ANACONDA

Report on data collection and processing

Deliverable No 4.1

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Executive summary

The ANACONDA (Assessment of user needs for adapting COBRA including online database) project builds on the results of the previous COBRA project and aims to position COBRA+ as a major 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 traffic systems 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.

The following C-ITS services (and combinations of them) can be analysed in ANACONDA:

- Hazard Location Warning
- Road Works Warning (short distance)
- Traffic Jam Ahead Warning
- Shockwave damping
- In-Vehicle Signage (excluding speed limits)
- In-Vehicle Signage Speed Limits
- Traffic information and Road Works (long distance) Information

This deliverable presents the approach taken in ANACONDA for collecting and processing the data required for the cost-benefit calculations in the tool. In general, the data can be divided into 1) country-specific data about the road network and infrastructure costs, 2) expected (societal) impacts of the C-ITS services and 3) assumptions for the underlying cost benefit models such as penetration curves for different technologies. This report is devoted to the former two groups of data, as the third one is included in the tool's user guide.

Data was updated and/or added to the tool for five countries, with input from the respective NRAs. The countries are Austria, Germany, Finland, the Netherlands and the UK. The collection of country-specific data was divided into two phases, which were conducted subsequently, i.e. the NRAs of the countries were first asked to provide general data about the network to be analysed in ANACONDA, and then asked to provide additional NRA-specific details. The data figures include e.g. network size, societal problem size (accidents, emissions etc.), forecasts of societal problem size data, driven distances per year as well as more specific data on the costs of existing and future ITS infrastructure (e.g. variable message signs and ITS-G5 beacons). To cope with missing data, the project team conducted a literature review to fill the gaps. If there was still data missing, default values were provided to complete the sheets for each country. This default data either stems from other countries, if applicable or from approximations by the project team.

Data on the expected societal impacts of the respective C-ITS services was synthesized from various impact assessment studies (e.g. CODIA, EasyWay, eIMPACT) and literature sources. By doing this, the percentage change of impacts on safety, traffic efficiency, fuel consumption and emissions due to the introduction of C-ITS was estimated. This estimation builds the basis for the societal cost-benefit calculations.

The next steps to be taken include the development of an in-depth description of the selected use-cases per country, including their geographical region, the C-ITS services involved and the legacy systems present. Moreover, a final stakeholder workshop with NRAs will be held by the end of February 2017. The project team will present and demonstrate the final version of the COBRA+ tool and the COBRA+ Monitor, before the application of the tool the selected use cases will be discussed.

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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 (Assessment of user needs for adapting COBRA including online database) project falls into this theme.

Current 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, positioning of road authorities across CEDR countries towards C-ITS and others.

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. In order to make COBRA+ work, a high amount of data is needed as basis for the calculations. In general, the data can be divided into 1) country-specific data about the road network and infrastructure costs, 2) expected (societal) impacts of C-ITS and 3) assumptions for the underlying cost benefit models such as penetration curves for different technologies. This report is devoted to the former two groups of data, as the third one is included in the tool’s user guide.

The deliverable starts with a description of the methodology in Section 2, including the collection procedure and the approach for the impact assessment. As the core part of this deliverable, Section 3 gives all collected data for each of the six countries included in ANACONDA, along with the sources and further comments. Section 4 presents the impact data, which were updated from the COBRA project, before the report is concluded with final remarks and an outlook on the next steps.

2 Method and description of data

This section describes the methodology for collecting the data and explains the data elements in detail.

2.1 Overview on country data collection

The aim was to allow a wide range of NRAs to be able to use the COBRA+ tool, while supported by the project team. Data was updated and/or added to the tool for five countries, with input from the respective NRAs. The countries are Austria, Germany, Finland, the Netherlands and the UK. For other countries, default data is provided, so that the respective NRAs can add data themselves with our support. Countries that do not wish to do this during the project duration, can still add their data themselves outside the project (but the ANACONDA team will not be able to assist them). To achieve this, a framework for collecting the data was developed, in order to have a common procedure for use in all selected countries (see Figure 1).

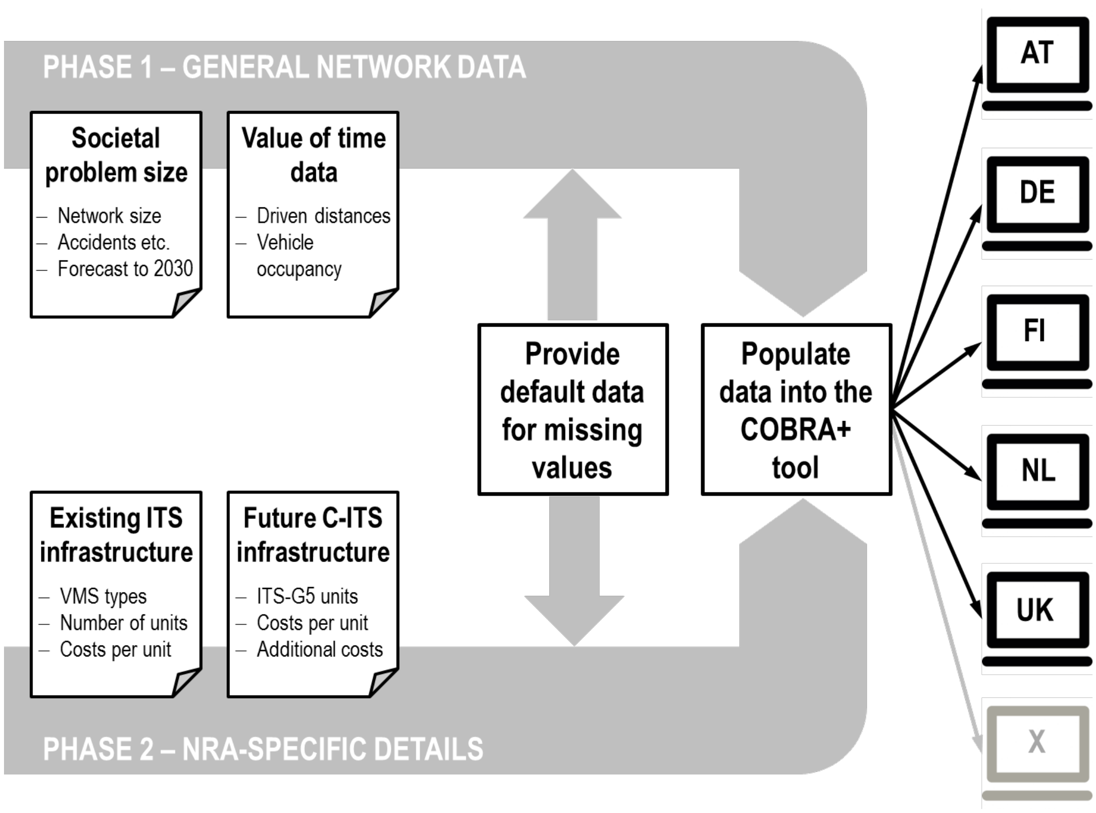

Figure 1: Methodology of the country data collection

The data collection was divided into two phases, which were conducted subsequently, i.e. the NRAs were first asked to provide data about the network to be analysed in ANACONDA, and then asked to provide additional NRA-specific details. Section 2.2 and 2.3 explain the data within the phases in depth. Note that some NRAs manage both motorways and other road types so that some country data include non-motorways as well. Additionally, as part of the use case analysis in WP5, specific road corridors are assessed within ANACONDA for Austria, Finland, the Netherlands and the UK. The corridors are described in-depth in the ANACONDA deliverable D5.1.

AIT provided data table templates in MS Excel with partly prefilled values to facilitate the data provision by the NRAs. However, not all of the requested data was available within the NRAs, which resulted in missing data values. To cope with this, the project team conducted a literature review to fill the gaps. If there was still data missing, default values were provided to complete the sheets for each country. This default data either stems from other countries, if applicable, or from approximations by the project team. However, the sources and whether it is an approximation is indicated in the respective tables' comments.

The data presented in Section 3 reflects the state of collected data by the time when this report was compiled. Future COBRA+ users are encouraged to update the data and to replace default values, if available.

2.2 Phase 1 – General network data

The first phase of the data collection comprised general data about the network, which is not necessarily NRA-specific, as it was available from other public sources as well, e.g. accident data. The data is primarily used to monetize the impacts of C-ITS in terms of safety, traffic flow and delay and environment, taking into account the reference situation in each country. In this phase, the following data figures were collected for each of the road types included for the respective country (i.e. motorways, non-motorways and corridor):

General data about the network:

- Organisation Name
- Total road network size in km, in both directions of travel
- Description of road type

Societal problem size data

- Fatalities/year
- People with non-fatal serious injuries/year
- Collisions involving an injury/year
- Mio. veh-hours/year
- Mio. litre petrol used/year
- Mio. litre diesel used/year
- Mio. tonnes CO2/year
- Driven passenger car km/year

Forecast of societal problem size data until 2030:

- Forecast of Fatalities/year in %
- Forecast of People with non-fatal serious injuries/year in %
- Forecast of Mio. veh-hours/year in %
- Forecast of Mio. litre petrol used/year in %
- Forecast of Mio. litre diesel used/year in %
- Forecast of Mio. tonnes CO2/year in %

Additional data for value of time calculation:

- Discount rate
- Driven km/year for passenger cars and taxis
- Driven km/year for light vans
- Driven km/year for goods vehicles
- % of total driven distance for business travel

- % of total driven distance for commuting travel
- % of total driven distance for other private travel
- % of total driven distance for car travel
- Average occupancy for business travel in people per car
- Average occupancy for non-working time in people per car

For each of the four groups of phase 1 data above, Section 3 includes the corresponding tables with the collected data for each country. The subsections are named either “motorway-specific data”, “non-motorway specific data” or “corridor-specific data”.

2.3 Phase 2 – NRA-specific details

In comparison to phase 1, the second collection phase comprised more detailed data about ITS infrastructure and future deployment plans, which was in most cases not publicly available. This data is used to estimate the expected cost savings due to existing infrastructure, as well as to reduce the expected impacts of C-ITS accordingly (see Section 2.5).

Cost data on existing VMS (all costs in Euros):

- VMS types used in the country
- 1-off Equipment costs per type and unit
- 1-off Installation costs per type and unit
- Annual operation & maintenance costs per type and unit
- Lifetime (renewal period) per type and unit
- Replacement cost per type and unit

Number of existing VMS units:

- On motorways
- On non-motorways, if applicable
- On the corridor, if applicable

Impact reduction factors for existing VMS types (see Section 2.5):

- Effectiveness range in km
- Impact reduction for the C-ITS service Hazardous Location Warning, per VMS type
- Impact reduction for the C-ITS service Road Works Warning, per VMS type
- Impact reduction for the C-ITS service Traffic Jam Ahead Warning, per VMS type
- Impact reduction for the C-ITS service Shock Wave Damping, per VMS type
- Impact reduction for the C-ITS service In-Vehicle Signage, per VMS type
- Impact reduction for the C-ITS service In-Vehicle Speed Limits, per VMS type
- Impact reduction for the C-ITS service Traffic Information, per VMS type

Future ITS infrastructure (all costs in Euros):

- ITS-G5 beacon types (e.g. gantry mounted, roadside, trailer etc.)
- 1-off Equipment costs per beacon type and unit
- 1-off Install. costs per beacon type and unit
- Annual operation & maintenance costs per beacon type and unit
- Lifetime (renewal period) per beacon type and unit
- Replacement cost per beacon type and unit

- Planned beacon units per km, on motor-ways
- Planned beacon units per km, on non-motor-ways, if applicable
- Planned beacon units per km, on the corridor, if applicable

Additional required ITS infrastructure (all costs in Euros):

- Additional infrastructure needed to deploy the C-ITS services (e.g. back office)
- Lifetime period per additional infrastructure
- Basic costs for all services, per additional infrastructure
- Additional costs specifically for C-ITS services, per additional infrastructure

For each of the five groups of phase 2 data above, Section 3 includes the corresponding tables with the collected data for each country, all given in the subsections called “Data on ITS infrastructure”.

2.4 Assessment of societal impacts

The project aims to assess the impacts of cooperative traffic systems relevant for road operators, in order to provide support for decision makers. The impacts are determined in terms of maximum effectiveness at 100% penetration of equipped vehicles and infrastructure. The focus was on both motorways and non-motorway non-urban roads. Note that in comparison to the data collection described above, the impact data is not country-specific but the same values are used for each country.

As in the initial COBRA project [1], the aim was to have the most promising cooperative services for analyses within ANACONDA. Day 1 and Day 1.5 services from the C-ITS Platform [4] were consulted. See Deliverable 1.1 for more details [2]. Table 1 shows the cooperative services included in the new COBRA+ tool, grouped into three bundles. As opposed to COBRA, the user of the COBRA+ tool has the option of selecting either an individual service or a bundle.

Table 1: List and bundles of cooperative services

Bundle	**Service**
Bundle 1 Local dynamic event warnings	1a. Hazard Location Warning 1b. Road Works Warning (short distance) 1c. Traffic Jam Ahead Warning 1d. Shockwave damping
Bundle 2 In-vehicle signage	2a. In-Vehicle Signage (excluding speed limits) 2b. In-Vehicle Signage Speed Limits
Bundle 3 Traffic Information	Traffic information and Road Works (long distance) Information

The methodology of the impact assessment is similar as in the initial COBRA project. Figure 2 depicts the concept of the impact assessment, which consists of four parts, of which two are presented in this deliverable. The first task is to assess each service at 100% penetration with regard to each of the impact indicators; as in COBRA, the safety, efficiency and environment indicators are identified from existing literature. The second task is to determine the overlap between the services, allowing for a calculation of the impact per bundle.

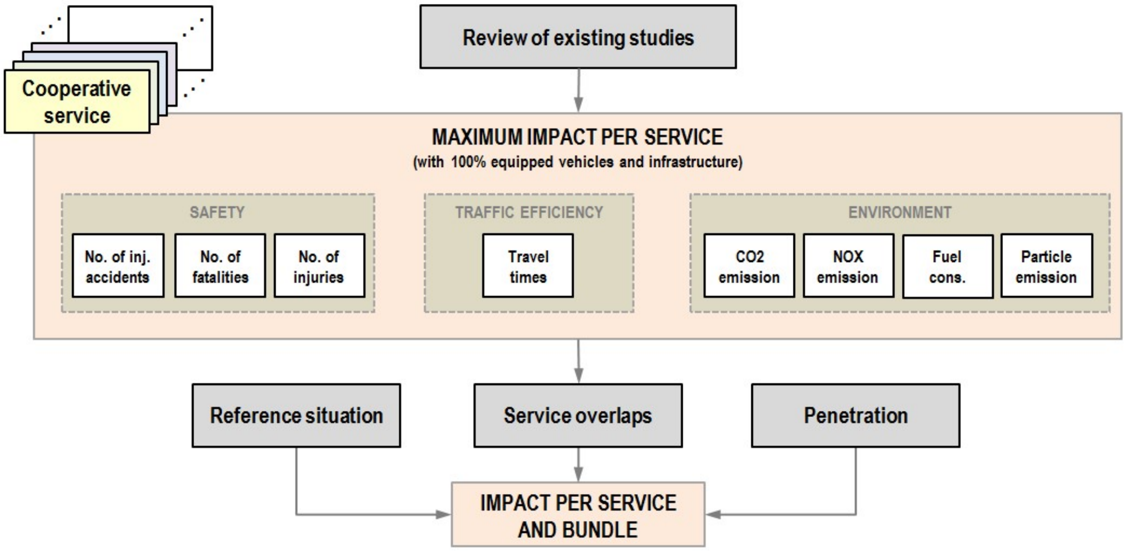

Figure 2: Methodology of impact assessment ([3])

The impact assessment is based on findings and results from previous studies and projects. As in COBRA, in ANACONDA no particular simulations or field operational trials were performed. Instead, existing literature provides relevant data on specific impact indicators. The indicators used were:

Safety:

- Number of injury accidents – number of road accidents that result in personal injuries.
- Number of fatalities – number of fatally injured people due to a road accident.
- Number of injuries – number of slightly or gravely injured people, wounded in a road accident.

Traffic efficiency:

- Travel times – measured time difference between departure and arrival times of vehicles, on a specific road segment.

Environment:

- CO2 – carbon dioxide (measured in g/km).
- NOx – nitrogen oxides NO (nitrogen oxide) and NO2 (nitrogen dioxide) (measured in g/km).
- Fuel consumption – consumption of fuel (gas or diesel) (measured in l/100km)
- Particles – particulate matter of different chemical compositions, suspended in air, generated from the burning of fossil fuels (measured in µg/m3)

The second task of assessing the impact of each bundle meant to evaluate the overlap between the services within a bundle, i.e. how the services could affect each other. This consisted of three steps:

1. Identify the overlapping cooperative services within a bundle
2. Estimate the overlapping range
3. Calculate the resulting impact per bundle

For more details on the methodology of the impact overlap, please see Deliverables 2.1 and 3.1 of the COBRA project [1], [3].

2.5 Impact reduction due to existing ITS infrastructure

When assessing impacts of C-ITS, it is important to know the extent of existing ITS infrastructure that delivers similar information to the drivers as the C-ITS service will do. For example, an in-vehicle signage service will certainly have an overlap of information with existing Variable Message Signs (VMS). Therefore, an impact reduction factor was introduced in ANACONDA that takes into account the coverage of existing VMS within the road network.

Figure 3 depicts the principle of the impact reduction calculation. In principle, the impact value for a certain C-ITS service (see Section 4) is multiplied by a factor between 0 and 1, calculated as given in the brackets of the lower formula in the figure. It must be noted that the following calculation is only applied to the C-ITS services in bundle 1 and 2, since bundle 3 (traffic information) includes routing information, for which the overlap with existing VMS is estimated by a fixed value of 50 percent. Three factors come into play:

1. The **effectiveness range d_{eff}** of existing VMS indicates the estimated length in kilometres for which the given information (e.g. speed limit) remains effective. In other words, this gives the length and/or duration how long the driver remains aware of the information. The project team estimated an effectiveness range, depending on the information the VMS can display.
2. The **compliance rate *comp*** is a percentage of how many drivers comply with the given advisory or information. Due to simplicity, a fixed value of 90% was assumed, which means that e.g. 90% of the drivers follow the speed limits. The users of the COBRA+ tool can adapt this value if necessary.
3. The C-ITS **impact factor f_{IR}** gives the extent of overlap between the information displayed by a certain VMS type and those given by the C-ITS service. The factors were estimated in the steps 0%, 25%, 50%, 75% and 100%, where 0% means that the C-ITS service has no impact at all, i.e. there is full overlap of information. On the other side of the scale, 100% means that all information given by the C-ITS service is “exclusive”, i.e. there is zero overlap. For example, for the C-ITS service Road Works Warning, the factor would be 100% for a VMS that cannot display road work signs at all. However, if the VMS was able to display a text instead to warn about an upcoming road work zone, the factor would be e.g. 50%, because the given information does not give the same level of detail as the C-ITS service does.

In the simplified motorway network in Figure 3, three VMS are given (2x VMS type 1 and 1x VMS type 2). Each of the two types has a certain effectiveness range, which adds up to the total effectiveness range for all VMS. Divided by the **network length d_{net}**, this gives the effective **coverage of existing infrastructure C_{INF}** on the whole network in percent. Now, it is possible to apply the three factors from above to the “informed network” only, i.e. the impact value is only reduced for the sections where the VMS are considered effective.

In the COBRA+ tool, the user is able to modify the default effectiveness ranges, compliance rates and impact reduction factors. Note that the impact reduction calculation is only applied to bundle 1 and bundle 2, as mentioned above.

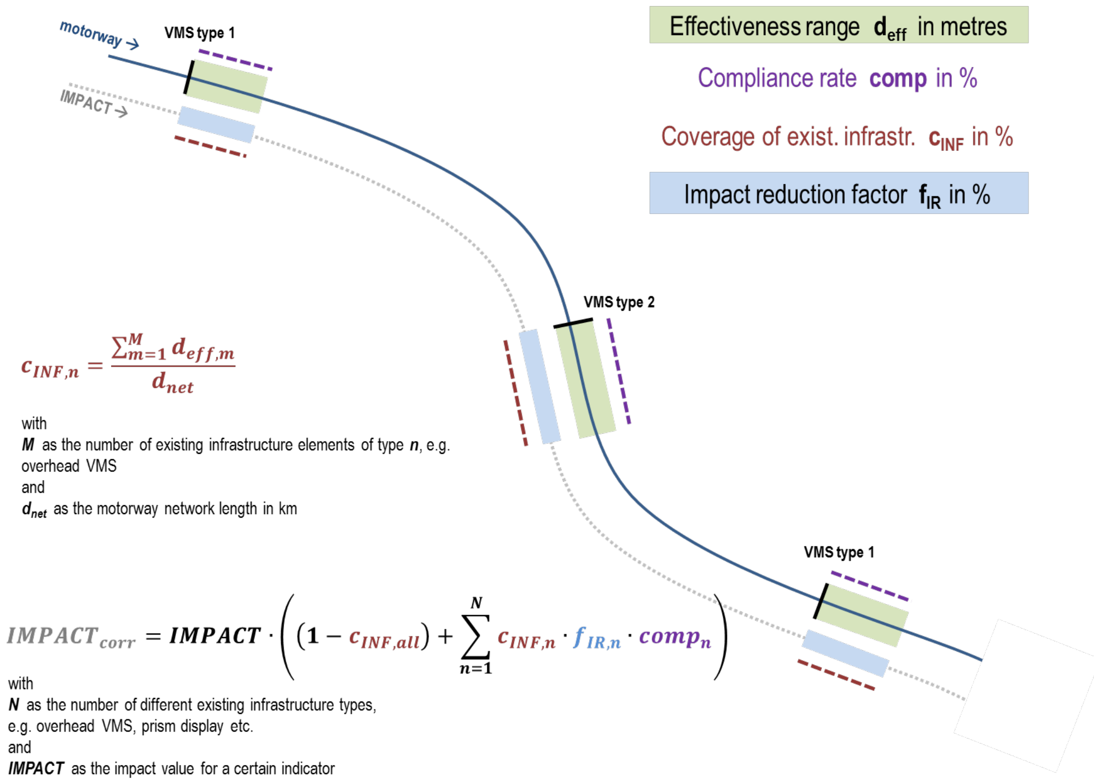

Figure 3: Illustration of the calculation of the impact reduction

3 Collected data for the COBRA+ tool

3.1 Austria

Data for Austria was collected from ASFINAG, in cooperation with AIT. The Austrian network to be analysed in ANACONDA comprises only motorways, also called “Autobahnen und Schnellstraßen”. The following sections present the data collected by the time of writing this report. Please note that the data in the latest version of the COBRA+ tool might have been updated after the submission of this report.

3.1.1 Data on ITS infrastructure

The Austrian motorway network is equipped with four different groups of VMS, as depicted in Figure 4, which the following data tables refer to.

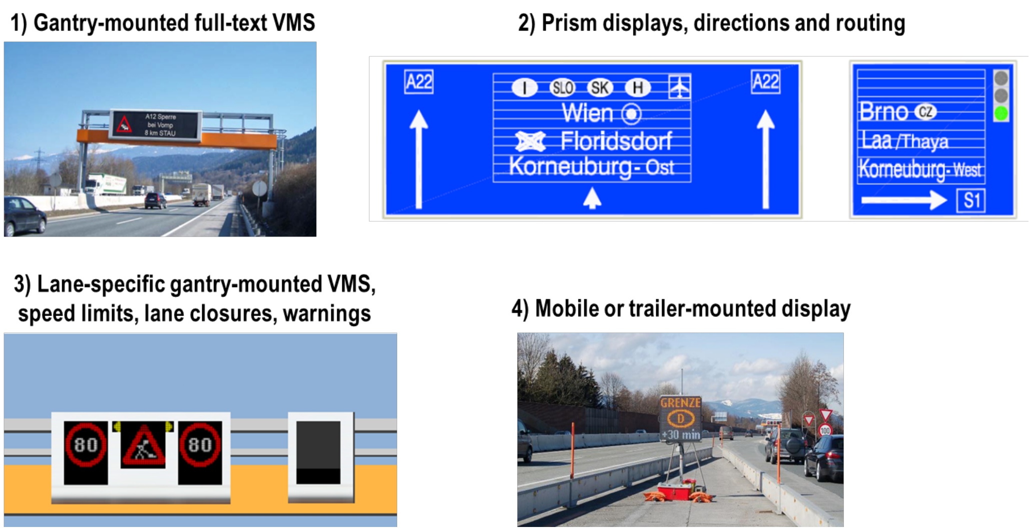

Figure 4: VMS types in Austria

Table 2 gives the estimated costs for each of the VMS types, as a basis for the calculation of potential infrastructure cost savings due to the deployment of C-ITS.

Table 2: Cost data on existing VMS in Austria (all costs are given in Euros)

VMS Type	1-off Equipment costs	1-off Installation costs	Annual operation & mainten. costs	Lifetime (renewal period)	Replacement cost
Gantry mounted full text VMS	90,000	80,000	5,000	15	80,000
Prism displays, directions and routing	90,000	80,000	5,000	15	80,000
Lane specific gantry-mounted VMS	90,000	80,000	5,000	15	80,000
Trailer-mounted mobile display	50,000	30,000	3,000	15	30,000

In Table 3, the existing units for each VMS type are given for motorways, non-motorway roads and the corridor, respectively.

Table 3: Number of existing VMS units in Austria

VMS type	Existing units		
	On motor-ways	On non-motorways	On the corridor
Gantry mounted full text VMS	651	n/a	41
Prism displays, directions and routing	218	n/a	21
Lane specific gantry-mounted VMS	65	n/a	9
Trailer-mounted mobile display	138	n/a	0

Table 4 indicates whether the information given by the VMS types overlap with the ANACONDA C-ITS services. This is necessary to estimate the reduction of impacts a C-ITS service might have due to this overlap of information to the drivers.

Table 4: Default impact reduction factors for existing VMS types in Austria (see Section 2.5)

VMS Type	Effective range in km	C-ITS impact factor (0: no impact, full overlap, 1: 100% impact, no overlap)						
		HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
Gantry mounted full text VMS	0.25	0.5	0.5	0.5	0.5	0.5	0.5	n/a
Prism displays, directions and routing	0.30	1	1	1	1	1	1	n/a
Lane specific gantry-mounted VMS	0.25	0.25	0.25	0.25	1	1	1	n/a
Trailer-mounted mobile display	0.25	1	0.75	1	1	1	1	n/a

Future C-ITS infrastructure, i.e. ITS-G5 beacons necessary to run the services are given in Table 5. The table lists both expected costs and expected units to be installed per kilometre.

Table 5: Future ITS infrastructure in Austria (all costs are given in Euros)

ITS beacon type	Costs					Expected units per km		
	1-off Equipm. costs	1-off Install. costs	Annual operation &mainten. costs	Lifetime (renewal period)	Replace-ment cost	On motor-ways	On non-motor-ways	On the corridor
Overhead wireless beacons	6,000	10,000	500	10	10,000	0.25	n/a	0.25

Besides ITS-G5 beacons, additional infrastructure is required to deploy a C-ITS service, as seen in Table 6.

Table 6: Required ITS infrastructure in Austria (all costs are given in Euros)

Infrastructure needed	Lifetime period	Basic costs for all services	Additional costs for C-ITS services						
			HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
Infrastructure for implementation in traffic management centres	10	2,500,000	0	0	0	0	0	0	0

Operation and management at traffic management centres	n/a	250,000	0	0	0	0	0	0	0
Development of Smartphone app	10	200,000	0	0	0	0	0	0	0
App operation and maintenance (annual)	n/a	20,000	0	0	0	0	0	0	0

3.1.2 Motorway-specific data

As Table 7 summarizes, the Austrian motorway network considered in ANACONDA covers 2,199 km. The societal problem size data, e.g. accident data and emissions, is given in Table 8.

Table 7: General data for the Austrian motorways and expressways

Organisation Name	ASFiNAG
Network size [km]	2,199 km [Source: ASFiNAG 2016]
Description of road type	Motorways and Expressways

Table 8: Societal problem size data for the Austrian motorways and expressways

Data variable	Value	Year	Source	Comment
Fatalities/year	50	2015	Statistik Austria	
People with non-fatal serious injuries/year	444	2015	Statistik Austria	
People with non-fatal slight injuries/year	2,806	2015	Statistik Austria	
Collisions involving an injury/year	2,164	2015	Statistik Austria	
Mio. veh-hours/year	298	2015	ASFiNAG	Assumed an average duration of 0.01 hours per km, at 100 km/h
Mio. litre petrol used/year	901	2015	Estimation based on NL data	computed from NL data for motorways
Mio. litre diesel used/year	1,652	2015	Estimation based on NL data	computed from NL data for motorways
Mio. tonnes CO2/year	5,778	2015	Estimation based on NL data	computed from NL data for motorways

3.1.3 Corridor-specific data

The Austrian corridor to be analysed in ANACONDA (see deliverable D5.1) covers a total distance of 171 km (see Table 9) between Vienna (West) and Linz (exit Ansfelden). The societal problem size data, e.g. accident data and emissions, is given in Table 10.

Table 9: General data for the Austrian corridor

Organisation Name	ASFINAG
Network size [km]	171
Description of road type	Wien – Linz (Ansfelden)

Table 10: Societal problem size data for the Austrian motorways and expressways

Data variable	Value	Year	Source	Comment
Fatalities/year	12	2015	Statistik Austria	
People with non-fatal serious injuries/year	82	2015	Statistik Austria	
People with non-fatal slight injuries/year	395	2015	Statistik Austria	
Collisions involving an injury/year	252	2015	Statistik Austria	
Mio. veh-hours/year	23	2015	Estimation	Downscaled based on the network length difference
Mio. litre petrol used/year	70	2015	Estimation based on NL data	computed from NL data for motorways
Mio. litre diesel used/year	128	2015	Estimation based on NL data	computed from NL data for motorways
Mio. tonnes CO2/year	446	2015	Estimation based on NL data	computed from NL data for motorways

3.1.4 General country specific data

This section summarizes all country data that is independent of the road type, such as unit costs or forecasts. The unit costs data for accidents, emissions and travel times are given in Table 11. Table 12 gives the number of registered vehicles.

Table 11: Unit cost data for Austria

Data variable	Value	Year	Source	Comment
Fatality - value of prevention in EUR/fatality	3,016,194	2011	bmvit 2011	
Serious injury - value of prevention in EUR/ serious injury	381,480	2011	bmvit 2011	
Slight injury - value of prevention EUR/ slight injury	26,894	2011	bmvit 2011	
Injury accidents - value of prevention EUR/ injury accident	5,245	2011	bmvit 2011	
Petrol (price at pump) in EUR	1.197	2016	http://www.bmwfw.gv.at/EnergieUndBergbau/Energiepreise/	Dated 1.1.2016

Fuel duty on petrol in EUR	0.482	2016	See above	
Diesel (price at pump) in EUR	1.113	2016	See above	
Fuel duty on diesel in EUR	0.397	2016	See above	
Cars (driver + passengers) EUR/hour working time	36.00	2015	RWS SEE (2015)	
Cars (driver) EUR/hour working time	30.93	2015	RWS SEE (2015)	
Cars (passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	
Light Good vehicle (driver or passenger) EUR/hour working time	49.02	2015	RWS SEE (2015)	
HGV (OGV) (driver or passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	
Car, non-working time (Commuting) EUR/hour non-working time OTHER	10.04	2015	RWS SEE (2015)	
Car, non-working time (Other) EUR/hour non-working time OTHER	8.14	2015	RWS SEE (2015)	

Table 12: Number of registered vehicles in Austria

Data variable	Value	Year	Source	Comment
Total number of vehicles registered in country	5,192,071	2015	Statistik Austria	Sum of numbers of cars, vans and lorries
Total number of cars	4,748,048	2015	Statistik Austria	
Total number of vans (LGVs)	375,163	2015	Statistik Austria	
Total number of lorries (HGVs)	68,860	2015	Statistik Austria	

Forecast estimations are needed for the calculations of the development of costs and benefits over time. Table 13 gives the forecast values for country-specific variables (such as GDP growth or oil price) until 2030, while Table 14 lists the forecasts for the societal problem size values for accidents and emissions.

Table 13: Unit cost forecast data (until 2030) for Austria

Data variable	Value	Year	Source	Comment
GDP growth	1.70%	2015	WLO (NL)	Average of low and high growth scenario
Value of time growth (working time)	0.63%	2015	WLO (NL)	Average of low and high growth scenario
Value of time growth (non-working time)	0.63%	2015	WLO (NL)	Average of low and high growth scenario
Current oil price in $/barrel	52	2015		
Oil price forecasts - growth	6.94%	2015	WLO (NL)	Average of low and high growth scenario

Non-traded values of CO2 in £/ton	6	2015	WLO (NL)	
Non-traded values of CO2 - growth	21.08%	2015	WLO (NL)	Average of low and high growth scenario

Table 14: Forecast of societal problem size data for the Austrian motorways and expressways (%-change from base year to 2030)

Data variable	Value	Year	Source	Comment
Fatalities/year	50%	2016	ASFiNAG	
People with non-fatal serious injuries/year	50%	2016	ASFiNAG	
People with non-fatal slight injuries/year	50%	2016	ASFiNAG	
Number of collisions involving an injury/year	50%	2016	ASFiNAG	
Mio. veh-hours/year	28%	2010	English value	
Mio. litre petrol used/year	-45%	2010	English value	
Mio. litre diesel used/year	-7%	2010	English value	
Mio. tonnes CO2/year	-11%	2010	English value	

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 15), which is taken for the motorway network and the corridor.

Table 15: Additional data for value of time calculation for the Austrian motorways and expressways

Data variable	Value	Year	Source	Comment
Discount rate	4%	2015	EC	
% of driven distance for passenger cars and taxis	86.83%	2004	Geschaeftsbericht_2004_Fahrleistung_ASFiNAG	including light vans
% of driven distance for light vans	-	-		not available (included in passenger cars)
% of driven distance for goods vehicles	13.17%	2004	Geschaeftsbericht_2004_Fahrleistung_ASFiNAG	
% of total driven distance for business travel	9,01%	2016	ASFiNAG	
% of total driven distance for commuting travel	26.13%	2016	ASFiNAG	
% of total driven distance for other private travel	58.73%	2016	ASFiNAG	
% of total driven distance for car travel	93.87%	2016	ASFiNAG	
Average occupancy for business travel in people per car	1.1	2016	Estimation	
Average occupancy for non-working time in people per car	1.2	2016	Estimation	

3.2 *The Netherlands*

Data for the Netherlands was collected from Rijkswaterstaat, in cooperation with TNO. The Dutch network to be analysed in ANACONDA comprises both motorways and non-motorway sections, further denoted as A roads and N roads respectively. The following sections present the data collected by the time of writing this report. Please note that the data in the latest version of the COBRA+ tool might have been updated after the submission of this report.

3.2.1 Data on ITS infrastructure

The Dutch road network is equipped with five different groups of VMS, some divided into two or more subgroups. Figure 5 depicts those VMS types, which the following data tables refer to.

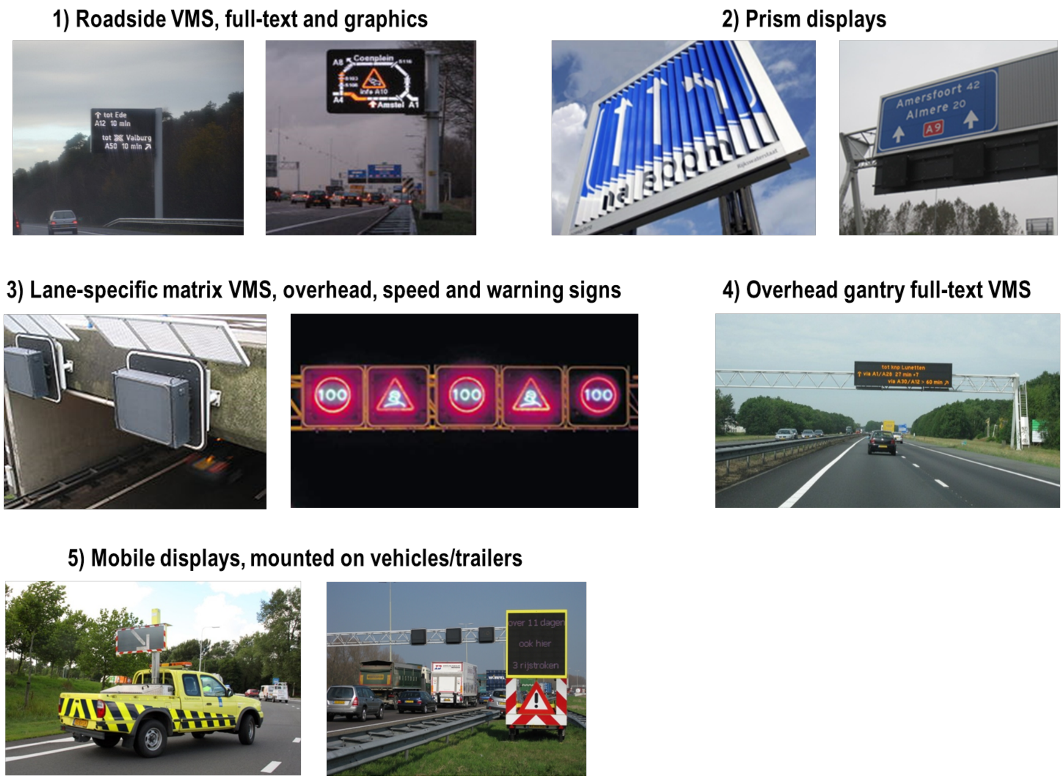

Figure 5: VMS types in the Netherlands

Table 16 gives the estimated costs for each of the VMS types, as a basis for the calculation of potential infrastructure cost savings due to the deployment of C-ITS. In the Dutch case equipment costs also includes installation and replacement costs. For the mobile displays, costs were estimated based on Austrian data.

Table 16: Cost data on existing VMS in the Netherlands (all costs are given in Euros)

VMS Type	1-off Equipment costs	1-off Installation costs	Annual operation & mainten. costs	Lifetime (renewal period)	Replacement cost
Roadside VMS, full-text and graphics	161,000	included in equipment costs	7,800	15	included in equipment

					costs
Prism displays	52,000	included in equipment costs	2,600	10	included in equipment costs
Lane-specific matrix VMS	900	included in equipment costs	200	15	included in equipment costs
Overhead gantry full-text VMS	161,000	included in equipment costs	7,800	15	included in equipment costs
Mobile displays, mounted an vehicles/trailers	50,000	30,000	3,000	15	30,000
Matrix VMS (typically central reservation)	52,000	included in equipment costs	2,600	10	included in equipment costs

In Table 17, the existing units for each VMS type are given for motorways, non-motorway roads and the corridor, respectively.

Table 17: Number of existing VMS units in the Netherlands

VMS type	**Existing units**		
	On motor-ways	**On non-motor-ways**	**On the corridor**
Roadside VMS, full-text and graphics	213	54	12
Prism displays	660	0	0
Lane-specific matrix VMS	15,888	106	1,363
Overhead gantry full-text VMS	104	2	4
Mobile displays, mounted an vehicles/trailers	517	0	0
Matrix VMS (typically central reservation)	139	0	90

Table 18 indicates whether the information given by the VMS types overlap with the ANACONDA C-ITS services. This is necessary to estimate the reduction of impacts a C-ITS service might have due to this overlap of information to the drivers.

Table 18: Default impact reduction factors for existing VMS types in the Netherlands (see Section 2.5)

VMS Type	**Effective range in km**	**C-ITS impact factor** (0: no impact, full overlap, 1: 100% impact, no overlap)						
		HLW	**RWW**	**TJW**	**SWD**	**IVS**	**IVS-SL**	**TI-RW**
Roadside VMS, full-text and graphics	0.25	1	0.25	0.25	1	0.5	0.75	n/a
Prism displays	0.30	1	1	1	1	1	1	n/a
Lane-specific matrix VMS	0.25	0.5	0.5	0.5	0.5	0.5	1	n/a
Overhead gantry full-text VMS	0.25	0.25	0.25	0.25	1	1	1	n/a
Mobile displays, mounted an vehicles/trailers	0.25	1	0.75	1	1	1	1	n/a
Matrix VMS (typically central reservation)	0.25	0.5	0.5	0.5	0.5	0.5	1	n/a

Future C-ITS infrastructure, i.e. ITS-G5 beacons necessary to run the services are given in Table 19. The table lists both expected costs and expected units to be installed per kilometre.

Table 19: Future ITS infrastructure in the Netherlands (all costs are given in Euros)

ITS beacon type	Costs					Expected units per km		
	1-off Equipm. costs	1-off Install. costs	Annual operation &mainten. costs	Lifetime (renewal period)	Replace-ment cost	On motor-ways	On non-motor-ways	On the corridor
Overhead wireless beacons	6,000	10,000	500	10	10,000	3.33	3.33	3.33

Besides ITS-G5 beacons, additional infrastructure is required to deploy a C-ITS service, as seen in Table 20.

Table 20: Required ITS infrastructure in the Netherlands (all costs are given in Euros)

Infrastructure needed	Lifetime period	Basic costs for all services	Additional costs for C-ITS services						
			HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
Infrastructure for implementation in traffic management centres *	10	2,500,000	0	0	0	0	0	0	0
Operation and management at traffic management centres	n/a	250,000	0	0	0	0	0	0	0
Development of Smartphone app	10	200,000	0	0	0	0	0	0	0
App operation and maintenance (annual)	n/a	20,000	0	0	0	0	0	0	0

3.2.2 Motorway-specific data

As Table 21 summarizes, the Dutch motorway network considered in ANACONDA covers 6,451 km. The societal problem size data, e.g. accident data and emissions, is given in Table 22.

Table 21: General data for the NL motorways

Organisation Name	Rijkswaterstaat
Network size [km]	6,451
Description of road type	Motorways

Table 22: Societal problem size date for the NL motorways

Data variable	Value	Year	Source	Comment
Fatalities/year	50	2015	RWS BRON	
People with non-fatal serious	141	2015	RWS BRON	

injuries/year				
People with non-fatal slight injuries/year	959	2015	RWS BRON	
Collisions involving an injury/year	927	2015	RWS BRON	
Mio. veh-hours/year	673	2015	INWEVA/TRIP	
Mio. litre petrol used/year	2,034	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=80101NED&D1=52,57&D2=0&D3=240,257,274,291,308,325&HDR=G1,G2&STB=T&VW=T	Based on 39% of the total vehicle kilometres driven by petrol vehicles on motorways (Source: CBS MethVerkeertabellen2014NED.xls)
Mio. litre diesel used/year	3,732	2015	See above	Based on 56% of the total vehicle kilometres driven by diesel vehicles on motorways (Source: CBS MethVerkeertabellen2014NED.xls)
Mio. tonnes CO2/year	13,050	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=37221&D1=0%2c6%2c8&D2=18&D3=12-17&HDR=G2%2cT&STB=G1&VW=T	Based on 45% of the total vehicle kilometres driven by passenger cars on motorways (Source: CBS MethVerkeertabellen2014NED.xls)

3.2.3 Non-motorway-specific data

As Table 23 summarizes, the Dutch non-motorway network considered in ANACONDA covers 1,160 km. The societal problem size data, e.g. accident data and emissions, is given in Table 24.

Table 23: General data for the NL non-motorways

Organisation Name	Rijkswaterstaat
Network size [km]	1,160
Description of road type	Non-Motorways (N roads operated by Rijkswaterstaat)

Table 24: Societal problem size date for the NL non-motorways

Data variable	Value	Year	Source	Comment
Fatalities/year	13	2015	RWS BRON	
People with non-fatal serious injuries/year	57	2015	RWS BRON	
People with non-fatal slight injuries/year	93	2015	RWS BRON	
Collisions involving an injury/year	115	2015	RWS BRON	
Mio. veh-hours/year	53	2015	INWEVA/TRIP	

Mio. litre petrol used/year	160	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=80101NED&D1=52,57&D2=0&D3=240,257,274,291,308,325&HDR=G1,G2&STB=T&VW=T	Result of scaling the value for motorways by the share of vehicle hours travelled on non-motorways
Mio. litre diesel used/year	294	2015	See above	Result of scaling the value for motorways by the share of vehicle hours travelled on non-motorways
Mio. tonnes CO2/year	1.028	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=37221&D1=0%2c6%2c8&D2=18&D3=12-17&HDR=G2%2cT&STB=G1&VW=T	Result of scaling the value for motorways by the share of vehicle hours travelled on non-motorways

3.2.4 Corridor-specific data

The Dutch corridor to be analysed in ANACONDA (see deliverable D5.1) covers a total distance of 316 km (see Table 25). The societal problem size data, e.g. accident data and emissions, is given in Table 26.

Table 25: General data for the NL corridor

Organisation Name	Rijkswaterstaat
Network size [km]	316
Description of road type	C-ITS corridor motorways (A16, A58, A2, A67)

Table 26: Societal problem size date for the Dutch corridor

Data variable	Value	Year	Source	Comment
Fatalities/year	3	2015	RWS BRON	
People with non-fatal serious injuries/year	12	2015	RWS BRON	
People with non-fatal slight injuries/year	44	2015	RWS BRON	
Collisions involving an injury/year	51	2015	RWS BRON	
Mio. veh-hours/year	47	2015	INWEVA/TRIP	
Mio. litre petrol used/year	142	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=80101NED&D1=52,57&D2=0&D3=240,257,274,291,308,325&HDR=G1,G2&STB=T&VW=T	Result of scaling the value for motorways by the share of vehicle hours travelled on non-motorways
Mio. litre diesel used/year	261	2015		Result of scaling the value for motorways by the share of vehicle hours travelled on non-motorways
Mio. tonnes CO2/year	0.911	2015	http://statline.cbs.nl/Statweb/publication/?DM=SLNL	Result of scaling the value for motorways by the share of vehicle

	&PA=37221&D1=0%2c6%2c8&D2=18&D3=12-17&HDR=G2%2cT&STB=G1&VW=T	hours travelled on non-motorways

3.2.5 General country specific data

This section summarizes all country data that is independent of the road type, such as unit costs or forecasts. The unit costs data for accidents, emissions and travel times are given in Table 27. Table 28 gives the number of registered vehicles.

Table 27: Unit cost data for the Netherlands

Data variable	Value	Year	Source	Comment
Fatality - value of prevention in EUR/fatality	2,645,759	2014	SWOV (2014). Factsheet Kosten van verkeersongevallen in internationaal perspectief. Rapport R-2014-6 (data van 2010)	
Serious injury - value of prevention in EUR/ serious injury	284,281	2014	See above	
Slight injury - value of prevention EUR/ slight injury	6,370	2014	See above	
Injury accidents - value of prevention EUR/ injury accident	3,566	2014	See above	
Petrol (price at pump) in EUR	1.52	2016	EC https://ec.europa.eu/energy/sites/ener/files/documents/2016_10_10_oil_prices_es95.pdf	
Fuel duty on petrol in EUR	0.7779	2016	EC http://ec.europa.eu/energy/observatory/reports/Oil_Bulletin_Duties_and_taxes.pdf	
Diesel (price at pump) in EUR	1.19	2016	EC https://ec.europa.eu/energy/sites/ener/files/documents/2016_10_10_oil_prices_es95.pdf	
Fuel duty on diesel in EUR	0.4925	2016	EC http://ec.europa.eu/energy/observatory/reports/Oil_Bulletin_Duties_and_taxes.pdf	
Cars (driver+passengers) EUR/hour working time	36.00	2015	RWS SEE (2015)	
Cars (driver) EUR/hour working time	30.93	2015	RWS SEE (2015)	
Cars (passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	
Light Good vehicle (driver or passenger) EUR/hour working time	49.02	2015	RWS SEE (2015)	
HGV (OGV) (driver or passenger) EUR/hour	24.74	2015	RWS SEE (2015)	

working time			
Car, non-working time (Commuting) EUR/hour non-working time OTHER	10.04	2015	RWS SEE (2015)
Car, non-working time (Other) EUR/hour non-working time OTHER	8.14	2015	RWS SEE (2015)

Table 28: Number of registered vehicles in the Netherlands

Data variable	Value	Year	Source	Comment
Total number of vehicles registered in country	8,927,926	2015	CBS Statline 2015	Total numbers added
Total number of cars	7,979,083	2015	CBS Statline 2015 (Motorvoertuigenpark; personenauto's)	
Total number of vans (LGVs)	814,954	2015	CBS Statline 2015 (Motorvoertuigenpark; bestelauto)	
Total number of lorries (HGVs)	133,889	2015	CBS Statline 2015 (Motorvoertuigenpark; vrachtauto excl+incl trekker oplegger)	

Forecast estimations are needed for the calculations of the development of costs and benefits over time. Table 29 gives the forecast values for country-specific variables (such as GDP growth or oil price) until 2030, while Table 30 lists the forecasts for the societal problem size values for accidents and emissions.

Table 29: Unit cost forecast data for the Netherlands

Data variable	Value	Year	Source	Comment
GDP growth	1.70%	2015	WLO (2015). Average of low and high growth scenario	
Value of time growth (working time)	0.63%	2015	WLO (2015). Average of low and high growth scenario	
Value of time growth (non-working time)	0.63%	2015	WLO (2015). Average of low and high growth scenario	
Current oil price in $ per Barrel	52	2015		Current oil price
Oil price forecasts - growth	6.94%	2015	WLO (2015). Average of low and high growth scenario	
Non-traded values of CO2 in £/ton	6	2015	WLO (2015). Average of low and high growth scenario	
Non-traded values of CO2 - growth	21.08%	2015	WLO (2015). Average of low and high growth scenario	

Table 30: Forecast of societal problem size data for the Netherlands (%-change from base year to 2030)

Data variable	Value	Year	Source	Comment
Fatalities/year	0%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	
People with non-fatal serious injuries/year	2.1%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	
People with non-fatal slight injuries/year	2.1%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	
Number of collisions involving an injury	0%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	
Mio. veh-hours/year	10%	2015	http://web.minienm.nl/mob 2015/7_1.html#tab-2	(road traffic measured in vehicle-kms). Otherwise the choice is time spent in congestion (index 1.45), but this latter number is based on a smaller denominator than total travel time.
Mio. litre petrol used/year	-13%	2015	WLO (2015)	Average of low and high scenario
Mio. litre diesel used/year	-16%	2015	WLO (2015)	Average of low and high scenario
Mio. tonnes CO2/year	-20%	2015	WLO (2015)	Average of low and high scenario

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 31), which is taken for motorways, non-motorways and the corridor.

Table 31: Additional data for value of time calculation for the Netherlands

Data variable	Value	Year	Source	Comment
Discount rate	4.50%	2015	RWS SEE (2015)	
% of driven distance for passenger cars and taxis	81%	2015	CBS Statline 2015 (Verkeersprestatie motorvoertuigen)	
% of driven distance for light vans	11.60%	2015	CBS Statline 2015 (Verkeersprestatie motorvoertuigen)	
% of driven distance for goods vehicles	6.40%	2015	CBS Statline 2015 (Verkeersprestatie motorvoertuigen)	
% of total driven distance for business travel	7.77%	2015	CBS	
% of total driven distance for commuting travel	22.55%	2015	CBS	
% of total driven distance for other private travel	50.68%	2015	CBS	
% of total driven distance for car travel	81%	2015	CBS	
Average occupancy for business travel in people per car	1.2	2016	Taken from England	
Average occupancy for private travel in people per car	1.4	2016	http://www.rijkswaterstaat.nl/images/Value%20of%20time%20personenvervoer%20per%20auto_tcm174-	Rough average based on RWS data

3.3 United Kingdom

Data for the UK was collected from Highways England, in cooperation with TRL. The UK network to be analysed in ANACONDA comprises both motorways and non-motorway sections. The following sections present the data collected by the time of writing this report. Please note that the data in the latest version of the COBRA+ tool might have been updated after the submission of this report.

3.3.1 Data on ITS infrastructure

The UK road network is equipped with five different groups of VMS. Figure 6 depicts those VMS types, which the following data tables refer to.

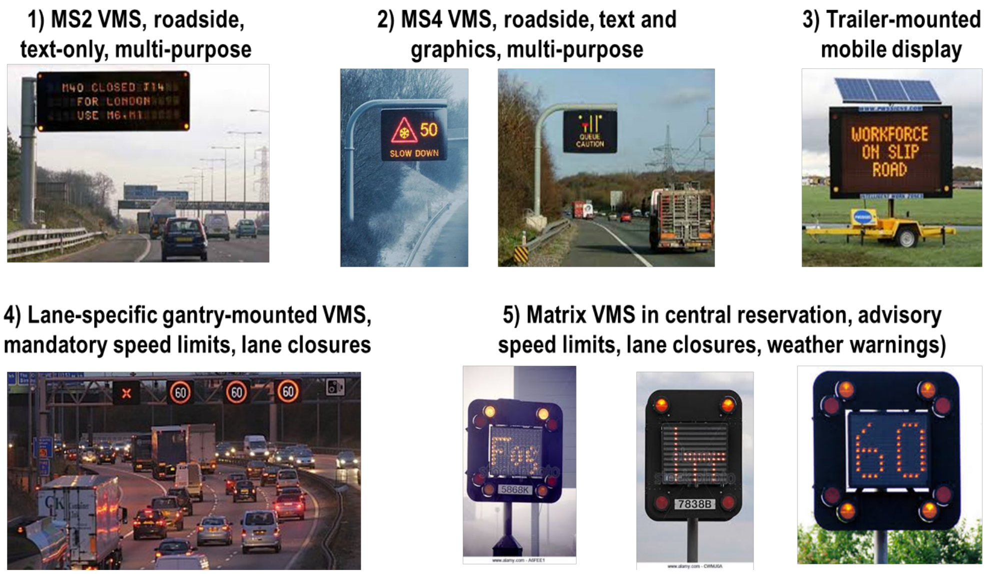

Figure 6: VMS types in the UK

Table 32 gives the estimated costs for each of the VMS types, as a basis for the calculation of potential infrastructure cost savings due to the deployment of C-ITS. Trailer-mounted VMS are rarely used in UK's strategic road network and are therefore excluded from the following tables.

Table 32: Cost data on existing VMS in the UK (all costs are given in Euros)

VMS Type	1-off Equipment costs	1-off Installation costs	Annual operation & mainten. costs	Lifetime (renewal period)	Replacement cost
MS2 VMS	140,330	165,289	30,225	15	140,330
MS4 VMS	94,000	315,000	1,000	15	94,000
Lane-specific gantry-mounted VMS	7,590	165,289	18,958	15	7,590
Matrix VMS in central reservation	135,660	165,289	30,225	15	135,660

In Table 33, the existing units for each VMS type are given for motorways, non-motorway roads and the corridor, respectively.

Table 33: Number of existing VMS units in the UK

VMS type	Existing units		
	On motor-ways	On non-motor-ways	On the corridor
MS2 VMS	1,947	381	57
MS4 VMS	483	84	0
Lane-specific gantry-mounted VMS	417	1	0
Matrix VMS in central reservation	8,710	1,211	205

Table 34 indicates whether the information given by the VMS types overlap with the ANACONDA C-ITS services. This is necessary to estimate the reduction of impacts a C-ITS service might have due to this overlap of information to the drivers.

Table 34: Default impact reduction factors for existing VMS types in the UK (see Section 2.5)

VMS Type	Effective range in km	C-ITS impact factor (0: no impact, full overlap, 1: 100% impact, no overlap)						
		HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
MS2 VMS	0.25	0.25	0.25	0.25	1	1	1	n/a
MS4 VMS	0.25	0.25	0.25	0.25	1	0.5	0.75	n/a
Lane-specific gantry-mounted VMS	0.25	0.5	0.5	0.5	0.5	0.5	0.5	n/a
Matrix VMS in central reservation	0.25	0.5	0.5	0.5	0.5	0.5	1	n/a

Future C-ITS infrastructure, i.e. ITS-G5 beacons necessary to run the services are given in Table 35. The table lists both expected costs and expected units to be installed per kilometre. The expected units are based on the assumption that the beacons are likely to be approximately 800 metres apart or closer together on busy sections of the network.

Table 35: Future ITS infrastructure in the UK (all costs are given in Euros)

ITS beacon type	Costs					Expected units per km		
	1-off Equipm. costs	1-off Install. costs	Annual operation &mainten. costs	Lifetime (renewal period)	Replace-ment cost	On motor-ways	On non-motor-ways	On the corridor
Overhead wireless beacons	6,000	10,000	500	10	10,000	1.4	1.25	1.4
Roadside wireless beacons mounted	6,000	7,500	500	10	7,500	1.4	1.25	1.4

Besides ITS-G5 beacons, additional infrastructure is required to deploy a C-ITS service, as seen in Table 36.

Table 36: Required ITS infrastructure in the UK (all costs are given in Euros)

Infrastructure needed	**Lifetime period**	**Basic costs for all services**	**Additional costs for C-ITS services**						
			HLW	**RWW**	**TJW**	**SWD**	**IVS**	**IVS-SL**	**TI-RW**
Infrastructure for implementation in traffic management centres *	10	2,500,000	0	0	0	0	0	0	0
Operation and management at traffic management centres	n/a	250,000	0	0	0	0	0	0	0
Development of Smartphone app	10	200,000	0	0	0	0	0	0	0
App operation and maintenance (annual)	n/a	20,000	0	0	0	0	0	0	0

3.3.2 Motorway-specific data

As Table 37 summarizes, the UK motorway network considered in ANACONDA covers 2,746 km. The societal problem size data, e.g. accident data and emissions, is given in Table 38.

Table 37: General data for UK's motorways

Organisation Name	Highways England
Network size [km]	2,746
Description of road type	Motorways

Table 38: Societal problem size date for UK's motorways

Data variable	**Value**	**Year**	**Source**	**Comment**
Fatalities/year	92	2015	HE accident data 2015	
People with non-fatal serious injuries/year	637	2015	HE accident data 2015	
People with non-fatal slight injuries/year	7,252	2015	HE accident data 2015	
Collisions involving an injury/year	4,826	2015	HE accident data 2015	
Mio. veh-hours/year	858	2015	1). English Regional plus Welsh Traffic, Emission and Speed Forecasts 2).Road traffic forecasts 2015	total hours=Total mileage/average speed
Mio. litre petrol used/year	2,392	2015	1.English Regional plus Welsh Traffic, Emission and Speed Forecasts 2.Webtag fuel consumption (2015 and 2030)	

CEDR Conférence Européenne des Directeurs des Routes Conference of European Directors of Roads

			3.Webtag ratio of Diesel and petrol cars and LGVs
Mio. litre diesel used/year	6,943	2015	See above
Mio. tonnes CO2/year	20		English Regional plus Welsh Traffic, Emission and Speed Forecasts

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 39).

Table 39: Additional data for value of time calculation for the UK

Data variable	Value	Year	Source	Comment
Discount rate	3.50%	2015	DfT TAG data book, A1.1.1, Dec 2015	
% of driven distance for passenger cars and taxis	74.34%	2015	NTS Sep 2015 (2014 value), NTS0901 - https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy	
% of driven distance for light vans	13.84%	2015	See above	
% of driven distance for goods vehicles	11.04%	2015	See above	
% of total driven distance for business travel	6.59%	2015	See above	
% of total driven distance for commuting travel	26.35%	2015	See above	
% of total driven distance for other private travel	41.40%	2015	See above	
% of total driven distance for car travel	74.34%	2015	See above	
Average occupancy for business travel in people per car	1.2	2015	NTS Sep 2015 (2014 value), NTS0906 - https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy	
Average occupancy for private travel in people per car	1.4	2016	http://www.rijkswaterstaat.nl/images/Value%20of%20time%20personenvervoer%20per%20auto_tcm174-332440.pdf	Rough average based on NL's RWS data

3.3.3 Non-motorway-specific data

As Table 40 summarizes, the UK non-motorway network considered in ANACONDA covers 6,957 km. The societal problem size data, e.g. accident data and emissions, is given in Table 41.

Table 40: General data for UK's non-motorways

Organisation Name	Highways England
Network size [km]	6,957
Description of road type	A-Roads

Table 41: Societal problem size date for UK's non-motorways

Data variable	Value	Year	Source	Comment
Fatalities/year	132	2015	HE accident data 2015	
People with non-fatal serious injuries/year	923	2015	HE accident data 2015	
People with non-fatal slight injuries/year	7,335	2015	HE accident data 2015	
Collisions involving an injury/year	5,473	2015	HE accident data 2015	
Mio. veh-hours/year	784	2015	1). English Regional plus Welsh Traffic, Emission and Speed Forecasts 2).Road traffic forecasts 2015	total hours=Total mileage/average speed
Mio. litre petrol used/year	1,416	2015	1.English Regional plus Welsh Traffic, Emission and Speed Forecasts 2.Webtag fuel consumption (2015 and 2030) 3.Webtag ratio of Diesel and petrol cars and LGVs	
Mio. litre diesel used/year	3,106	2015	See above	
Mio. tonnes CO_2/year	11		English Regional plus Welsh Traffic, Emission and Speed Forecasts	

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 42).

Table 42: Additional data for value of time calculation for UK's non-motorways

Data variable	Value	Year	Source	Comment
Discount rate	3.50%	2015	DfT TAG data book, A1.1.1, Dec 2015	
% of driven distance for passenger cars and taxis	76.06%	2015	NTS Sep 2015 (2014 value), NTS0901 - https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy	Not available for motorway traffic; this is average data across all car mileage

% of driven distance for light vans	14.46%	2015	See above	
% of driven distance for goods vehicles	8.48%	2015	See above	
% of total driven distance for business travel	6.74%	2015	See above	
% of total driven distance for commuting travel	26.96%	2015	See above	
% of total driven distance for other private travel	42.36%	2015	See above	
% of total driven distance for car travel	76.06%	2015	See above	
Average occupancy for business travel in people per car	1.2	2015	NTS Sep 2015 (2014 value), NTS0906 - https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy	Not available for motorway traffic; this is average data across all car mileage
Average occupancy for private travel in people per car	1.4	2016	http://www.rijkswaterstaat.nl/images/Value%20of%20time%20personenvervoer%20per%20auto_tcm174-332440.pdf	Rough average based on NL's RWS data

3.3.4 Corridor-specific data

The UK corridor to be analysed in ANACONDA (see deliverable D5.1) covers a total distance of 130 km (see Table 43). The societal problem size data, e.g. accident data and emissions, is given in Table 44.

Table 43: General data for the UK corridor

Organisation Name	Highways England
Network size [km]	130
Description of road type	Motorway and A-roads

Table 44: Societal problem size date for the UK corridor

Data variable	Value	Year	Source	Comment
Fatalities/year	1	2015	HE accident data	
People with non-fatal serious injuries/year	36	2015	HE accident data	
People with non-fatal slight injuries/year	459	2015	HE accident data	
Collisions involving an injury/year	292	2015	HE accident data	
Mio. veh-hours/year	23	2015	1) English Regional plus Welsh Traffic, Emission and Speed Forecasts	total hours=Total mileage/average speed

			2)Road traffic forecasts 2015	
Mio. litre petrol used/year	54	2015	1.English Regional plus Welsh Traffic, Emission and Speed Forecasts 2.Webtag fuel consumption (2015 and 2030) 3.Webtag ratio of Diesel and petrol cars and LGVs	The annual mileage data from source 1 was multipled by source 3 to calculate the mileage for diesel and petrol. mileage data was divided by the mpg data from source 2 to produce total fuel consumption in gallons. gallons were multiplied by 4.55 to output total fuel consumption in litres.
Mio. litre diesel used/year	396	2015	See above	
Mio. tonnes CO2/year	1.19	2016	conversion factors (litre -> Kg Co2 emitted) from https://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation%20of%20CO2%20emissions%20from%20fuels.htm	

3.3.5 General country specific data

This section summarizes all country data that is independent of the road type, such as unit costs or forecasts. The unit costs data for accidents, emissions and travel times are given in Table 45. Table 46 gives the number of registered vehicles.

Table 45: Unit cost data for UK

Data variable	Value	Year	Source	Comment
Fatality - value of prevention EUR/fatality	2,059,645	2015	DfT TAG data book	A4.1.3, row 30, Dec 2015 (2010 value)
Serious injury - value of prevention EUR/ serious injury	231,446	2015	See above	See above
Slight injury - value of prevention EUR/ slight injury	17,842	2015	See above	See above
Injury accidents - value of prevention EUR/ injury accident	5,524	2015	See above	See above
Petrol (price at pump)	1.31	2015	DECC average retail prices of petroleum products Table 4.1.1, Jul 2016 (2015 value) https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-monthly-statistics	
Fuel duty on petrol	0.9443	2016	https://www.gov.uk/fuel-duty#rates-of-fuel-duty	
Diesel (price at pump)	1.36	2015	DECC average retail prices of petroleum products Table 4.1.1, Jul 2016 (2015 value) https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-monthly-	

			statistics	
Fuel duty on diesel	0.7296	2016	https://www.gov.uk/fuel-duty#rates-of-fuel-duty	
Cars (driver+passengers) EUR/hour working time	40.93	n/a		Derived using occupancy data
Cars (driver) EUR/hour working time	35.69	2010	DfT TAG data book, A1.3.1, Dec 2015 (2010 value, resource cost)	
Cars (passenger) EUR/hour working time	25.58	2010	See above	
Light Good vehicle (driver or passenger) EUR/hour working time	13.75	2010	See above	
HGV (OGV) (driver or passenger) EUR/hour working time	13.75	2010	See above	
Car, non-working time (Commuting) EUR/hour non-working time OTHER	6.84	2010	See above	
Car, non-working time (Other) EUR/hour non-working time OTHER	6.04	2010	See above	

Table 46: Number of registered vehicles in the UK

Data variable	Value	Year	Source	Comment
Total number of vehicles registered in country	34,617,963	2016	DfT Vehicle Licensing Statistics; Table VEH0101 (2016 Q1 value)	
Total number of cars	30,461,111	2016	See above	
Total number of vans (LGVs)	3,674,364	2016	See above	
Total number of lorries (HGVs)	482,488	2016	See above	

Forecast estimations are needed for the calculations of the development of costs and benefits over time. Table 47 gives the forecast values for country-specific variables (such as GDP growth or oil price) until 2030, while Table 48 lists the forecasts for the societal problem size values for accidents and emissions.

Table 47: Unit cost forecast data for the UK

Data variable	Value	Year	Source	Comment
GDP growth	2.40%	2015	DfT TAG data book, 'Annual Parameters', Dec 2015 (2010-2040 values)	
Value of time growth (working time)	1.66%	2015	DfT TAG data book, A1.3.2, Dec 2015 (2010-2040 values)	
Value of time growth (non-working time)	1.66%	2015	DfT TAG data book, A1.3.2, Dec 2015 (2010-2040 values)	
Current oil price in $ per	63.8	2015	DECC Fossil Fuel Price	

Barrel			Projections Table 4, Nov 2015 (Central value) - https://www.gov.uk/government/publications/fossil-fuel-price-projections-2015
Oil price forecasts - growth	-35.30%	2015	DECC Fossil Fuel Price Projections Table 4, Nov 2015 (Central value) - https://www.gov.uk/government/publications/fossil-fuel-price-projections-2015
Non-traded values of CO2	57.3	2015	DfT TAG data book, A3.4, Dec 2015 (2010-2040 values, , Central estimates)
Non-traded values of CO2 - growth	1.50%	2015	DfT TAG data book, A3.4, Dec 2015 (2010-2040 values, , Central estimates)

Table 48: Forecast of societal problem size data for the UK (%-change from base year to 2030)

Data variable	Value	Year	Source	Comment
Fatalities/year	-43%	2010	Updated post-2010 casualty forecasts, TRL Report PPR552; Tables 3.1 and 3.4: (Forecast is 2010 to 2030)	
People with non-fatal serious injuries/year	-52%	2010	See above	
People with non-fatal slight injuries/year	-12%	2010	See above	
Number of collisions involving an injury	-15%	2010	See above	
Mio. veh-hours/year	28%	2010	Road Transport Forecasts 2011 (National Transport Model), Table 4.1: (Forecast is 2010 to 2030)	
Mio. litre petrol used/year	-45%	2015	1.English Regional plus Welsh Traffic, Emission and Speed Forecasts 2.Webtag fuel consumption (2015 and 2030) 3.Webtag ratio of Diesel and petrol cars and LGVs	
Mio. litre diesel used/year	-7%		See above	
Mio. tonnes CO2/year	-11%	2010	Road Transport Forecasts 2011 (National Transport Model), Table 4.1: (Forecast is 2010 to 2030)	

3.4 *Germany*

Data for the Netherlands was collected from BaSt. The German network to be analysed in ANACONDA comprises only motorways, also called “Autobahnen”. The following sections present the data collected by the time of writing this report. Please note that the data in the latest version of the COBRA+ tool might have been updated after the submission of this report.

3.4.1 Data on ITS infrastructure

The German motorway network is equipped with different groups of VMS, as depicted in Figure 4. The category “Streckenbeeinflussungsanlage (SBA)” comprises gantry-mounted and roadside VMS for speed limits and warning signs, and the category “Netzbeeinflussungsanlage (NBA)” includes gantry-mounted or roadside full-text VMS for routing and traffic information. For ANACONDA, the NBA and SBA are of major relevance and are therefore listed in the following tables.

Figure 7: VMS types in Germany

Table 49 gives the estimated costs for each of the VMS types, as a basis for the calculation of potential infrastructure cost savings due to the deployment of C-ITS. Please note that due to missing data on costs and existing units, it was not differentiated into roadside and gantry-mounted VMS, but into SBA and NBA. The costs therefore apply to the more expensive equipment, e.g. the gantry-mounted VMS.

Table 49: Cost data on existing VMS in Germany (all costs are given in Euros)

VMS Type	1-off Equipment costs	1-off Installation costs	Annual operation & mainten. costs	Lifetime (renewal period)	Replacement cost
Gantry-mounted, lane specific VMS or roadside VMS (SBA)	90,000	80,000	5,000	15	80,000

Gantry-mounted or roadside full-text VMS (NBA)	90,000	80,000	5,000	15	80,000

In Table 50, the existing units for each VMS type are given for motorways and the corridor, respectively. Note that there are only motorways included in the German network to be analysed in ANACONDA. 50 percent of the motorway network is selected as C-ITS corridor.

Table 50: Number of existing VMS units in Germany

VMS type	**Existing units**		
	On motor-ways	**On non-motorways**	**On the corridor**
Gantry-mounted, lane specific VMS or roadside VMS (SBA)	162	n/a	81
Gantry-mounted or roadside full text VMS (NBA)	242	n/a	121

Table 51 indicates whether the information given by the VMS types overlap with the ANACONDA C-ITS services. This is necessary to estimate the reduction of impacts a C-ITS service might have due to this overlap of information to the drivers.

Table 51: Default impact reduction factors for existing VMS types in Germany (see Section 2.5)

VMS Type	**Effective range in km**	**C-ITS impact factor** (0: no impact, full overlap, 1: 100% impact, no overlap)						
		HLW	**RWW**	**TJW**	**SWD**	**IVS**	**IVS-SL**	**TI-RW**
Gantry-mounted, lane specific VMS or roadside VMS (SBA)	0.25	0.5	0.5	0.5	0.25	0.25	0.25	n/a
Gantry-mounted or roadside full text VMS (NBA)	0.3	0.5	0.5	0.5	0.75	0.75	0.75	n/a

Future C-ITS infrastructure, i.e. ITS-G5 beacons necessary to run the services are given in Table 52. The roll-out concept in Germany is based on roadworks safety trailers to be upgraded with ITS G5 modules. So, there are no plans so far to equip fixed infrastructure. The table lists both expected costs and expected units to be installed per kilometre.

Table 52: Future ITS infrastructure in Germany (all costs are given in Euros)

ITS beacon type	**Costs**					**Expected units per km**		
	1-off Equipm. costs	**1-off Install. costs**	**Annual operation &mainten. costs**	**Lifetime (renewal period)**	**Replace-ment cost**	**On motor-ways**	**On non-motor-ways**	**On the corridor**
ETSI ITS G5 module on trailers	2,000	1,000	500	10	3,000	0.2	n/a	0.2

Besides ITS-G5 beacons, additional infrastructure is required to deploy a C-ITS service, as seen in Table 53.

Table 53: Required ITS infrastructure in Germany (all costs are given in Euros)

Infrastructure needed	**Lifetime period**	**Basic costs for all services**	**Additional costs for C-ITS services**						
			HLW	**RWW**	**TJW**	**SWD**	**IVS**	**IVS-SL**	**TI-RW**
Infrastructure for implementation in traffic management centres	10	2,500,000	0	0	0	0	0	0	0
Operation and management at traffic management centres	n/a	250,000	0	0	0	0	0	0	0
Development of Smartphone app	10	200,000	0	0	0	0	0	0	0
App operation and maintenance (annual)	n/a	20,000	0	0	0	0	0	0	0

3.4.2 Motorway-specific data

As Table 54 summarizes, the Germany motorway network considered in ANACONDA covers 12,917 km. The societal problem size data, e.g. accident data and emissions, is given in Table 55.

Table 54: General data for the German motorways

Organisation Name	Bundesanstalt für Straßenwesen (BASt)
Network size [km]	12,917
Description of road type	Motorway network is owned by the Federal level, however management is delegated by the constitutional law to the 16 Federal States.

Table 55: Societal problem size data for the German motorways

Data variable	**Value**	**Year**	**Source**	**Comment**
Fatalities/year	375	2014	Verkehr in Zahlen	
People with non-fatal serious injuries/year	5,700	2014	Verkehr in Zahlen	
People with non-fatal slight injuries/year	25,100	2014	Verkehr in Zahlen	
Collisions involving an injury/year	18,901	2014	Verkehr in Zahlen	
Mio. veh-hours/year	2,709	2014	Verkehr in Zahlen	Mileage on motorways divided by estimated average speed
Mio. litre petrol used/year	26,639	2014	Verkehr in Zahlen	All road traffic
Mio. litre diesel used/year	41,229	2014	Verkehr in Zahlen	All road traffic
Mio. tonnes CO2/year	151	2013	Verkehr in Zahlen	All road traffic

3.4.3 Corridor-specific data

The German corridor to be analysed in ANACONDA (see deliverable D5.1) covers a total distance of 6,459 km (see Table 56). The societal problem size data, e.g. accident data and emissions, is given in Table 57.

Table 56: General data for the German corridor

Organisation Name	Bundesanstalt für Straßenwesen (BASt)
Network size [km]	6,459
Description of road type	The corridor is assumed as 50% of the motorway network length, with 2/3 of the traffic volume.

Table 57: Societal problem size data for the German corridor

Data variable	Value	Year	Source	Comment
Fatalities/year	250	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
People with non-fatal serious injuries/year	3,800	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
People with non-fatal slight injuries/year	16,733	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
Collisions involving an injury/year	12,601	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
Mio. veh-hours/year	1,806	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
Mio. litre petrol used/year	17,759	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
Mio. litre diesel used/year	27,486	2014	Verkehr in Zahlen	2/3 taken from the German motorway values
Mio. tonnes CO2/year	101	2013	Verkehr in Zahlen	2/3 taken from the German motorway values

3.4.4 General country specific data

This section summarizes all country data that is independent of the road type, such as unit costs or forecasts. The unit costs data for accidents, emissions and travel times are given in Table 58. Table 59 gives the number of registered vehicles.

Table 58: Unit cost data for Germany

Data variable	Value	Year	Source	Comment
Fatality - value of prevention in EUR/fatality	1,191,397	2014	http://www.bast.de/DE/Statistik/Unfaelle/volkswirtschaftliche_kosten.pdf?__blob=publicationFile&v=9	
Serious injury - value of prevention in EUR/ serious injury	120,921	2014	See above	
Slight injury - value of prevention EUR/ slight injury	5,014	2014	See above	
Injury accidents - value of prevention EUR/ injury	6,040	2014	See above	

accident				
Petrol (price at pump) in EUR	1.36	2017	https://de.statista.com/statistik/daten/studie/29999/umfrage/zusammensetzung-des-benzinpreises-aus-steuern-und-kosten/	
Fuel duty on petrol in EUR	0.88	2017	See above	
Diesel (price at pump) in EUR	1.19	2017	https://de.statista.com/statistik/daten/studie/779/umfrage/durchschnittspreis-fuer-dieselkraftstoff-seit-dem-jahr-1950/	
Fuel duty on diesel in EUR	0.81	2017	https://de.statista.com/statistik/daten/studie/803/umfrage/zusammensetzung---verbraucherpreis-fuer-diesel/	
Cars (driver+passengers) EUR/hour working time	36.00	2015	RWS SEE (2015)	
Cars (driver) EUR/hour working time	30.93	2015	RWS SEE (2015)	
Cars (passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	
Light Good vehicle (driver or passenger) EUR/hour working time	49.02	2015	RWS SEE (2015)	
HGV (OGV) (driver or passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	
Car, non-working time (Commuting) EUR/hour non-working time OTHER	10.04	2015	RWS SEE (2015)	
Car, non-working time (Other) EUR/hour non-working time OTHER	8.14	2015	RWS SEE (2015)	

Table 59: Number of registered vehicles in Germany

Data variable	Value	Year	Source	Comment
Total number of vehicles registered in country	54,602,441	2016	http://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/FahrzeugklassenAufbauarten/2016_b_fzkl_eckdaten_pkw_dusl.html;jsessionid=42A2E780826810467E8B6D134DCA5BF9.live11292?nn=652402	
Total number of cars	45,071,209	2016	See above	
Total number of vans (LGVs)	-	-		Included in number of cars
Total number of lorries (HGVs)	4,942,275	2016	See above	

Forecast estimations are needed for the calculations of the development of costs and benefits over time. Table 60 gives the forecast values for country-specific variables (such as GDP growth or oil price) until 2030, while Table 61 lists the forecasts for the societal problem size values for accidents and emissions.

Table 60: Unit cost forecast data (until 2030) for Germany

Data variable	Value	Year	Source	Comment
GDP growth	1.70%	2015	WLO (NL)	Average of low and high growth scenario
Value of time growth (working time)	0.63%	2015	WLO (NL)	Average of low and high growth scenario
Value of time growth (non-working time)	0.63%	2015	WLO (NL)	Average of low and high growth scenario
Current oil price in $/barrel	52	2015	-	-
Oil price forecasts - growth	6.94%	2015	WLO (NL)	Average of low and high growth scenario
Non-traded values of CO2 in £/ton	6	2015	WLO (NL)	
Non-traded values of CO2 - growth	21.08%	2015	WLO (NL)	Average of low and high growth scenario

Table 61: Forecast of societal problem size data for Germany (%-change from base year to 2030)

Data variable	Value	Year	Source	Comment
Fatalities/year	-30%	2014		Own estimation taking into account
People with non-fatal serious injuries/year	-30%	2014	BAST report M 224 forecast to 2020	
People with non-fatal slight injuries/year	-30%	2014		Own estimation taking into account
Number of collisions involving an injury/year	-30%	2014		Own estimation taking into account
Mio. veh-hours/year	9%	2015		Similar to mileage, BVWP 2030 forecast 0.6% increase per year, multiplied by 15 years
Mio. litre petrol used/year	-18%	2015	BVWP 2030 forecast	1.2% decrease per year, multiplied by 15 years
Mio. litre diesel used/year	-18%	2015	BVWP 2030 forecast	1.2% decrease per year, multiplied by 15 years
Mio. tonnes CO2/year	-18%	2015	BVWP 2030 forecast	1.2% decrease per year, multiplied by 15 years

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 62), which is taken for the motorway network and the corridor.

Table 62: Additional data for value of time calculation for Germany

Data variable	Value	Year	Source	Comment
Discount Rate	4.00%	2015	EC	
% of driven distance for	86.83%	2004	Geschaeftsbericht_2004_F	including light vans (Values taken from

passenger cars and taxis			ahrleistung_ASFiNAG	Austria)
% of driven distance for light vans	-	-		not available (included in passenger cars)
% of driven distance for goods vehicles	13.17%	2004	Geschaeftsbericht_2004_Fahrleistung_ASFiNAG	Values taken from Austria
% of total driven distance for business travel	22%	2014	http://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/verkehr-in-zahlen-pdf-2016-2017.pdf?__blob=publicationFile	
% of total driven distance for commuting travel	14%	2014	See above	
% of total driven distance for other private travel	64%	2014	See above	
% of total driven distance for car travel	93.87%	2016	ASFiNAG	Values taken from Austria
Average occupancy for business travel in people per car	1.1	2016	Estimation	Values taken from Austria
Average occupancy for non working time in people per car	1.2	2016	Estimation	Values taken from Austria

3.5 Finland

Data for Finland was collected from the Finish Transport Agency, in cooperation with Traficon Ltd., a transport planning consultant company. The Finish network to be analysed in ANACONDA comprises both motorways and non-motorway sections, further denoted as main roads. The following sections present the data collected by the time of writing this report. Please note that the data in the latest version of the COBRA+ tool might have been updated after the submission of this report.

3.5.1 Data on ITS infrastructure

The Finish road network is equipped with six different groups of VMS, some divided into two or more subgroups. Figure 8 depicts those VMS types, which the following data tables refer to.

Figure 8: VMS types in Finland

Table 63 gives the estimated costs for each of the VMS types, as a basis for the calculation of potential infrastructure cost savings due to the deployment of C-ITS. For lane-specific gantry mounted VMS (for lane closures), two different values are estimated, depending if they are mounted on a portal in open environment (EUR 17,000) or on tunnel structures (EUR 9,000).

Table 63: Cost data on existing VMS in Finland (all costs are given in Euros)

VMS Type	1-off Equipment costs	1-off Installation costs	Annual operation & mainten. costs	Lifetime (renewal period)	Replacement cost

1a) Roadside VMS, speed limit, large	6,000	40,000	2,000	10-15	8,500
1b) Roadside VMS, speed limit, large, wireless connection	6,000	20,000	2,000	10-15	8,500
1c) Roadside VMS, speed limit, normal size	4,000	40,000	2,000	10-15	7,000
1d) Roadside VMS, speed limit, normal size in a countryside interchange, wireless connection	4,000	22,000	2,000	10-15	7,000
2a) Roadside VMS, speed limit and warning sign, large	9,000	42,000	2,500	10-15	14,000
2b) Roadside VMS, speed limit and warning sign, normal size	7,000	42,000	2,500	10-15	12,000
3a) Fulltext VMS, roadside	20,000	45,000	2,500	10-15	28,000
3b) Fulltext VMS, above the carriageway	25,000	63,000	2,500	10-15	50,000
4a) Fulltext and warning sign VMS, roadside	25,000	45,000	3,000	10-15	35,000
4b) Fulltext and warning sign VMS, above the carriageway	60,000	73,000	7,000	10-15	100,000
5a) Prism display, roadside	12,000	41,000	1,000	10-15	18,000
5b) Prism display, above the carriageway	20,000	51,000	1,000	10-15	35,000
6) Lane-specific gantry mounted VMS, for lane closures	3,000	17,000 / 9,000	1,000	10-15	4,000

In Table 64, the existing units for each VMS type are given for motorways. Note that at the time when this report was completed, data on the units for non-motorway roads and the corridor was not yet available, but will be entered in the tool at a later point.

Table 64: Number of existing VMS units in Finland

VMS type	Existing units in network		
	Motorways	Non-motorways	Corridor
1a, b, c, d (Roadside VMS)	737	n/a	n/a
2a, b (Roadside VMS)	132	n/a	n/a
3a, b (Fulltext VMS)	71	n/a	n/a
4a, b (Fulltext VMS)	150	n/a	n/a
5a, b (Prism displays)	139	n/a	n/a
6 (Lane-specific gantry mounted VMS)	458	n/a	n/a

Table 65 indicates whether the information given by the VMS types overlap with the ANACONDA C-ITS services. This is necessary to estimate the reduction of impacts a C-ITS service might have due to this overlap of information to the drivers.

Table 65: Default impact reduction factors for existing VMS types in Finland (see Section 2.5)

VMS Type	Effective range in km	C-ITS impact factor (0: no impact, full overlap, 1: 100% impact, no overlap)						
		HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
1a, b, c, d (Roadside VMS)	0.25	0.25	0.25	0.25	1	0.5	0.75	n/a
2a, b (Roadside VMS)	0.25	0.25	0.25	0.25	1	0.5	0.75	n/a
3a, b (Fulltext VMS)	0.25	0.25	0.25	0.25	1	1	1	n/a
4a, b (Fulltext VMS)	0.25	0.25	0.25	0.25	1	1	1	n/a
5a, b (Prism displays)	0.3	1	1	1	1	1	1	n/a
6 (Lane-specific gantry mounted VMS)	0.25	0.5	0.5	0.5	0.5	0.5	0.5	n/a

Future C-ITS infrastructure, i.e. ITS-G5 beacons necessary to run the services are given in Table 66. The table lists both expected costs and expected units to be installed per kilometre. Note that for Finland the numbers of expected units are zero, because the Finish Transport Agency is planning to deploy 5G-based C-ITS services instead of ITS-G5.

Table 66: Future ITS infrastructure in Sweden (all costs are given in Euros)

ITS beacon type	Costs					Expected units per km		
	1-off Equipm. costs	1-off Install. costs	Annual operation &mainten. costs	Lifetime (renewal period)	Replace-ment cost	On motor-ways	On non-motor-ways	On the corridor
ITS-G5 wireless beacons	6,000	10,000	500	10	10,000	0	0	0

Besides ITS-G5 beacons, additional infrastructure is required to deploy a C-ITS service, as seen in Table 67.

Table 67: Required ITS infrastructure in Sweden (all costs are given in Euros)

Infrastructure needed	Lifetime period	Basic costs for all services	Additional costs for C-ITS services						
			HLW	RWW	TJW	SWD	IVS	IVS-SL	TI-RW
Infrastructure for implementation in traffic management centres *	10	2,500,000	0	0	0	0	0	0	0
Operation and management at traffic management centres	n/a	250,000	0	0	0	0	0	0	0
Development of Smartphone app	10	200,000	0	0	0	0	0	0	0
App operation and maintenance (annual)	n/a	20,000	0	0	0	0	0	0	0

3.5.2 Motorway-specific data

As Table 68 summarizes, the Finish motorway network considered in ANACONDA covers 881 km. The societal problem size data, e.g. accident data and emissions, is given in Table 69.

Table 68: General data for Finland's motorways

Organisation Name	Finnish Transport Agency
Network size [km]	881 km [Source: 06 Väyläpituudet ja suorite Ely-alueittain (2015)]
Description of road type	Motorways

Table 69: Societal problem size data for Finland's motorways

Data variable	Value	Year	Source	Comment
Fatalities/year	10	2015	Statistics of Finnish Transport Agency ("TIIRA")	Without ramps 7
People with non-fatal serious injuries/year	275	2015	Statistics of Finnish Transport Agency ("TIIRA")	There is no separation between serious and slight injury. Without ramps 218
Collisions involving an injury/year	214	2015	Statistics of Finnish Transport Agency ("TIIRA")	Number of collisions involving fatalities: 10 (with ramps), 7 (without ramps) Number of collisions involving injury: 204 (with ramps), 161 (without ramps)
Mio. veh-hours/year	72.2	2015	Statistics of Finnish Transport Agency	Average speed limit of each road section and road calculated taken into account winter speed limitations. 365 days a year.
Mio. litre petrol used/year	277.0	2013	Transport and Communication Statistical Yearbook for Finland 2014, p. 46	Total 1 751.7 million litre/year. Value approximated based on travel time compared to the total network travel time.
Mio. litre diesel used/year	420.8	2013	See above	Total 2 660.8 million litre/year. Value approximated based on travel time compared to the total network travel time.
Mio. tonnes CO2/year	1.773	2013	Transport and Communication Statistical Yearbook for Finland 2014, p. 48	Total 11.214 million tonne/year. Value approximated based on the travel time compared to the total network travel time.

3.5.3 Non-motorway-specific data

As Table 70 summarizes, the UK non-motorway network considered in ANACONDA covers 12,535 km. The societal problem size data, e.g. accident data and emissions, is given in Table 71.

Table 70: General data for Finland's non-motorways

Organisation Name	Finnish Transport Agency
Network size [km]	12,535 km [Source: 06 Väyläpituudet ja suorite Ely-alueittain (2015)]
Description of road type	Main roads (numbers 1 - 99) excluding motorways but including semi-motorways

Table 71: Societal problem size data for Finland's non-motorways

Data variable	Value	Year	Source	Comment

Fatalities/year	111	2015	Statistics of Finnish Transport Agency ("TIIRA")	
People with non-fatal serious injuries/year	1,549	2015	Statistics of Finnish Transport Agency ("TIIRA")	Without ramps 1 547
Collisions involving an injury/year	1,103	2015	Statistics of Finnish Transport Agency ("TIIRA")	Number of collisions involving fatalities: 100 Number of collisions involving injury: 1 003 (with ramps), 1 001 (without ramps)
Mio. veh-hours/year	200.1	2015	Statistics of Finnish Transport Agency	Average speed limit of each road section and road calculated taken into account winter speed limitations. 365 days a year.
Mio. litre petrol used/year	767.6	2013	Transport and Communication Statistical Yearbook for Finland 2014, p. 46	Total 1 751.7 million litre/year. Value approximated based on travel time compared to the total network travel time.
Mio. litre diesel used/year	1,166	2013	See above	Total 2 660.8 million litre/year. Value approximated based on travel time compared to the total network travel time.
Mio. tonnes CO2/year	4.914	2013	Transport and Communication Statistical Yearbook for Finland 2014, p. 48	Total 11.214 million tonne/year. Value approximated based on the travel time compared to the total network travel time.

3.5.4 Corridor-specific data

The Finish corridor to be analysed in ANACONDA (see deliverable D5.1) covers a total distance of 158 km (see Table 72). The societal problem size data, e.g. accident data and emissions, is given in Table 73.

Table 72: General data for Finland's corridor

Organisation Name	Finnish Transport Agency
Network size [km]	158 km
Description of road type	Motorway E18 HELSINKI - TURKU

Table 73: Societal problem size data for Finland's corridor

Data variable	Value	Year	Source	Comment
Fatalities/year	0	2015	Statistics of Finnish Transport Agency ("TIIRA")	
People with non-fatal serious injuries/year	24	2015	See above	
Collisions involving an injury/year	18	2015	See above	
Mio. veh-hours/year	11.4	2015	Statistics of Finnish Transport Agency	
Mio. litre petrol used/year	43.8	2013	Transport and Communication Statistical	

			Yearbook for Finland 2014, p. 46
Mio. litre diesel used/year	66.6	2013	See above
Mio. tonnes CO2/year	0.281	2013	Transport and Communication Statistical Yearbook for Finland 2014, p. 48

3.5.5 General country specific data

This section summarizes all country data that is independent of the road type, such as unit costs or forecasts. The unit costs data for accidents, emissions and travel times are given in Table 74. Table 75 gives the number of registered vehicles.

Table 74: Unit cost data for Finland

Data variable	Value	Year	Source	Comment
Fatality - value of prevention EUR/fatality	2,766,677.4	2015	Tervonen, J. Tieliikenteen onnettomuuskustannusten tarkistaminen - Kuolemat sekä vakavat ja lievät loukkaantumiset. Trafi Research Reports 5/2016. p. 51	lost output, medical and ambulance, human costs
Serious injury - value of prevention EUR/ serious injury	793,646.7	2015	See above	lost output, medical and ambulance, human costs
Slight injury - value of prevention EUR/ slight injury	34,411.7	2015	See above	lost output, medical and ambulance, human costs
Injury accidents - value of prevention EUR/ injury accident	3,200	2013	Finnish Transport Agency. Tie- ja rautatieliikenteen hankearvioinnin yksikköarvot 2013. Liikenneviraston ohjeita 1/2015. p. 13	police costs, insurance and admin, property damage
Petrol (price at pump)	1.461	2015	Petroleum & Biofuels Association - Finland. 1.1 Consumer price update. [http://www.oil.fi/en/statistics-1-prices-and-taxes/11-consumer-price-update]. 23.6.2016.	
Fuel duty on petrol	0.936	2015	See above	
Diesel (price at pump)	1.294	2015	See above	
Fuel duty on diesel	0.749	2015	See above	
Cars (driver+passengers) EUR/hour working time	36.00	2015	RWS SEE (2015)	Values taken from NL
Cars (driver) EUR/hour working time	30.93	2015	RWS SEE (2015)	Values taken from NL
Cars (passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	Values taken from NL
Light Good vehicle (driver or passenger) EUR/hour working time	49.02	2015	RWS SEE (2015)	Values taken from NL

HGV (OGV) (driver or passenger) EUR/hour working time	24.74	2015	RWS SEE (2015)	Values taken from NL
Car, non-working time (Commuting) EUR/hour non-working time OTHER	10.04	2015	RWS SEE (2015)	Values taken from NL
Car, non-working time (Other) EUR/hour non-working time OTHER	8.14	2015	RWS SEE (2015)	Values taken from NL

Table 75: Number of registered vehicles in Finland

Data variable	Value	Year	Source	Comment
Total number of vehicles registered in country	3,758,032	2015	Finnish Transport Safety Agency. [http://www.trafi.fi/filebank/a/1436521609/1e10f1fd7e9d2e13e7275ae3765c25de/18156-Ajoneuvokanta_-_rekisterissa_olevat_maakunnittain_30062015.pdf]	Busses and special cars not included.
Total number of cars	3,211,425	2015	See above	
Total number of vans (LGVs)	407,319	2015	See above	
Total number of lorries (HGVs)	139,288	2015	See above	

Forecast estimations are needed for the calculations of the development of costs and benefits over time. Table 76 gives the forecast values for country-specific variables (such as GDP growth or oil price) until 2030, while Table 77 lists the forecasts for the societal problem size values for accidents and emissions.

Table 76: Unit cost forecast data for Finland

Data variable	Value	Year	Source	Comment
GDP growth	1.20%	2016 - 2018	http://vm.fi/en/economic-forecasts	Average of the estimates for the years 2016, 2017 and 2018. Estimate based on the Finland's Ministry of Finance Economic Survey, Summer 2016
Value of time growth (working time)	0.63%	2015	WLO (2015). Average of low and high growth scenario	values taken from NL
Value of time growth (non-working time)	0.63%	2015	WLO (2015). Average of low and high growth scenario	values taken from NL
Current oil price in $ per Barrel	52	2015		Current oil price
Oil price forecasts - growth	6.94%	2015	WLO (2015). Average of low and high growth scenario	Values taken from NL
Non-traded values of CO2 in £/ton	6	2015	WLO (2015). Average of low and high growth scenario	Values taken from NL

Non-traded values of CO2 - growth	21.08%	2015	WLO (2015). Average of low and high growth scenario	Values taken from NL

Table 77: Forecast of societal problem size data for Finland's motorways (%-change from base year to 2030)

Data variable	Value	Year	Source	Comment
Fatalities/year	0%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	values taken from NL
People with non-fatal serious injuries/year	2.1%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	values taken from NL
People with non-fatal slight injuries/year	2.1%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	values taken from NL
Number of collisions involving an injury	0%	2015	http://www.swov.nl/rapport/r-2015-17.pdf	values taken from NL
Mio. veh-hours/year	10%	2015	http://web.minienm.nl/mob2015/7_1.html#tab-2	(road traffic measured in vehicle-kms). Otherwise the choice is time spent in congestion (index 1.45), but this latter number is based on a smaller denominator than total travel time. (values taken from NL)
Mio. litre petrol used/year	-13%	2015	WLO (2015)	Average of low and high scenario (values taken from NL)
Mio. litre diesel used/year	-16%	2015	WLO (2015)	Average of low and high scenario (values taken from NL)
Mio. tonnes CO2/year	-20%	2015	WLO (2015)	Average of low and high scenario (values taken from NL)

For the calculation of values of travel time or congestion, specific data about the driven distances per year and the average vehicle occupancy was collected from the road authority (see Table 78), which is taken for the motorway and non-motorway network as well as the corridor. Note that due to missing Finish data, values have been taken from the Austrian data sheets.

Table 78: Additional data for value of time calculation for Finland

Data variable	Value	Year	Source	Comment
Discount Rate	4.00%	2015	EC	
% of driven distance for passenger cars and taxis	86.83%	2004	Geschaeftsbericht_2004_Fahrleistung_ASFiNAG	including light vans (values taken from Austria)
% of driven distance for light vans	-	-		not available (included in passenger cars) (values taken from Austria)
% of driven distance for goods vehicles	13.17%	2004	Geschaeftsbericht_2004_Fahrleistung_ASFiNAG	values taken from Austria
% of total driven distance for business travel	9,01%	2016	ASFiNAG	values taken from Austria
% of total driven distance for commuting travel	26.13%	2016	ASFiNAG	values taken from Austria
% of total driven distance for other private travel	58.73%	2016	ASFiNAG	values taken from Austria

% of total driven distance for car travel	93.87%	2016	ASFiNAG	values taken from Austria
Average occupancy for business travel in people per car	1.1	2016	Estimation	
Average occupancy for non-working time in people per car	1.2	2016	Estimation	

4 Impact data

This chapter presents the results of the impact assessment both per service and per bundle. If not mentioned otherwise, the data distinguishes between their applicability for the motorway network and for the non-motorway non-urban network. The latest studies and project on cooperative services were utilized, although the initial impact figures used in the COBRA project were taken into account. In the case of missing or no useful data, i.e. no relevant studies were found in the literature or the studies found did not provide useful results, the consortium made expert assumptions.

It must be mentioned that the figures for the indicator of number of injury accidents were reached through a calculation of the correlation between the number of injury accidents and the number of injuries. European data statistics for the years 2010 - 2013 for the countries available in the tool (i.e. England, Austria, the Netherlands, Germany, Finland and Sweden) were analysed and an average ratio of 1.27 was calculated, meaning for one injury accident, there will be 1.27 injuries.

Furthermore, it must be noted that although travel time increase may be seen as a dis-benefit, this contribution to the benefits appears when the increased travel time is due to speed reduction (and it cancels out the cost linked to it). In fact, this case implies improved speed limit compliance, therefore the longer travel times cannot be really considered as a dis-benefit.

4.1 Impacts assessment of individual services

The following subsections present the assessed impact figures for each of the ANACONDA C-ITS services.

4.1.1 Hazardous Location Warning

The service refers to increasing traffic safety by informing drivers about critical weather conditions ahead especially where the danger can hardly be visually perceived. In contrast to the C-ITS Platform description [4], this service also includes the Priority Action C for Road Safety-related Traffic Information [5], such as animal/people, obstacles/debris on the road.

Studies such as eIMPACT [6], CODIA [7] and EasyWay [8] provide reliable information on the impact of this service and were used in the COBRA project. However, a study on the deployment of C-ITS in Europe performed by Ricardo Energy & Environment for DG MOVE [9], published in 2015 provides the latest figures and has been used as a literature source for this service. Nevertheless, the analyses performed in this study are also based on data from the above-mentioned projects. As this is primarily a safety-oriented service, it is considered that efficiency and environmental impacts are minimal, especially when extrapolated at EU level. Therefore, the following figures can be found in the COBRA+ tool:

Table 79: Impact figures for Hazardous Location Warning

Hazardous Location Warning		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	-5,20%	-5,30%
	Number of injuries	-5,30%	-5,40%
	Number of injury accidents	-4,17%	-4,30%
Efficiency	Travel time	0%	0%
Fuel consumption	Gasoline/Diesel	0%	0%
	CO_2	0%	0%

Emissions	NO_x	0%	0%
	Particles	0%	0%

4.1.2 Road Works Warning (short distance)

Within this service, a party can communicate with drivers through I2V communication about road works a short distance ahead. The information provided can vary from a limited amount of information, such as the position of the trailer or arrow position, as well as a basic service (called by EIP+ [10] the "standard solution") where a back-end system delivers additional information via the warning trailer carrying the ITS-Roadside unit to the road users (e.g. number of closed lanes, what kind of work is carried out).

EasyWay, Drive C2X [11] and the DG MOVE report provide the latest and more reliable information regarding the impacts of this service. The latter also uses the Drive C2X report as its main source for the safety indicators. Similarly, as this is primarily a safety-oriented service, it is considered that efficiency and environmental impacts are minimal, especially when extrapolated at EU level. These figures are assumed for all road types, in the absence of other data. The following figures can be found in the COBRA+ tool:

Table 80: Impact figures for Road Works Warning (short distance)

Road Works Warning (short distance)		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	-1,90%	-1,90%
	Number of injuries	-1,50%	-1,50%
	Number of injury accidents	-1,18%	-1,18%
Efficiency	Travel time	0%	0%
Fuel consumption	Gasoline/Diesel	0%	0%
	CO_2	0%	0%
Emissions	NO_x	0%	0%
	Particles	0%	0%

4.1.3 Traffic Jam Ahead Warning

Through this service, congestion is detected and its location is communicated to road users. Detection can take place via loops / roadside detection, and can be supported by vehicle generated data. Vehicle generated data allows a traffic jam to be detected even in the gap between 2 detectors and the position of the end of the congestion queue can be located very precisely. This information can be used for both on-trip and pre-trip information.

Four different studies ([7], [12], [13], [14]) provided impact data for this service and were used as sources in COBRA. However, all studies are now between 5 and 10 years old and were not used in this assessment. Instead, Drive C2X and the DG MOVE report were once more utilised as a reliable source for the impact assessment of this service. Similarly, as this is primarily a safety-oriented service, it is considered that efficiency and environmental impacts are minimal /statistically insignificant, especially when extrapolated at EU level.

Table 81: Impact figures for Traffic Jam Ahead Warning

Traffic Jam Ahead Warning		**Motorway**	**Non-motorway non-urban**

Road safety	Number of fatalities	-1,50%	-2,00%
	Number of injuries	-2,10%	-3,70%
	Number of injury accidents	-1,65%	-2,91%
Efficiency	Travel time	0%	0%
Fuel consumption	Gasoline/Diesel	0%	0%
Emissions	CO_2	0%	0%
	NO_x	0%	0%
	Particles	0%	0%

4.1.4 Shockwave Damping

Shock wave damping aims to smooth the flow of traffic, by damping traffic/shock waves. Real-time traffic data is used to feed advisory speeds to cars to smooth out speed variations.

The DG MOVE report provides reliable data on the impact of this service. Similarly, as this is primarily a safety-oriented service, it is considered that efficiency and environmental impacts are minimal /statistically insignificant, especially when extrapolated at EU level. It is assumed that the impact on non-motorways non-urban is zero for all indicators.

Table 82: Impact figures for Shockwave Damping

Shockwave Damping		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	-7,80%	0%
	Number of injuries	-5,00%	0%
	Number of injury accidents	-3,94%	0%
Efficiency	Travel time	0%	0%
Fuel consumption	Gasoline/ Diesel	0%	0%
Emissions	CO_2	0%	0%
	NO_x	0%	0%
	Particles	0%	0%

4.1.5 In-vehicle signage

This service provides in-vehicle information to drivers regarding relevant static and dynamic road signs via V2I communication. Roadside units may be mounted on traffic sings and key points along roads. Examples of provided information include potential dangerous road conditions ahead, upcoming junctions, lane configuration, prohibitions, right of way and other information given by static or dynamic traffic signs.

The DG MOVE report provides reliable data on the impact of this service based on the results of the Drive C2X project. Data on the efficiency impacts of this service were not found. Similarly, it is considered that environmental impacts are minimal /statistically insignificant, especially when extrapolated at EU level.

Table 83: Impact figures for In-Vehicle Signage

In-Vehicle Signage		**Motorway**	**Non-motorway non-urban**

Road safety	Number of fatalities	-1,04%	-1,30%
	Number of injuries	-0,46%	-0,72%
	Number of injury accidents	-0,36%	-0,57%
Efficiency	Travel time	-	-
Fuel consumption	Gasoline/ Diesel	0%	0%
Emissions	CO_2	0%	0%
	NO_x	0%	0%
	Particles	0%	0%

4.1.6 In-Vehicle Signage Speed Limits

This service broadcasts information to the drivers, via V2I communication regarding speed limits. Speed limit information is displayed to the driver continuously, bringing safety benefits through the prevention of speeding.

CODIA provides reliable data on the impact of this service and were used in the COBRA project. However, Drive C2X provides the latest information and has been used as a literature source for this service. It must be mentioned that the project assumes an 8% increase in delay at 100% infrastructure equipment. This is justified by the argument that as drivers comply with the speed limits, they will decrease their safety risk but they will increase their journey duration. Nevertheless, travel time increase can still be considered a benefit, as crash occurrence, for example, and thus the costs associated with it would decrease. Therefore, the following figures can be found in the COBRA+ tool:

Table 84: Impact figures for In-Vehicle Signage Speed Limits

In-Vehicle Signage Speed Limits		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	-6,09%	-16,62%
	Number of injuries	-3,00%	-8,38%
	Number of injury accidents	-2,36%	-6,60%
Efficiency	Travel time	8,00%	8,00
Fuel consumption	Gasoline/ Diesel	-2,30%	-3,50%
Emissions	CO_2	-2,30%	-3,50%
	NO_x	-0,50%	-0,40%
	Particles	-0,40%	4,20%

4.1.7 Traffic information (including Road Works Warning long distance)

This service aims to improve traffic flow management by offering re-routing information and suggestions based on real-time traffic information, travel times, road works information and routes to Park & Ride facilities.

Three studies ([15], [16], [17]) among which the euroFOT project provided impact figures for this service. However the DG MOVE report provides the latest results of 2015 and has been used as a literature source. Nevertheless, as this report does not provide any information on traffic efficiency, the figure for travel time was taken from the euroFOT project. The following figures can be found in the COBRA+ tool:

Table 85: Impact figures for Traffic Information

Traffic Information		Motorway	Non-motorway non-urban
Road safety	Number of fatalities	0%	0%
	Number of injuries	0%	0%
	Number of injury accidents	0%	0%
Efficiency	Travel time	-9,40%	-9,40%
Fuel consumption	Gasoline/ Diesel	-1,95%	-1,95%
Emissions	CO_2	-1,95%	-1,95%
	NO_x	-0,40%	-1,70%
	Particles	-0,30%	0,80%

4.2 Impact assessment of bundles

The services within the COBRA+ tool have been grouped into three bundles. In order to avoid overestimation of impact per bundle, an estimation of the overlap between the services within each bundle was devised.

4.2.1 Bundle 1: Local dynamic event warnings

Assessing the impact of this bundle translates into estimating the impact of Hazardous Location Warning (HLW), Traffic Jam Ahead Warning (TJW), Road Works Warning (RWW) (short distance) and Shockwave Damping (SWD). The first three services might overlap to some extent, e.g. a traffic jam or hazard warning could be triggered by a case of road works on the network. Shockwave Damping is seen as a separate service and would have minimal or no overlap with the other functions. Therefore, the impact figures of the first bundle were determined by taking the maximum reduction of the first three services plus the impact of the fourth:

Impact value = max (HLW, TJW, RWW) + SWD

Table 86: Impact figures for Bundle 1

Bundle 1		Motorway	Non-motorway non-urban
Road safety	Number of fatalities	-13,00%	-5,30%
	Number of injuries	-10,30%	-5,40%
	Number of injury accidents	-8,11%	-4,25%
Efficiency	Travel time	0%	0%
Fuel consumption	Gasoline/ Diesel	0%	0%
Emissions	CO_2	0%	0%
	NO_x	0%	0%
	Particles	0%	0%

4.2.2 Bundle 2: In-vehicle signage

The second bundle contains two services, namely In-Vehicle Signage (IVS) and In-Vehicle Signage incl. Speed Limits (IVS-SL). Both services deal with varying the speed of a vehicle in order to increase safety and harmonise traffic; therefore an overlap is inevitable. The impact figures of this bundle were considered to be the maximum reduction of the two services.

Impact value = max (IVS, IVS-SL)

Table 87: Impact figures for Bundle 2

Bundle 2		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	-6,09%	-16,62%
	Number of injuries	-3,00%	-8,38%
	Number of injury accidents	-2,36%	-6,60%
Efficiency	Travel time	8,00%	8,00%
Fuel consumption	Gasoline/ Diesel	-2,30%	-3,50%
Emissions	CO_2	-2,30%	-3,50%
	NO_x	-0,50%	-0,40%
	Particles	-0,40%	4,20%

4.2.3 Bundle 3: Traffic Information

This last bundle refers to Traffic and Road Works Information - aiding drivers by providing routing and navigation, while managing traffic flows efficiently. At this moment, only one service exists in this bundle; however, the user of the COBRA+ tool has the option of adding other services, such as Parking Information. At this moment, the impact figures for this bundle are:

Table 88: Impact figures for Bundle 3

Bundle 3		**Motorway**	**Non-motorway non-urban**
Road safety	Number of fatalities	0%	0%
	Number of injuries	0%	0%
	Number of injury accidents	0%	0%
Efficiency	Travel time	-9,40%	-9,40%
Fuel consumption	Gasoline/ Diesel	-1,95%	-1,95%
Emissions	CO_2	-1,95%	-1,95%
	NO_x	-0,40%	-1,70%
	Particles	-0,30%	0,80%

5 Conclusions and next steps

This report summarized work package 4 of the ANACONDA project, which included the collection and processing of data for the COBRA+ tool. The necessary data can be divided into 1) country-specific data about the road network and infrastructure costs, 2) expected (societal) impacts of C-ITS. The first group of data was primarily collected from the respective NRAs of six different countries or from literature. Missing data was completed with default values based on other countries' data or on expert assumptions.

For the second group of data, various impact assessment studies and literature sources were synthesized to get impact figures for each of the ANACONDA C-ITS services. The impacts were divided into safety, traffic efficiency, fuel consumption and emissions. As the COBRA+ tool allows conflating several individual C-ITS services into bundles, the impacts had to be calculated for the bundles as well, taking into account potential overlaps of impacts.

The following next steps are planned for the subsequent work in ANACONDA:

- The data presented reflects the state of collected data by the time when this report was compiled. Future COBRA+ users are encouraged to update the data and to replace default values, if available.
- 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+.
- A final stakeholder workshop with national road authorities will be at the beginning of March. The project team will present and demonstrate the COBRA+ Monitor.

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7 Abbreviations

Abbreviation	Description
ANACONDA	Assessment of user needs for adapting COBRA including online database
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
C-ITS	Cooperative Intelligent Transport Systems
COBRA	Cooperative Benefits for Road Authorities
HLW	Hazardous Location Warning
I2V	Infrastructure to Vehicle (Communication)
ITS	Intelligent Transport System
IVS	In-Vehicle Signage
IVS-SL	In-Vehicle Signage – Speed Limits
NRA	National Road Authority
OEM	Original Equipment Manufacturer (e.g. vehicle manufacturer)
RWW	Road Works Warning
SWD	Shockwave Damping
TI-RW	Traffic information and Road Works (long distance) Information
TJA	Traffic Jam Ahead Warning
VMS	Variable Message Sign