the non-NRA stakeholders may be difficult to fully quantify.	high	✓
21	Outputs	Usability	All the outputs of the tool should be reviewed and improved e.g. could include pie charts.	The style of all outputs will be reviewed; pie charts may be appropriate to supplement the existing outputs.	low	
22	User guide	Usability	A guide on how to fill the COBRA+ tool with necessary data should be provided.	Annex A of COBRA D4.2 provides explanations regarding the country data needed in the tool. This will be reviewed and expanded.	low	
23	User guide	Usability	The tool's user guide should be improved (better understanding of the tool's contents, the modifications possible, benefit assumptions, etc.)	Important for stakeholders; should improve user experience.	low	

No	Theme	Requirement classification	Requirement	Justification	Estimation of resources	Input necessary (from NRAs, others, etc.
24	Future project	Use cases	Have maintenance of the COBRA+ tool and data after the ANACONDA project has ended.	Ongoing contracts should be negotiated after project ending. This is not explicitly part of the ANACONDA project but rather up to the CEDR organization.	-	✓

Table 2 "Nice to have" – requirements for the COBRA+ tool

No	Requirement classification	Requirement	Justification	Input necessary (from NRAs, others, etc.)
25	Functional	The COBRA+ tool could include more safety-oriented C-ITS services	Some safety services are in COBRA+ already; it is not possible to have only safety-oriented services; some more can be added to COBRA+, we will take this into consideration.	✓
26	Functional, Data	Electric vehicles could be included in the COBRA+ model	The projections for travel time and emissions, currently existing in the model, already include forecasts on the proportion of EVs in the vehicle fleet. Could be updated.	✓
27	Functional	Add Finland in the list of countries to be included in the COBRA+ tool.	The current proposal of countries is: Austria, England, Germany, the Netherlands and Sweden. Blank space for additional countries will be provided along with instructions for required data and how to include it in the tool.	✓
28	Usability	The COBRA+ tool could produce one output page for experts and one output page for high-level users.	This would be time consuming. Would suggest to include in the user guide – instructions for the high-level users on which graphs are the most relevant.	
29	Use cases	The tool could give evidence of the benefits of PVD (probe vehicle data) collection.	PVD is not a service in itself but rather would facilitate services; may be part of cellular of wireless beacons platforms. The benefits implied are related to the value of the data and thus could be captured in a business model. This is currently outside the focus COBRA.	✓

Table 3 "Not feasible within this project" – requirements for the COBRA+ tool

No	Requirement classification	Requirement	Justification	Input necessary (from NRAs, others, etc.)
30	Functional, Usability	The user should have the option of choosing longer time horizons in the analysis.	For any time horizons beyond 2030, this would require new data sources and extrapolations. While possible, the validity of the predictions for what will happen with C-ITS in the future would be questionable.	✓
31	Functional, Data	The COBRA+ tool could give the opportunity to the user of using not only average values of data, but different classes/distribution of data.	Difficult to implement, as this type of data is difficult to collect. Requires more detailed data for both impacts and at country level.	
32	Functional, Data	MaaS (in the form of car sharing) could be included in the tool.	Equipping car sharing vehicles may have a temporary "hot spot" effect, but it is expected that it would be negligible.	✓
33	Use cases	The COBRA+ tool could answer focused questions regarding specific C-ITS services, as there is a need to identify positive benefit to cost ratios.	Satisfying this requirement would mean "reversing" the purpose of the tool. Too difficult to implement, as there are too many variables.	
34	Functional, Usability	The COBRA+ tool could provide decision support for road authorities to keep investing in existing infrastructure or to invest in C-ITS.	Satisfying this requirement explicitly would change the scope of the COBRA+ tool. However, conducting multiple runs of the tool may go some way to addressing this requirement.	✓
35	Functional	The COBRA+ tool could provide output in comparable common unit – LoS (Level of Service).	Difficult to implement, there are limitations to including more detailed input data, as very detailed country data is very difficult to collect; same applies to impact data.	✓

3 User requirements for the COBRA+ Monitor

3.1 Introduction

The COBRA+ spreadsheet will be accompanied by a private website called the COBRA+ Monitor. The requirements for the Monitor were discussed at the stakeholder workshop and subsequent meetings and the outcomes are presented below.

3.2 Requirements collection

The first stage in developing the user requirements for the COBRA+ Monitor involved presenting an initial proposal for the COBRA+ Monitor to the workshop for representatives of the NRAs held in November 2015, and capturing the feedback from the NRAs during the workshop. This feedback was then used to refine the initial proposal; the revised proposal was then presented to some of the PEB members individually during January and February 2016, and to a meeting of the CEDR ITS Group in February 2016. The following requirements were identified from these discussions.

Purpose:

- The COBRA+ Monitor is intended to monitor: plans for deployment of C-ITS; implementations of C-ITS; impacts of C-ITS; and use of the COBRA+ tool.
- It should promote information sharing between countries to learn from each other.

Countries covered and access to information:

- Countries where the COBRA+ tool is being used – the five countries covered by the tool as a minimum.
- Users of the COBRA+ Monitor are expected to mainly be users of the COBRA+ tool; however other CEDR road authorities may also wish to use it. Access will be granted to these five countries (and the PEB?) via a private website (possibly hosted on the new CEDR website).

Content of the COBRA+ Monitor should include:

- Cost data used by the NRAs in the COBRA+ tool;
- Bundles of services analysed by the NRAs in the COBRA+ tool to indicate deployment plans;
- Outcomes of analyses carried out by NRAs in the COBRA+ tool to provide lessons learned;
- Monitor C-ITS implementations using common indicators;
- Monitor use of the COBRA+ tool.

Timing and flexibility:

- The Monitor should be designed so that it is flexible enough to be refined during 2016 to take account of the results of current deployment projects; an iterative process is envisaged.

3.3 Current proposal for the COBRA+ Monitor

A further proposal for the COBRA+ Monitor was developed on the basis of the requirements summarised above. This outline proposal was presented to the CEDR ITS Group in February 2016 and was well received. This outline proposal is summarised here and a more detailed description will be given in the COBRA+ Monitor specification deliverable, D2.1.

Functionality: questions the COBRA+ Monitor will help to address

The various functionality requirements were synthesised into six proposed questions that the COBRA+ Monitor will help NRAs to answer:

A. **Who** is using the COBRA+ tool, **what scenarios** are they conducting and **what outputs** are they obtaining?

B. What **user-defined inputs** are being used in the COBRA+ tool, e.g. different **cost data**?

C. What is the **experience of users** of the COBRA+ tool?

D. What are the **impacts of different C-ITS** services and bundles, measured in terms of indicators **within the COBRA+ tool**?

E. What are the **impacts of different C-ITS** services and bundles, measured in terms of indicators **not within the COBRA+ tool, from other ad hoc data sources**?

F. What **strategic plans** are there for C-ITS in different countries?

Data sources

The COBRA+ Monitor will draw on a range of data; specifically it is proposed to use the following sources to enable for the six functions outlined above, respectively:

A. Run-specific data (output from the COBRA+ tool)

B. User defined input data (output from the COBRA+ tool)

C. User feedback on experiences (optional user survey)

D. Impact assessment data (D3 from previous COBRA project and also updated data in COBRA+)

E. Ad hoc data sources (shared by individual users via a message board / email list)

F. Survey of CEDR members (one-off online survey)

The intention is that there will be approximately five parallel versions of the COBRA+ tool, with some but not all of the data being pushed from the tool into a central database while the majority of the data is stored only within the COBRA+ tool. An online survey will be carried out among CEDR members on the C-ITS deployment and implementation plans, to provide additional data to monitor C-ITS deployment which is not available from the COBRA+ tool itself. The outputs available in the COBRA+ Monitor will be in the form of graphs and tables.

Figure 4 below provides an overview of the data flows and functions.

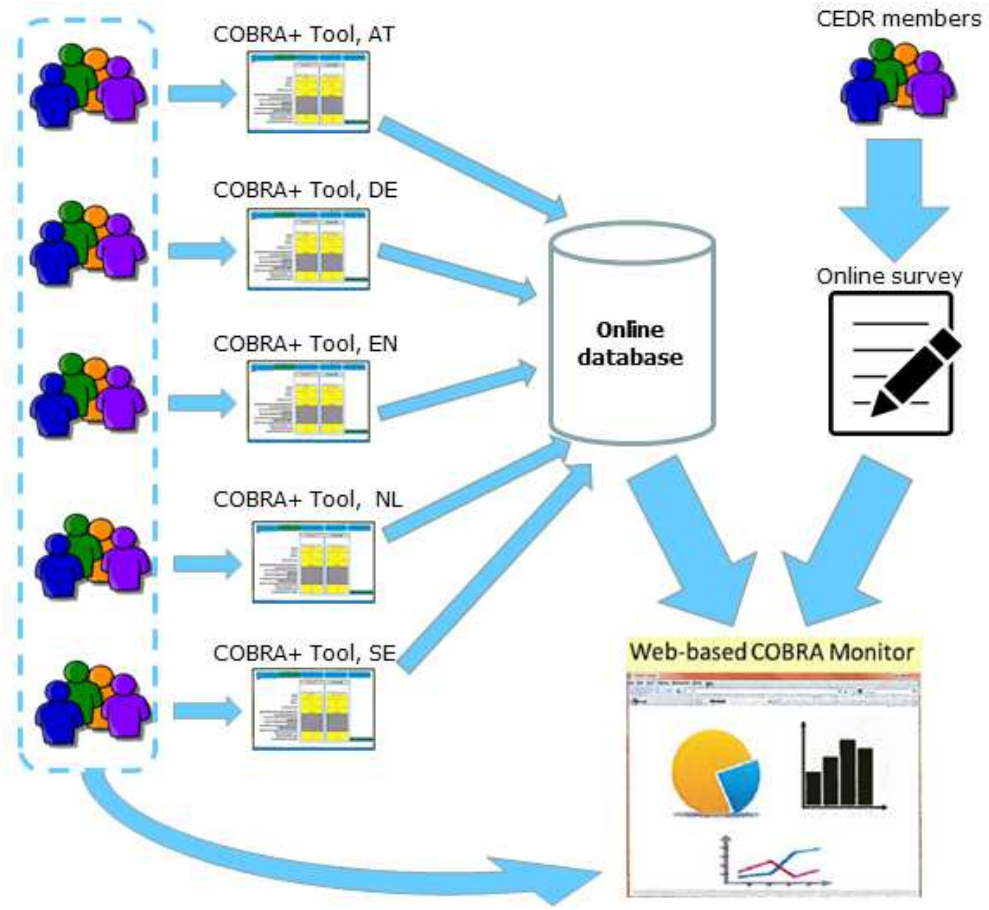

Figure 4 Proposed architecture of the COBRA+ Monitor

3.4 Developing the specification for the COBRA+ Monitor

The project will now begin work on developing the specification for the COBRA+ Monitor. Initially further information will be gathered on some specific details, such as the scope and content of the data to be gathered by means of an on-line survey to identify C-ITS deployment and implementation plans, which data fields are to be exported from the COBRA+ tool into the Monitor, the specification of the online database and the web hosting arrangements.

Outline specifications will then be developed for:

- The user interface
- Arrangements for data storage and manipulation on the database
- Data fields for COBRA+ tool and online survey data used in the Monitor
- Import functions
- An iterative process for taking account of developments in C-ITS corridor projects while finalising the specification the Monitor.

4 Initial list of use cases

4.1 Introduction

This chapter describes the initial list of use cases in consideration for implementation in the COBRA+ tool. Although the analysis of the use cases will take place later in the project, the choice of use cases has an impact on the way the COBRA+ tool needs to work, and on the data that needs to be collected for the tool. One of the goals of this chapter is to identify the geographical networks covered by the use cases in order to collect data that can be used within the COBRA+ tool. The other goal is to identify what services will be implemented in the use cases. In case new services are introduced, the existing bundle and services structure used for the current COBRA tool has to be updated.

The use cases correspond to corridors or parts of the European road network that have been committed to deployment of cooperative ITS services. More European corridor projects are active than the number of use cases that will be analysed in detail in ANACONDA. Therefore, a choice of use cases will take place. The COBRA+ tool will however be flexibly designed so that more use cases can be added to the COBRA+ tool in the future.

The corridor projects that will be discussed in this document are:

1. NordicWay;
2. UK A2/M2 Corridor London-Dover;
3. C-ITS Corridor Rotterdam-Vienna; and
4. SCOOP@F.

In each of the corridor projects, a set of ITS services will be introduced. There are services that will be introduced in almost all corridors, but even though they have the same name, there may be slight differences in the way data is collected or communicated between roadside units and vehicles. These differences and similarities will be examined in the course of the ANACONDA project.

Sections 4.2 - 4.5 provide short overviews of the project description and services for each corridor. Section 4.6 presents the overview of services of the four use cases plus the existing COBRA bundles. The chapter concludes with a discussion of the consequences for the COBRA+ tool. 9 provides a more detailed overview of the original COBRA services, the services of the C-ITS Platform [Asselin-Miller and Biedka, 2015] and the services from the use cases from this chapter.

4.2 NordicWay

NordicWay is a pilot project that seeks to enable vehicles to communicate safety hazards through cellular networks on a road corridor through Finland, Norway, Sweden and Denmark [Kulmala, 2015]. During the project, cars will utilise cellular networks (3G and 4G/LTE) to share specific and low latency traffic safety information regarding e.g. obstacles on the road, weather conditions, slippery surfaces and accidents. Cellular networks are chosen due to the low traffic-intensity networks in these countries, the use of proven technology and the fact that cellular networks already provide almost 100% coverage in the project countries. Voluntary drivers of up to 2000 vehicles will connect and share information with other vehicles on the road and the surrounding infrastructure in a C-ITS network using DENM and DATEX2 message standards between vehicles, roadside base stations and traffic

management centers.

The project goal is to pilot and facilitate specific C-ITS functionalities through a common architecture. The end goal of the project is to lay the foundation for automated cloud communication via cellular networks with data generated by vehicle on-board sensors and the surrounding infrastructure. Communication will be established between vehicles, smart devices on the road, service providers, road administrators and other public administrations. A business model and a detailed scenario for the roll-out of cellular based C-ITS services will also be developed.

Figure 5 and Table 4 provide an overview of the planned NordicWay road network and the services to be deployed.

Figure 5 The NordicWay road network (from INEA)

Table 4 Planned NordicWay services and specifications of the road network

List of services	Road network
Common/core services (cellular) • Hazardous Location Warnings (HLW) • Cooperative Weather Warnings (WW) • Probe vehicle data (PVD) Additional national services • In-vehicle Signage (IVS) • Cooperative Traffic Management (TM) • Road Works Warning (RWW)	• FI: E18 (Turku-Helsinki), Ring I, Ring III • NO/SE: E6, E4 (Oslo-Malmö-Stockholm) • DK: E20, E47 (Helsingborg-Copenhagen-Malmö)

4.3 UK A2/M2 Corridor London-Dover

The A2/M2 Connected Vehicle Corridor in the UK is a project aimed at deployment of C-ITS

on the corridor between the Blackwell tunnel near London to Dover. This is part of the Route Strategy Kent Corridor to M25 (M2 and M20). This corridor will co-operate in achieving the goals described in the Road Investment Strategy from Highways England [Hanson, 2015]. This strategy states that in 2040, technology to increase road capacity and regulate traffic flow has to be implemented. Furthermore, the network of Managed Motorways has to be expanded in order to fully support connected vehicles. The development of in-vehicle, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) systems has to be stimulated by increasing the number of roadside WiFi-p systems.
Figure 6 and Table 5 provide an overview of the planned UK Corridor road network and services.

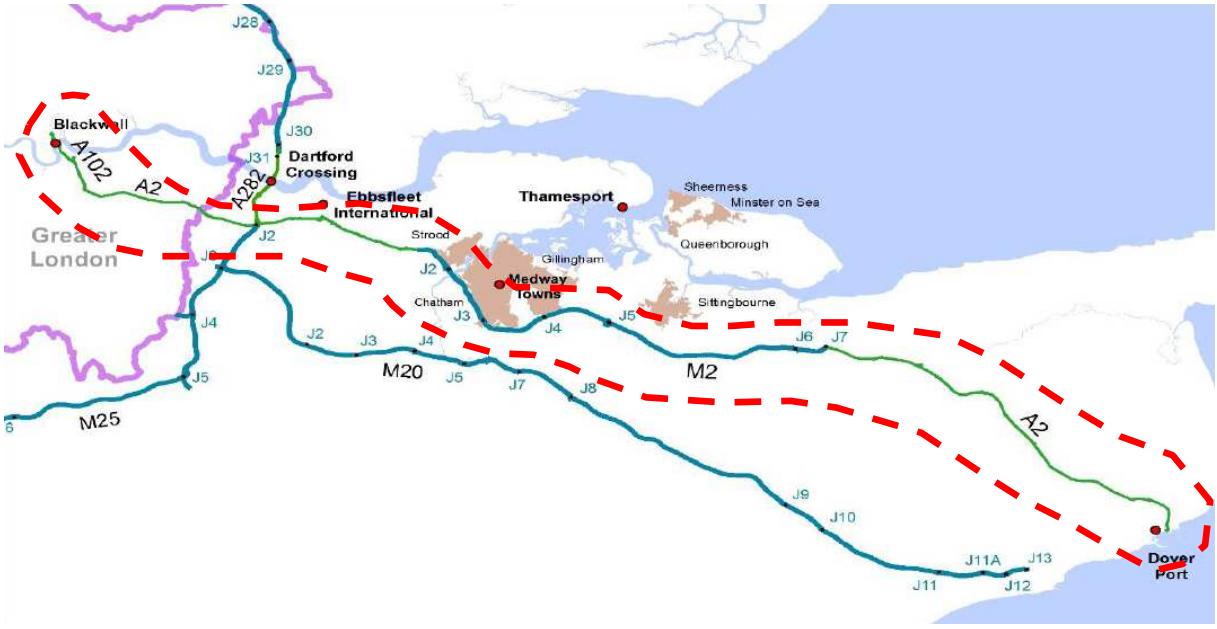

Figure 6 The UK Corridor road network (from Hanson, 2015)

Table 5 Planned UK Corridor services and specifications of the road network

List of services	Road network
• Road works warning (RWW) • Vehicles ahead breaking (TJAW) • Freight operations • Urban C-ITS • Traffic information services (TI)	• A102 • A2 • M2

4.4 C-ITS Corridor Rotterdam-Vienna

In the Cooperative ITS Corridor project, road operators in the Netherlands, Germany and Austria are working with industrial partners to take the first step towards the introduction of cooperative services in Europe on the route between Rotterdam, Frankfurt/M and Vienna. The goal of the introduction is to improve road safety, reduce the number of incidents and traffic jams, make more efficient use of the road network and reduce CO2 emissions [itscorridor.mett.nl].
To facilitate these services, road operators are planning to install beacons along the corridor. These beacons communicate with the on-board units of approaching vehicles using WiFi-p. It

is expected that car manufacturers will install these on-board units in many vehicles in the coming years. Using a data communications network, the beacons will also communicate with the traffic information centers where traffic will be monitored. Beacons may be mobile or fixed. Mobile beacons will be fitted to the information display vehicles placed near road works. Fixed beacons will be installed on the existing roadside infrastructure.

Figure 7 and Table 6 provide an overview of the C-ITS Corridor road network and services.

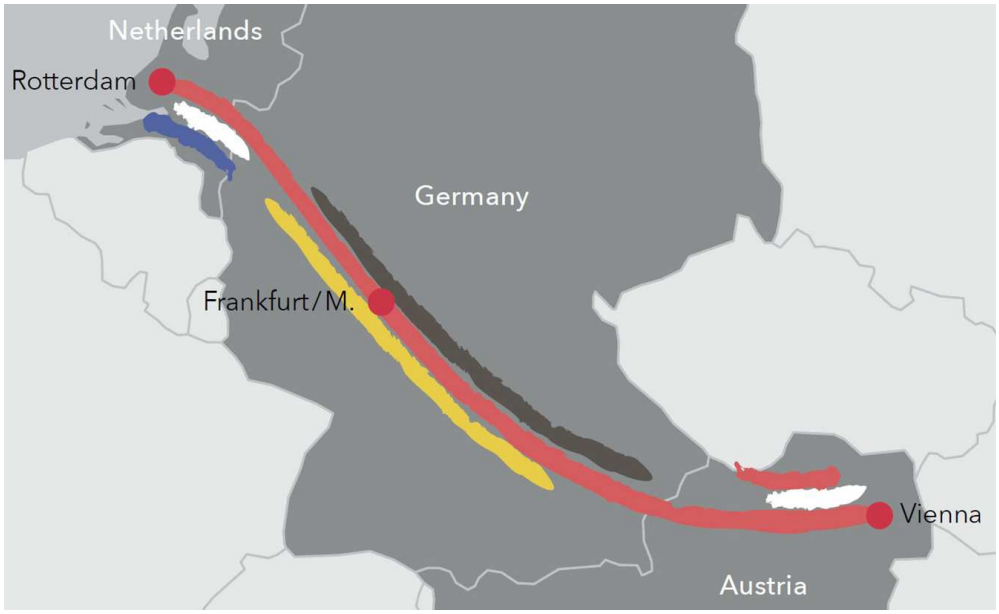

Figure 7 The C-ITS Corridor road network (from itscorridor.mett.nl)

Table 6 Planned C-ITS Corridor services and specifications of the road network

List of services	Road network
• Road works warning (RWW) • Probe Vehicle Data (PVD)	• NL: A16, A58, A2, A67 • DE: not specified • AT: not specified

4.5 SCOOP@F

SCOOP@F is a cooperative ITS pilot deployment project that intends to connect approximately 3000 vehicles with 2000 kilometres of roads [Ollinger, 2015]. It consists of five specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1 from 2014 to 2017 (ongoing) and SCOOP@F Part 2 from 2016 to 2018. Its main objective is to improve the safety of road transport and of road operating staff during road works or maintenance.

For each test site, roads and vehicles will communicate through wireless networks:

- Using Wi-Fi routers along the roadside and embedded receptors within vehicles;
- Using public GSM networks.

Vehicles will exchange information about their position, speed, obstacles, etc., with the infrastructure and other connected vehicles. Roads will broadcast about traffic conditions, works, speed limit, accidents, obstacles, etc. The driver will receive alerts through a tablet

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computer. The data sent by vehicles to routers will be gathered by road operators as traffic information, to help them react faster in case of emergencies. The system increases safety for workers in construction zones, since an alert will be sent to each and every connected vehicle to make drivers aware of the danger.

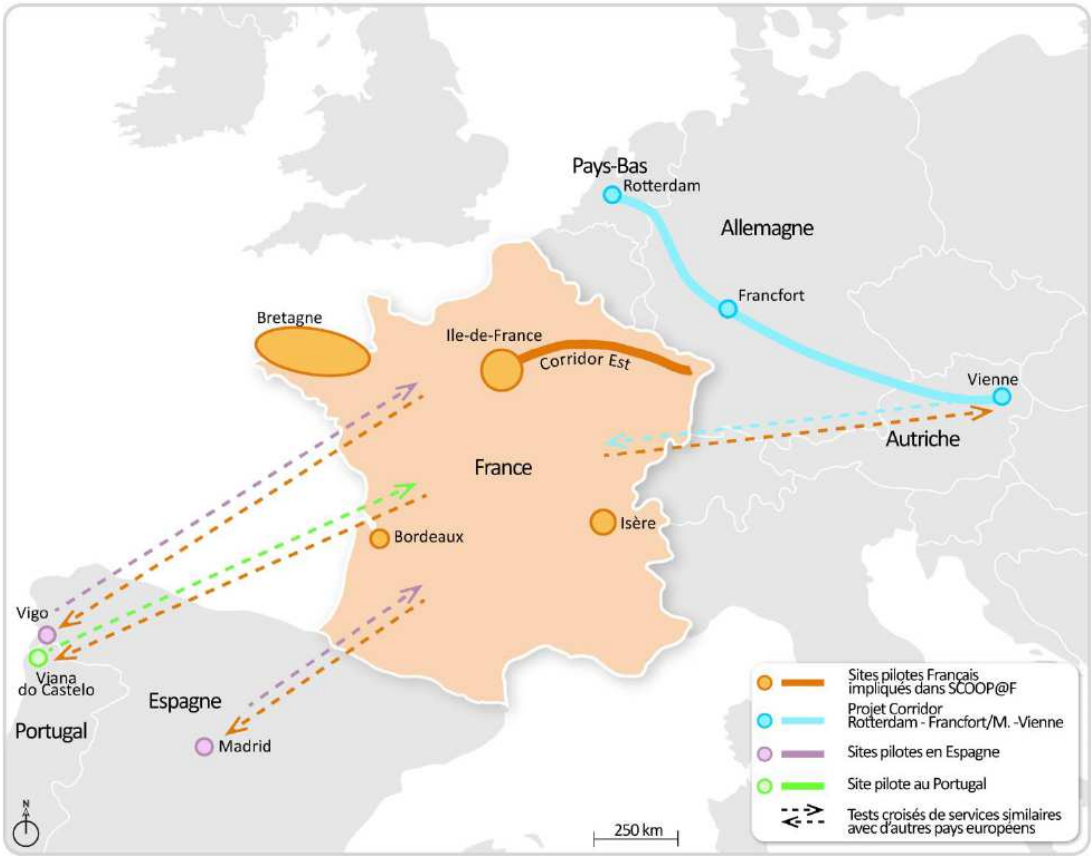

Figure 8 The SCOOP@F locations and projected links with other corridors and pilots (from Ollinger, 2015)

Table 7 Planned SCOOP@F services and locations

List of services	Locations
Hybrid cellular/ITS G5 communications • Probe vehicle data (PVD) • Road works warning (RWW) • Hazardous location notification (HLW) • Weather warning (WW) • End of queue warning (TJAW)	• Bretagne • Ile-de-France • Bordeaux • Isère • Corridor Est (Paris-Strasbourg)

4.6 Overview of services within use cases

This overview of the four use cases and the existing COBRA bundles shows that the corridors have services in common with each other or the existing COBRA bundles, with two exceptions. The first exception, Probe Vehicle Data, is a service which is more a facilitator than a service that directly provides impacts. It will be considered how to take this into account in the COBRA+ tool. The second exception, Urban C-ITS, will not be taken into account in the improved version of the COBRA+ tool, as described in Section 2.5.

Table 8 Overview of services in the use cases and existing COBRA bundles

Service	NordicWay	UK Corridor London-Dover	C-ITS Corridor Rotterdam-Vienna	SCOOP@F	COBRA bundle
TJAW		X		X	1
RWW	X*	X	X	X	1
HLW - WW	X			X	1
IVS	X*				2
TI		X			3
Freight operations		X			3
PVD	X		X	X	
Urban C-ITS		X			

* not clear or confirmed from project description

4.7 Overview of services in the C-ITS Platform

The European Commission (EC) established the C-ITS Deployment Platform in 2014 to address the main barriers and enablers identified for the deployment of C-ITS in the EU, in relation to the services likely to be introduced in the first stage ('Day 1' applications). Eleven working groups were established to carry out this work. Working Group 1, Cost-Benefit Analysis, developed a list of 'Day 1' and 'Day 1.5' services. This section reviews these services of the C-ITS Platform with respect to the extent that the COBRA bundles and the use cases described in this chapter overlap or not with the C-ITS Platform services.

The overlap of the Day 1 services of the C-ITS Platform with the current COBRA bundles and the use cases are shown in Table 9. Although there is significant overlap, some of the Day 1 services are not included in the current COBRA bundles or the use cases. Some of these services are Vehicle-to-Vehicle (V2V), which are not included the COBRA and use case bundles. These services are: Emergency Electronic Brake Light, Emergency Vehicle Approaching and Slow or Stationary Vehicle(s). The services GLOSA / TTG, Signal Violation / Intersection Safety, and Traffic Signal Priority Request by Designated Vehicles are largely urban applications, which is currently outside the COBRA+ tool development in ANACONDA. Of the Day 1 services, only Shockwave Damping is a service that could be relevant for inclusion in COBRA+ tool under the ANACONDA project.

Table 9 Overview of Day 1 services specified by the C-ITS Platform (Asselin-Miller and Biedka, 2015)

Day 1 Services C-ITS Platform	In COBRA	In use cases
Emergency Electronic Brake Light		
Emergency Vehicle Approaching		
Slow or Stationary Vehicle(s)	X	
Traffic Jam Ahead Warning	X	X
Hazardous Location Notification	X	X
Road Works Warning	X	X
Weather Conditions	X	X
In-vehicle Signage	X	X

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Day 1 Services C-ITS Platform	In COBRA	In use cases
In-vehicle Speed Limits	X	
Probe Vehicle Data		X
Shockwave Damping		
Green Light Optimal Speed Advisory (GLOSA) / Time To Green (TTG)		
Signal Violation / Intersection Safety		
Traffic Signal Priority Request by Designated Vehicles		

Table 10 shows that there is little overlap of the Day 1.5 services of the C-ITS Deployment Platform with the current COBRA bundles and the use cases. Again, some of these services are Vehicle-to-Vehicle (V2V), which are not included the COBRA and use case bundles. The V2V services are Cooperative Collision Risk Warning and Motorcycle Approaching Indication. The Off-street Parking Information (and Management) and Information on AFV Fueling & Charging Stations primarily delivers benefits in the urban environment. These last three services are applicable on motorway and on non-motorway/non-urban roads but provide limited benefits. Urban Zone Access Control is applicable only in urban environments. Loading Zone Management (for freight) is primarily used in the urban environment, but can also be applied on motorways. Vulnerable Road Use Protection (for pedestrians and cyclists) is primarily meant for urban areas but can also be applied to non-motorway/non-urban roads. Finally, Wrong-way Driving is a Vehicle-to-Infrastructure (V2I) service.

Table 10 Overview of Day 1.5 Services specified by the C-ITS Platform (Asselin-Miller and Biedka, 2015)

Day 1.5 Services C-ITS Platform	In COBRA	In use cases
Off-street Parking Information		
On-street Parking Information and Management		
Park & Ride Information	X	
Information on AFV Fueling & Charging Stations		
Traffic Information and Smart Routing	X	X
Zone Access Control for Urban Areas		
Loading Zone Management		
Vulnerable Road User Protection (pedestrians and cyclists)		
Cooperative Collision Risk Warning		
Motorcycle Approaching Indication		
Wrong-way Driving		

The Urban C-ITS service mentioned in the UK corridor could include a lot of services in Table 9 and Table 10. Because the description is not very specific from the project description and because urban roads are not within the scope of COBRA+, these services are not indicated in Table 9 and Table 10.

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4.8 Consequences for the COBRA+ tool

The list of services from the use cases mentioned above corresponds for a large part with the services that already exist in the bundles in the COBRA tool and are also in line with the description of services from the C-ITS Platform (see 9). The only exceptions are the services Probe Vehicle Data (PVD) and Urban C-ITS. Furthermore, the service Road Works Warning (RWW) is sometimes identified as 'Short-term RWW' and in other cases 'Long-term RWW' (mostly cellular information). Also, 'Freight Operations' is a service that is rather vague (e.g. it is not clear now which type of services belong to this description).

An option for the COBRA+ tool to implement PVD is to split the existing three bundles in sub-variants (e.g. 1a and 1b, 2a-2b, 3a-3b) where variant a stands for existing vehicle monitoring data sources and variant b stands for monitoring using PVD. In this way different business scenarios can be calculated using the tool (e.g. selling PVD to service providers).

The Urban C-ITS service, mentioned in the UK corridor, falls outside the scope of the COBRA+ tool. The tool only will only consider motorway / trunk networks.

A suggestion for the existing service RWW in Bundle 1 is to split it into Short-term RWW (influences only the operational driving task) and Long-term RWW (influences the strategic driving task). Currently, Long-term RWW is not included as a service in any bundle of the COBRA tool. Short-term RWW fits best in Bundle 1, whereas Long-term RWW is more about advising alternative routes and therefore would fit better in Bundle 3.

Services from Bundle 2 generally do not occur in the use cases (except for the national optional service for countries in NordicWay).

Comparing the COBRA services with the service description from the C-ITS platform, the C-ITS platform distinguishes a separate Hazardous Location Warning for weather warnings and one for infrastructure-based warnings. Of the C-ITS services not included in the COBRA bundles and use cases, most are V2V or urban services. The services that are V2I and thus can be considered for inclusion in the COBRA+ tool are Shockwave Damping and Wrong-way Driving.

5 Next steps

Several next steps are already planned for the subsequent work in ANACONDA. These include:

- Develop specifications for the COBRA+ Monitor and COBRA+, based on the outputs of the first workshop and the resulting user requirements that have been presented in this report. The project consortium will further investigate in more detail the feasibility and the added value of each requirement, taking into account time and budget constraints.
- Start the data collection and fill the COBRA+ tool with data. As planned, for five countries, i.e. Austria, England, the Netherlands, Germany and Sweden, the consortium will update and add the data to the tool, with input from the respective NRAs.
- Finalise selection of use cases to be investigated in ANACONDA. The project team will develop in-depth description of the selected use-cases, including their geographical region, the C-ITS services involved and the legacy systems present. Moreover, more detailed descriptions of the cooperative services within the use cases will be procured. The latter will be used for the impact assessment of the services within COBRA+.
- Hold the second stakeholder workshop with national road authorities. A second ANACONDA workshop will be held on the 19th of May in Amsterdam, the Netherlands to present and demonstrate a version of the COBRA+ tool and a mock-up of the COBRA+ Monitor and to discuss the application of the tool to the selected use cases.

6 References

Asselin-Miller, N., and M. Biedka (2015), "Study on the Development of C-ITS in Europe, Summary Report," Framework Contract on Impact Assessment and Evaluation Studies in the Field of Transport M)VE/A3/119-2013-LOT No 5 "Horizontal", Report for DG MOVE MOVE/C.3/No 2014-794,

Hanson, G. (2015), "The UK Corridor – A2/M2 Connected Vehicle Corridor". Presentation from the Department for Transport, United Kingdom, September 2015.

Kulmala, R. (2015), "Cellular C-ITS pilot: NordicWay". Presentation held at the 22nd ITS World Congress Bordeaux, France, 5-9 October 2015.

Mocanu, I., P. Nitsche, S. Deix, K. Malone, J. Hopkins and S. Ball (2012). "COBRA Cooperative Benefits for Road Authorities, Deliverable 3.1 Impact Assessment", COBRA Consortium, Nov. 2012.

Ollinger, E. (2015), "Project SCOOP@F". Presentation held at the 22nd ITS World Congress Bordeaux, France, 5-9 October 2015.

7 Annex A List of participants at stakeholder workshop

List of participants to the first ANACONDA stakeholder workshop with national road authorities held in Delft, on November 23, 2015:

Name	Affiliation
Frans op de Beek	RWS, the Netherlands
Henk Schuurman	RWS, the Netherlands
Fred Verweij	RWS, the Netherlands
Ronan Cunniffe	CEDR
Kristof Rombaut	Flemish Road Authority, Flanders
Manfred Harrer	ASFINAG, Austria
Phil Proctor	Highways England, UK
Marco Schreuder	RWS, the Netherlands
Torsten Geissler	BASt, Germany
Tom Alkim	RWS, the Netherlands
Hans van Saan	RWS, the Netherlands

8 Annex B Full list of classified user requirements

This annex contains a complete list of the classified user requirements for the COBRA+ tool, culled from the ANACONDA workshop held in Delft on November 23, 2015.

FUNCTIONALITY Requirements

- The COBRA+ tool should provide the option of choosing between individual C-ITS services or bundles according to NRAs' priorities
- The C-ITS services and corresponding bundles should be updated according to the state of the art (and in turn – cost and impact data); The C-ITS Platform categories of services will be taken into account
- The C-ITS services within the COBRA+ tool should be updated in accordance with the ITS Directive Priority Action C, "Safety-related Universal Traffic Information"
- More countries should be included in the COBRA+ tool
- For each country, the road network to be included will need to be defined and agreed with CEDR. This could be the network operated and managed by the NRA (e.g. the SRN in England, etc.) or alternatively the TEN-T Comprehensive network. These networks will be predominantly motorway, but include some non-motorway roads, but no 'urban' roads.
- The tool should provide output in comparable common units – i.e. cost/km
- The COBRA+ tool should provide as an output: the cost of a corridor project
- The COBRA+ tool should include a do-nothing scenario in the output page
- The user should have the ability of influencing situational variables, as different levels of existing infrastructure exist across NRAs. Specifically the user should be able to define the extent of existing infrastructure and the overlap with C-ITS. This should also be made more visible and obvious within the tool.
- The COBRA+ tool should include a Cellular Public & Private business model where the whole service is provided by the private sector, so that part of the services are paid by the public sector
- The assumptions on whether to include new communication platforms in the COBRA+ tool should be revisited (i.e. "Wireless + cellular" (hybrid), 4G, 5G). Take into account that the assumptions may change over time; e.g. 2017 assumptions may be different from ones of 2025
- The assumptions regarding existing communications platforms (in the model – "wireless beacons" and "3G cellular communication") that are currently in the COBRA+ tool should be revisited
- Within the COBRA+ model, the aftermarket should be included in the scenario that involves the wireless beacons communication platform (aftermarket should not be restricted to cellular)
- The COBRA+ tool could include more safety-oriented C-ITS services
- Electric vehicles could be included in the COBRA+ model
- Add Finland in the list of countries to be included in the COBRA+ tool

- The user should have the option of choosing longer time horizons in the analysis
- The COBRA+ tool could give the opportunity to the user of using not only average values of data, but different classes/distribution of data
- MaaS (in the form of car sharing) could be included in the tool
- The COBRA+ tool could provide decision support for road authorities to keep investing in existing infrastructure or to invest in C-ITS
- The COBRA+ tool could provide output in comparable common unit – LoS (Level of Service)

USABILITY Requirements

- The user should have the option of changing and adjusting Life Cycle costs in the COBRA+ tool, if desired; for example the life span of wireless beacons.
- The user could offer the opportunity to the user to input very country-specific data into the COBRA+ tool, such as road-specific congestion;
- The flexibility of the tool should be enhanced for: modeling of communication platform penetration curves, extension of hotspot curves, choice of key assumptions, costs
- The COBRA+ tool should present more clearly the benefit to cost ratios, i.e. stating explicity the BCR in 2030. Consider using templates from the Ricardo report for output graphs
- The output page could provide data on the costs and benefits of different stakeholders, not only NRAs
- All the outputs of the tool will be reviewed and improved, e.g. could include pie charts
- The user should have the option of choosing shorter time horizons, as NRAs could have different horizons for investments
- A guide on how to fill the COBRA+ tool with necessary data should be provided
- The tool's user guide should be improved (better understanding of the tool's contents, the modifications possible, benefit assumptions, etc.)
- The COBRA+ tool could produce one output page for experts and one output page for high-level users
- The user should have the option of choosing longer time horizons in the analysis
- The COBRA+ tool could provide decision support for road authorities to keep investing in existing infrastructure or to invest in C-ITS

USE CASES Requirements

- More countries should be included in the COBRA+ tool
- Have maintenance of the COBRA+ tool and of the data
- The COBRA+ tool should incorporate road operator services and how to implement

them

- The tool could give evidence of the benefits of PVD (probe vehicle data) collection
- The COBRA+ tool could answer focused questions regarding specific C-ITS services, as there is a need to identify positive benefit to cost ratios

DATA Requirements

- More countries should be included in the COBRA+ tool
- For each country, the road network to be included will need to be defined and agreed with CEDR. This could be the network operated and managed by the NRA (e.g. the SRN in England, etc.) or alternatively the TEN-T Comprehensive network. These networks will be predominantly motorway, but include some non-motorway roads, but no 'urban' roads.
- The COBRA+ tool should provide as an output: the cost of a corridor project
- The user should have the option of choosing shorter time horizons, as NRAs could have different horizons for investments
- Electric vehicles could be included in the COBRA+ model
- The COBRA+ tool could give the opportunity to the user of using not only average values of data, but different classes/distribution of data
- MaaS (in the form of car sharing) could be included in the tool

9 Annex C Comparison of services in COBRA, C-ITS Platform and use cases

This annex contains a table in which the COBRA services are compared with the service description from C-ITS Platform and with the services from the use cases. The COBRA service definitions are based on those in COBRA D3 [Mocanu et al., 2012] but have been modified to reflect changes agreed so far for COBRA+ tool. C-ITS platform definitions are from the Ricardo report [Asselin-Miller and Biedka, 2015].

Table 11 Mapping of COBRA services against C-ITS Platform services to start process of defining potential services and bundles

COBRA				*C-ITS Platform*			*Use cases*		
Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
Local dynamic event warnings (LDEW)	Hazardous location notification (weather) Warns drivers approaching potentially hazardous areas. These areas statistically have more collisions and incidents, requiring more attention from the driver. This is particularly beneficial in dynamic situations such as changing weather conditions.	Cellular Beacons	Weather? (Not clear from wording)	Weather conditions Provides accurate and up-to-date local weather information. Drivers are informed about dangerous weather conditions ahead, especially where the danger is difficult to perceive visually, such as black ice or strong gusts of wind.	Hybrid cellular or ITS-G5 depending on infrastructure	Weather	Nordic Scoop@F	Nordic: cellular Scoop@F: Hybrid cellular/ ITS-G5	
LDEW	Road works warning (short term) Temporary traffic management at road works usually involves deploying signs and equipment. A vehicle-infrastructure system offers more flexibility, enabling faster reconfiguring of the work zone and precise alerts and instructions to drivers about lane choices, speeds, close following of preceding vehicles etc.	Cellular Beacons	??				UK C-ITS corridor Scoop@F	Hybrid cellular/ ITS-G5	

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COBRA				*C-ITS Platform*			*Use cases*		
Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
				Road works warning Roadworks warnings enable road operators to communicate information about road works and restrictions to drivers. This allows drivers to be better prepared for upcoming roadworks and potential obstacles in the road.	Hybrid cellular or ITS-G5 depending on infrastructure		Nordic UK C-ITS corridor Scoop@F	Nordic: cellular Rest: Hybrid cellular/ ITS-G5	
LDEW	Traffic jam ahead warning Warns drivers approaching the tail end of a traffic jam	Cellular Beacons	Loops, CCTV	Traffic jam ahead warning Provides an alert to the driver on approaching the tail end of a traffic jam at speed - for example if it is hidden behind a hilltop or curve	V2V ITS G5; Cellular 4G/ 5G	In-vehicle	UK Scoop@F	UK: Loops, ITS G5 Scoop@F: Hybrid cellular/ ITS-G5	
LDEW	eCall and post-crash warning If sensors in the vehicle detect that a collision has occurred, the vehicle can automatically call the emergency services to provide information about the vehicle and its location, opening a voice channel to communicate with the emergency call centre. The post-crash warning warns drivers approaching a crashed vehicle.	Cellular	In-vehicle	Slow or stationary vehicle (overlap with post-crash warning) Slow or stationary vehicle(s) warning, is intended to deliver safety benefits by warning approaching drivers about slow or stationary/broken down vehicle(s) ahead, which may be acting as obstacles in the road. The warning helps to prevent dangerous manoeuvres as drivers will have more time to prepare for the hazard. This service can also be referred to as car breakdown warning.	V2V ITS G5; Cellular 4G/ 5G	In-vehicle			

COBRA				*C-ITS Platform*			*Use cases*		
Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
LDEW				Hazardous location notification Gives drivers an advance warning of upcoming hazardous locations in the road. Examples include a sharp bend in the road, steep hill, pothole, obstacle, or slippery road service. (Some overlap with COBRA in-vehicle signage)	V2V ITS G5; Cellular 4G/ 5G	In-vehicle data combined with V2I info from weather and signage	Nordic Scoop@F	Nordic: cellular Scoop@F: Hybrid cellular/ ITS-G5	
In-vehicle speed and signage (IVSS)	In-vehicle signage (permanent features e.g. curve speed, roundabout, pedestrian crossing, planned road works) A vehicle-infrastructure link gives information or a warning to a driver about the content of an upcoming roadside sign which is beyond the line-of-sight. Drivers can also be informed of features such as roundabouts, traffic calming and segregated lanes. Information can be both static and dynamic.	Cellular Beacons		In-vehicle signage Informs drivers of relevant road signs in the vehicle's vicinity, alerting drivers to signs that they may have missed, or may not be able to see.	Hybrid cellular or ITS-G5 depending on infrastructure				
IVSS	Intelligent speed adaptation – informative ISA monitors a vehicle's speed and the speed limit on the road and informs the driver if the vehicle exceeds that limit.	Cellular		In-vehicle speed limits Speed limit information may be displayed to the driver continuously, or targeted warnings may be displayed in the vicinity of road signs, or if the driver exceeds or drives slower than the speed limit.	Hybrid cellular or ITS-G5 depending on infrastructure				

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Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
IVSS	Intelligent speed adaptation – warning ISA monitors a vehicle's speed and the speed limit is fed back to the driver via a haptic throttle – termed 'voluntary' ISA.	Beacons							
IVSS	Dynamic speed limits Provides drivers with information in the vehicle about the current dynamic speed limit (e.g as a response to congestion shock waves, approaching fog, ice, slippery road, exceeding emission limits)	Cellular Beacons							
				Shock wave damping Aims to smooth the flow of traffic, by damping traffic shock waves. Real time data is used to feed advisory speeds to cars to smooth out speed variations	Hybrid cellular or ITS-G5 depending on infrastructure				
				Probe vehicle data Road operators collect and collate vehicle data, which can then be used for a variety of applications	Hybrid cellular or ITS-G5 depending on infrastructure	In-vehicle	Nordic C-ITS corridor Scoop@F	Nordic: cellular Rest: cellular/ ITS-G5	

COBRA				*C-ITS Platform*			*Use cases*		
Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
Travel information and dynamic route guidance (TIDRG)	Traffic information and recommended itinerary (pre-trip route choice, on-trip route choice after incident) Recommends a route for the vehicle navigation system to direct the driver around congested locations and dangerous roads and to distribute the traffic load on alternative routes.	Cellular	Loops	Traffic information and smart routing (Day 1.5) Provision of traffic information and smart routing services to vehicles is intended to improve traffic efficiency and aid traffic flow management	Hybrid cellular or ITS-G5 depending on infrastructure		UK	Hybrid cellular/ ITS-G5	UK: also Loops
TIDRG	Multimodal traffic information (pre-trip route choice, on-trip route choice after incident) Provides drivers with information relevant to using alternative modes or interchanging with other modes during their journey.	Cellular							
TIDRG	Truck parking information and guidance Provides truck drivers with information to enable them to optimise their search for a parking space	Cellular					UK	ITS G5	
				Wrong-way driving Advance warning of wrong way driving has two main functions: firstly, to alert the driver that they are driving in the wrong direction, and secondly, to warn surrounding vehicles of the danger	ITS-G5 Possibly cellular				

COBRA				*C-ITS Platform*			*Use cases*		
Bundle	**Service**	**Comms**	**Sensors**	**Inter-urban services involving infrastructure**	**Comms**	**Sensors**	**Service from corridor**	**Comms**	**Sensors**
				Information on fueling and charging stations for alternative fuel vehicles (day 1.5) Broadcast electric vehicle charging point availability and AFV fuelling point information to relevant vehicles.	Hybrid cellular or ITS-G5 depending on infrastructure				
				Park and ride information (Day 1.5) The provision of Park & Ride information is intended to reduce congestion in urban areas and also shift travel from cars to public transport	Hybrid cellular or ITS-G5 depending on infrastructure		UK	Hybrid cellular/ ITS-G5	

NB for full definition of C-ITS platform services see WG1 Annex 1 C-ITS service list

Details of platforms for C-ITS platform services can be found at WG1 Annex 2 Summary report-FV.pdf