Dutch Profile Part A - Use case catalogue

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Document log

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Writing team

The Use case catalogue is maintained by the Architecture and Interoperability Round Table writing team, any questions, comments or suggested can be forwarded to the members of this writing team.

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Table of contents

Executive summary

For C-ITS services to be a success, these services need to work cross-country and independently of specific suppliers. To achieve that goal, harmonized descriptions and requirements of those services are needed.

This document provides the high level and functional descriptions of 17 C-ITS use cases which are currently considered in the Netherlands and consequently serves as the Dutch starting point to the beforementioned harmonization.

This Use case catalogue (part A) will serve as a basis for the functional and technical requirements of these use cases (part B) and is aligned with Dutch ITS stakeholders at the national ITS Round Tables and is supported by Rijkswaterstaat, I&M and Dutch industrial stakeholders. The requirements in part B are subject to approval by the Round Table Architecture and Interoperability.

1 Introduction

1.1 Objective

The aim of the Use case catalogue is to be the single point of reference in the Netherlands to enable harmonisation. The Use case catalogue provides the high level and functional descriptions of C-ITS use cases which serve as a basis for the requirements of these use cases. By providing these descriptions and requirements (the latter in part B, see below) an important technical barrier for deployment of C-ITS services is removed.

A use case is a textual description of a context and a process based on actors, a 'system' and a flow of events. It describes how the system behaves while interacting with actors to achieve a certain objective, as well as the dialogue between the system and the actors. A use case is written in an implementation neutral language, which means that no choices are made with regards to technology, hardware, or stakeholders.

1.2 Intended audience

This Use case catalogue is aligned with Dutch ITS stakeholders at the national ITS Round Tables and is supported by Rijkswaterstaat, I&M and Dutch industrial stakeholders.

1.3 Use case catalogue overview

This document is part A in a sequence of documents as is shown in the figure below.

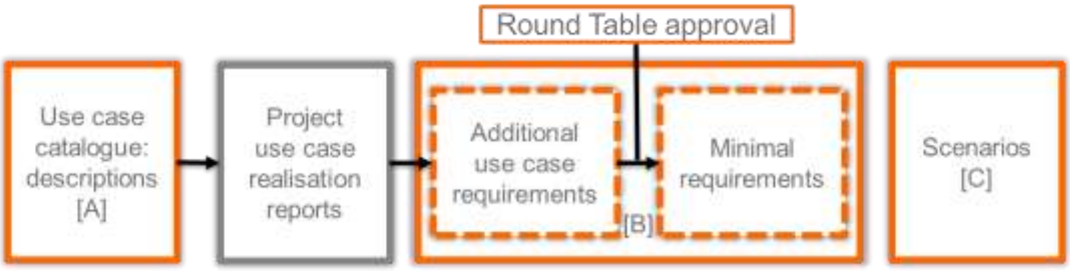

Figure 1: Overview of Dutch Profile documents

Part A: the Use case catalogue contains high level and functional descriptions of use cases, in an implementation neutral language, but with sufficient detail on expected behaviour, actors, roles and flow. This version describes 17 use cases which are currently considered in the Netherlands.

Project reports of national deployment projects describe the technical implementations of these use cases. The existence of these deployments is noted in Part B, while their outcome is input for Part B.

Part B: describes minimum requirements which apply to all use cases (i.e. which are generic) and additional requirements which are specific to each single use case. It includes references to standards and profiles to serve as a library. Requirements identification is subject to approval by the Round Table Architecture and Interoperability.

Part C: scenarios describe the alternatives when multiple options are available and no uniform decision has been made by the Round Table (i.e. the topic at hand is subject to debate). For that reason it is not possible to formulate the corresponding principles and/or constraints as a binding requirement.

1.4 Structure of this document

The structure of this document is as follows. Chapter 2 contains the references used in this document. Chapter 3 provides some definitions, describes the structure used in the subsequent use case chapters and lists the 17 use cases described in this document. Each of the chapters thereafter describes one the 17 use cases.

1.5 Current state of this document

This v0.3 of the Use case catalogue is a draft version. There is much potential to further improve and detail the use case descriptions by including the expertise of others. For example, the desired behaviour of both the system and the users could be further specified, while triggering conditions could be elaborated in the scenario descriptions. If desired, additional sections could be added to the use case descriptions, for example ‘functional requirements’ as a stepping stone to Part B. Finally, new use cases and situations could be added.

The work plan is as follows. First, the chairs of the Dutch C-ITS round tables will be asked to review and improve this version with their teams. Next, a new version will be prepared and the members of the different round tables will be asked to review this version.

2 References

[1] Ulbrich, S., Menzel, T., Reschka, A., Schuldt, F. and Maurer, M. (undated), Defining and substantiating the terms scene, situation and scenario for automated driving

[2] Architecture for C-ITS applications in the Netherlands, Version 1.00, 03-2016

[3] ETSI TS 101 539-1 V1.1.1, "Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification"

[4] ETSI TS 101 539-3 V1.1.1, "Intelligent Transport Systems (ITS); V2X Applications; Part 3: Longitudinal Collision Risk Warning (LCRW) application requirements specification"

[5] ComESafety2, C-ITS SERVICES CATALOGUE v0.1

[6] ETSI TR 102 638 V1.1.5,"Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Use case definitions"

[7] ETSI TR 102 638 V1.1.1 "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Use case definitions"

[8] Ministry I&M, Talking Traffic: CALL FOR INNOVATION PARTNERSHIPS FOR SMARTER URBAN AND INTER-URBAN MOBILITY THROUGH INTELLIGENT SERVICES, v1.0

[9] European Commission, C-ITS Deployment Platform - final report

[10] DITCM, Landelijke use case tabel en prioritering 2015

[11] CODECS (COoperative ITS DEployment Coordination Support) project

3 Use case descriptions

3.1 Definitions

For making use case descriptions the following definitions were adopted [1]:

- **Situation**: describes relevant scenery (everything present within a static snapshot) considering (driving) function-related goals and values.
- **Scenario**: describes temporal development in a sequence of situations (e.g. initial and after) based on events and actions. It is story telling.
- **Use case**: function of the system, the desired behaviour (of the system and actors), specification of system boundaries and definition of one or more usage scenarios.

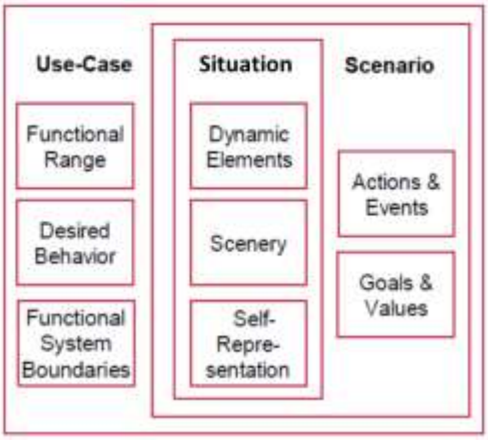

Figure 2: schematic view on situation, scenario, use case [1]

3.2 System boundaries

The decomposition of the C-ITS system is provided in the 'Architecture for C-ITS applications in the Netherlands' [2]. Four layers are considered: central, roadside, vehicle and traveller, and interfaces between these layers and their sub-components are described.

3.3 Actors

Actors are external (human) entities that interact with the system. The system affects and is affected by the behaviour of actors, therefore these relations are described in the use case descriptions. For the C-ITS system the relevant actors are indicated in the 'Architecture for C-ITS applications in the Netherlands' [2]:

- Vehicle driver: the driver of the subject vehicle.
- Road operator: the road authority, policy maker and traffic manager.
- Service provider: the entity providing a service to the vehicle driver.
- End user: an individual using the information of the C-ITS system (e.g. pre-trip).
- Vulnerable road user: pedestrians and cyclists.
- Other: e.g. entities with an interest in the C-ITS system, e.g. fleet owners and insurance companies.

3.4 Use case selection

Based on current project activities and interests of public and private stakeholders, the Dutch national round tables selected the following 17 use cases (also see chapter 3.5). These are described in more detail the following sections, in a implementation neutral language.

- Static signage information
- Dynamic signage information
- Stationary vehicle
- Adverse weather condition
- Hazardous location notification
- Traffic condition warning
- Road works warning
- Lane change, merge and overtaking assistance
- Regulatory / contextual speed limits notification
- Traffic light optimal speed advisory
- Basic probe vehicle data
- Extended probe vehicle data
- Traffic signal priority request
- Traffic signal optimisation
- Traffic information and route guidance
- Parking management
- Multi-modal cargo transport optimisation

3.5 Use case overview

There already exist many descriptions of C-ITS use cases, but both naming and descriptions differ frequently, even if the same meaning was intended. Moreover, drafting rules for describing use cases are often not complied with, not even in standardisation documents. For that reason a new use case table was created by carefully bringing together use case definitions, descriptions and clustering from different sources [3-11]. In addition, use cases are mapped against national projects. The resulting table is shown below.

The table distinguishes class, application, use case and situation:

- **Class**: clustering of applications based on common objectives, e.g. traffic safety.
- **Application**: clustering of use cases based on common functionalities, for example awareness. Applications are also known as ‘service’.
- **Use case**: see sections 1.1 and 3.1.
- **Situation**: see section 3.1.

Class	Application	Use Case	Situation	EC	BBV	Corridor	InterCor	PPA	Smartwayz
Road safety	Driving assistance (info) – In-vehicle signage	Static signage information (descriptive/prescriptive)	Merge or diverge	Day 1	1d3, 1d4	(x)	(x)		
			Change in carriageway configuration		1b5				
			Overtaking prohibition		1c1				
		Dynamic signage information (descriptive/prescriptive)	Status peak-hour lanes		1d1				
			Status tidal flow lanes		1d2				
			(Dynamic) legal speed limit		1a1				
	Driving assistance (awareness) - Road Hazard Signalling	Emergency vehicle warning		Day 1	2a6				
		Slow vehicle indication		Day 1					
		Stationary vehicle	Accident	Day 1	2a4, 2a8				
			Vehicle Problem		2a4, 2a8				
			Road Inspector		2a7				
		Emergency electronic brake lights		Day 1					
		Wrong way driving warning		Day 1.5					
		Adverse weather condition	Precipitations	Day 1	2a3				
			Road adhesion		2a3				
			Visibility		2a3				
			Wind		2a3				
		Hazardous location notification	Object on the road	Day 1	2a9				
			Spilled load		2a9				
			Pothole						
		Traffic condition warning	Traffic jam ahead warning / AID	Day 1	2a2				
		Road work warning	Short-term mobile	Day 1	2b1, 2b2	x	(x)		
			Short-term static		2b1, 2b2				
			Long-term road works		2b1, 2b2				
			Unplanned (ad-hoc) road works						
		VRU safety warning		Day 1.5					
	Collision avoidance (warning) - (Longitudinal) Collission Risk Warning	Forward collision warning		Day 1.5		(x)			
		Lane change, merge and overtaking assistance			2a10				
		Motorcycle approaching		Day 1.5					
	Collision avoidance (warning) - Intersection Collision (Risk) Warning	Across traffic turn collision risk warning							
		Merging traffic turn collision risk warning							
		VRU crossing while turning							
		Signal violation warning		Day 1					
Automated driving	Driving assistance (automatic)	Cooperative Adaptive Cruise Control / Platooning							
Traffic efficiency	Speed management	Regulatory / contextual speed limits notification	Shockwave damping	Day 1	1b1, 1b2				x
			Weather condition		1b3				
			Hazardous location		1b4				
			Emergency vehicle		1b6				
		Traffic light optimal speed advisory	Time-to-green information and speed advice	Day 1	4.1, 4.3		x		x
			Time-to-red information and speed advice		4.2, 4.3				
	Probe data	Basic probe vehicle data		Day 1		x	(x)	(x)	
		Extended probe vehicle data				(x)			

Class	Application	Use Case	Situation	EC	BBV	Corridor	InterCor	PPA	Smartwayz
	Traffic management	Flexible lane allocation							
		Traffic signal priority request	Priority public transport	Day 1	3a1				x
			Priority trucks		3a2				
			Priority vehicle platoon		3a3				
			Priority group of cyclists		3a4				
			Preemption emergency vehicle		3b1				
		Zone access control for urban areas		Day 1.5					
		Traffic signal optimisation	Traffic lights		5.1, 5.2			x	
			Ramp metering					x	
	Cooperative navigation	Traffic information and route guidance	Bridge open	Day 1.5	2a1			(x)	
			Reduced speed due to event		2a5				
			Parking routes		6.3				
			Eco-routes						
			Limited access						
			Tunnel information				x		
		Parking management	Off street parking information	Day 1.5	6.1, 6.2				
			On street parking information	Day 1.5	6.1, 6.2				
			Parking facilities at events		6.4			x	
			Bicycle parking facilities		6.5				
			Truck parking				x		
Smart mobility	Location based services	Point of interest notification							
		Automatic access control and parking access		Day 1.5					
		ITS local electronic commerce							
		Media downloading							
	Urban mobility	Multimodality support		Day 1.5					
	Communities services	Insurance and financial services							
		Fleet management (goods delivery)							
		Loading zone management (goods delivery)		Day 1.5					
		Information on AFV fuelling & charging stat.		Day 1.5					
		Multi-modal cargo transport optimisation					x		
Operational management	ITS station life cycle management	Vehicle software / data provisioning and update							
		Vehicle and RSU data calibration							

4 Use case: Static signage information

4.1 Introduction use case

4.1.1 Background

On the road static traffic signs show current restrictions at that location and specific road situations occurring further up on the route. This information must be provided in the vehicle, which means that drivers always know about the restrictions at that location. Along with the restrictions a current situation-specific speed recommendation (with the reason for it) must be given to drivers. The in-car provision of a speed recommendation will allow the driver to timely anticipate to the changing situation downstream.

4.1.2 Objective (function)

To provide in-car information about static traffic signs.

4.1.3 Desired behaviour

The vehicle driver adapts his/her driving behaviour compliant to the applicable driving regulations and any advice or guidance provided.

4.1.4 Expected impact

The primary expected impact is more attentive driving, which improves traffic safety as it reduces (the severity of) accidents.

4.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **InterCor** EU-funded project

4.2 Use case description

4.2.1 Situation

Situation 1: Merge or diverge

Warning of approaching the end of a (rush-hour, extra or reversible) lane, the distance (or time) left to the end of the lane and the current need to merge (if available including corresponding speed advise).

Situation 2: Change in carriageway configuration

Speed advise will be given due to a current change of carriageway configuration downstream.

Situation 3: Overtaking prohibition

Continual display of current and location-centric overtaking restrictions for trucks in the driving direction of the vehicle.

4.2.2 Actors and relations

- Vehicle driver: receives static signage information on the in-vehicle display.
- Road operator: provides information on static signage.
- Service provider: disseminates static signage information to vehicle drivers.
- End user: trip planners may use static signage information to optimise their trip planning.
- Vulnerable road user: n/a.
- Other: n/a.

4.2.3 Scenario

While driving, vehicle drivers receive actual static signage information on the in-vehicle display.

5 Use case: Dynamic signage information

5.1 Introduction use case

5.1.1 Background

Dynamic signs usually affect the road layout, driving regulations, etc. Despite dedicated signage prior to peak hour/tidal flow lanes, such changed conditions frequently come as a surprise to vehicle drivers. This may lead to unsafe situations and sometimes even accidents, which involve road users.

5.1.2 Objective (function)

To provide in-car information about dynamic traffic signs.

5.1.3 Desired behaviour

The vehicle driver adapts his/her driving behaviour compliant to the applicable driving regulations and any advice or guidance provided.

5.1.4 Expected impact

The primary expected impact is more attentive driving when approaching dynamic signage zones, which improves traffic safety as it reduces (the severity of) accidents.

5.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **InterCor** EU-funded project

5.2 Use case description

5.2.1 Situation

Situation 1: Status peak hour lanes

Continual display of current and location-centric relevant open or closed rush-hour/extra lanes in the driving direction of the vehicle.

Situation 2: Status tidal flow lanes

Continual display of current and location-centric relevant open or closed reversible lanes in the driving direction of the vehicle.

Situation 3: (Dynamic) legal speed limit

Continual display of the current statutory maximum speed at the location and direction the vehicle is driving.

5.2.2 Actors and relations

- Vehicle driver: receives dynamic signage information on the in-vehicle display.
- Road operator: provides information on dynamic signage.
- Service provider: disseminates dynamic signage information to vehicle drivers.

- End user: trip planners may use dynamic signage information to optimise their trip planning.
- Vulnerable road user: n/a.
- Other: n/a.

5.2.3 Scenario

While driving, vehicle drivers receive actual dynamic signage information on the in-vehicle display.

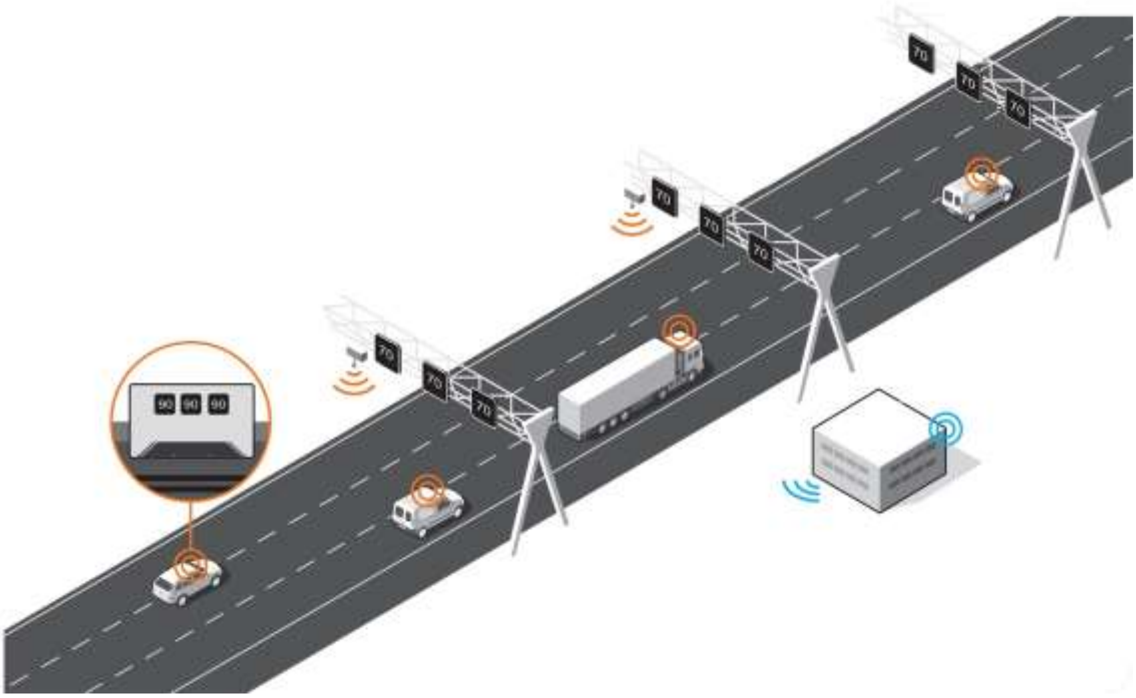

Figure 3: Dynamic signage information ilustration

6 Use case: Stationary vehicle

6.1 Introduction use case

6.1.1 Background

Stationary vehicles on the road, on the hard shoulder or next to the road may cause hazardous situations especially when they are not noticed timely by vehicle drivers passing by. This may, for example, lead to a collision with the stationary vehicle or an unexpected steering or braking manoeuvre.

6.1.2 Objective (function)

To provide timely in-car driving assistance information on a stationary vehicle(s) downstream of the current position and in the driving direction of the vehicle.

6.1.3 Desired behaviour

The in-car driving assistance information improves the awareness of drivers, increases their attentiveness and allows them to better anticipate to the situation. As a consequence they can more timely adapt their driving behaviour as appropriate.

6.1.4 Expected impact

In-car information on stationary vehicles is expected to improve traffic safety and reduce the risk of accidents.

6.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

6.2 Use case description

6.2.1 Situation(s)

Situation 1: Accident

A vehicle approaches a calamity or incident downstream of the current position and in the driving direction.

Situation 2: Vehicle Problem

A vehicle approaches a stationary vehicle on the lane or hard shoulder downstream of the current position and in the driving direction.

Situation 3: Road Inspector

A vehicle approaches a highways inspector vehicle on the lane or hard shoulder downstream of the current position and in the driving direction.

6.2.2 Actors and relations

- Vehicle driver: receives stationary vehicle information on the in-vehicle display.
- Road operator: may detect and signal the presence of a stationary vehicle.
- Service provider: disseminates the stationary vehicle information to vehicle drivers.
- End user: traffic jams caused by stationary vehicles may be used by route planners.

- Vulnerable road user: n/a.
- Other: n/a.

6.2.3 Scenario

A vehicle approaches a stationary vehicle downstream of the current position and in the driving direction. The vehicle driver receives timely an awareness message on the in-vehicle display. This message includes: the remaining distance (or time) to reach the stationary vehicle and, where appropriate, a driving recommendation (e.g. lane or speed change).

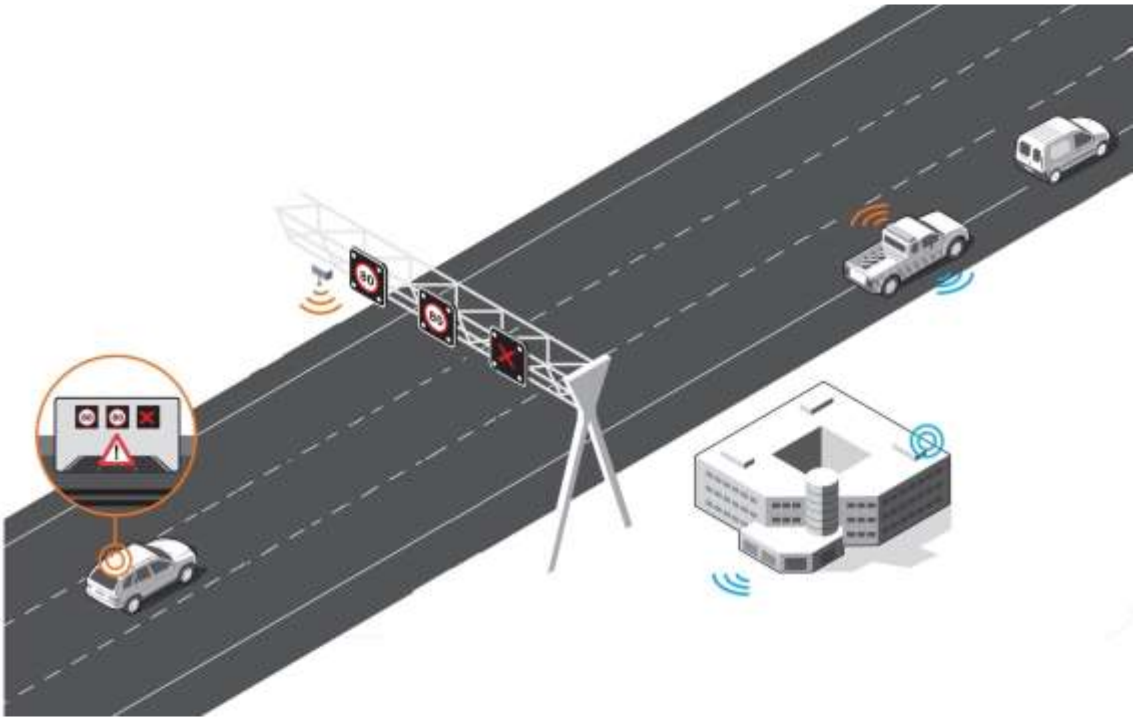

Figure 4: Stationary vehicle ilustration

7 Use case: Adverse weather condition

7.1 Introduction use case

7.1.1 Background

Adverse weather conditions may cause hazardous situations, especially when vehicle drivers do not anticipate appropriately to them. This may, for example, lead to unsafe driving situations and in the worst case accidents.

7.1.2 Objective (function)

To provide timely in-car driving assistance information on adverse weather conditions downstream of the current position and in the driving direction of the vehicle.

7.1.3 Desired behaviour

The in-car driving assistance information improves the awareness of drivers, increases their attentiveness and allows them to better anticipate to the situation. As a consequence they can more timely adapt their driving behaviour as appropriate.

7.1.4 Expected impact

In-car information on adverse weather conditions is expected to improve traffic safety and reduce the risk of accidents.

7.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

7.2 Use case description

7.2.1 Situation

Situation 1: Precipitation

A vehicle approaches an area with precipitation (e.g. heavy rain or snow) downstream of the current position and in the driving direction.

Situation 2: Road adhesion:

A vehicle approaches a slippery road section downstream of the current position and in the driving direction.

Situation 3: Visibility:

A vehicle approaches an area with poor visibility (e.g. fog) downstream of the current position and in the driving direction.

Situation 4: Wind

A vehicle approaches an area with strong winds downstream of the current position and in the driving direction.

7.2.2 Actors and relations

- Vehicle driver: receives adverse weather information on the in-vehicle display.

- Road operator: may impose temporary driving restrictions due to the adverse weather.
- Service provider: disseminates the adverse weather information to vehicle drivers.
- End user: (expected) delays caused by adverse weather may be used by route planners.
- Vulnerable road user: n/a.
- Other: meteorological institutes may predict adverse weather conditions.

7.2.3 Scenario

A vehicle approaches adverse weather conditions downstream of the current position and in the driving direction. The vehicle driver receives timely an awareness message on the in-vehicle display. This message includes: the remaining distance (or time) to reach the adverse weather conditions and, where appropriate, a driving recommendation (e.g. lane or speed change).

8 Use case: Hazardous location notification

8.1 Introduction use case

8.1.1 Background

Unawareness of hazardous locations may lead to unsafe driving situations or in the worst case accidents, especially when vehicle drivers do not anticipate appropriately to them.

8.1.2 Objective (function)

To provide timely in-car driving assistance information on hazardous locations downstream of the current position and in the driving direction of the vehicle.

8.1.3 Desired behaviour

The in-car driving assistance information improves the awareness of drivers, increases their attentiveness and allows them to better anticipate to the situation. As a consequence they can more timely adapt their driving behaviour as appropriate.

8.1.4 Expected impact

In-car information on hazardous locations is expected to improve traffic safety and reduce the risk of accidents.

8.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

8.2 Use case description

8.2.1 Situation

Situation 1: Object on the road

A vehicle approaches an object on the lane or hard shoulder downstream of the current position and in the driving direction.

Situation 2: Spilled load

A vehicle approaches spilled load on the lane or hard shoulder downstream of the current position and in the driving direction.

Situation 3: Pothole

A vehicle approaches a pothole on the lane or hard shoulder downstream of the current position and in the driving direction.

8.2.2 Actors and relations

- Vehicle driver: receives hazardous location information on the in-vehicle display.
- Road operator: may signal the existence of a hazardous location.
- Service provider: disseminates the hazardous location information to vehicle drivers.
- End user: n/a.
- Other: organisations charged with repair, maintenance and/or cleaning may act on the hazardous location information.

8.2.3 Scenario

A vehicle approaches a hazardous location downstream of the current position and in the driving direction. The vehicle driver receives timely an awareness message on the in-vehicle display. This message includes: the remaining distance (or time) to reach the hazardous location and, where appropriate, a driving recommendation (e.g. lane or speed change).

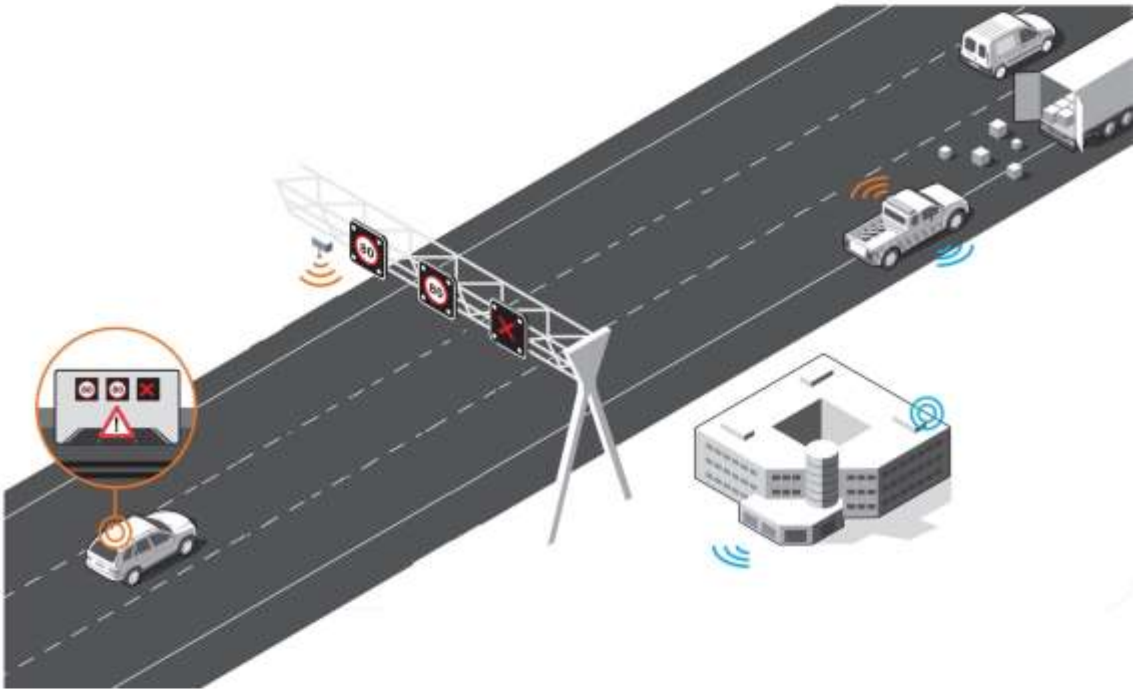

Figure 5: Hazardous location ilustration

9 Use case: Traffic condition warning

9.1 Introduction use case

9.1.1 Background

Sudden changes in traffic conditions downstream of the current position and in the driving direction of the vehicle may have an impact on both traffic safety and efficiency.

9.1.2 Objective (function)

To provide timely in-car driving assistance information on traffic conditions downstream of the current position and in the driving direction of the vehicle.

9.1.3 Desired behaviour

The vehicle driver adapts his/her driving behaviour compliant to any advice or guidance provided.

9.1.4 Expected impact

In-car information on downstream traffic conditions is expected to improve traffic safety by reducing the risk of accidents and to improve traffic efficiency

9.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

9.2 Use case description

9.2.1 Situation

Situation 1: Traffic jam ahead warning

A vehicle approaches the tail of a traffic jam downstream of the current position and in the driving direction.

9.2.2 Actors and relations

- Vehicle driver: receives traffic condition information on the in-vehicle display.
- Road operator: provides policy constraints.
- Service provider: disseminates the traffic condition information to vehicle drivers.
- End user: traffic jams may be used by route planners.
- Other: n/a.

9.2.3 Scenario

A vehicle approaches a traffic condition (e.g. the tail of a traffic jam) downstream of the current position and in the driving direction. The vehicle driver receives timely an awareness message on the in-vehicle display. This message includes: the remaining distance (or time) to reach the traffic condition and, where appropriate, a driving recommendation (e.g. lane or speed change). The recommendations may include, where appropriate, an adjustment of the scheduled route to the destination on the basis of the designated diversion route.

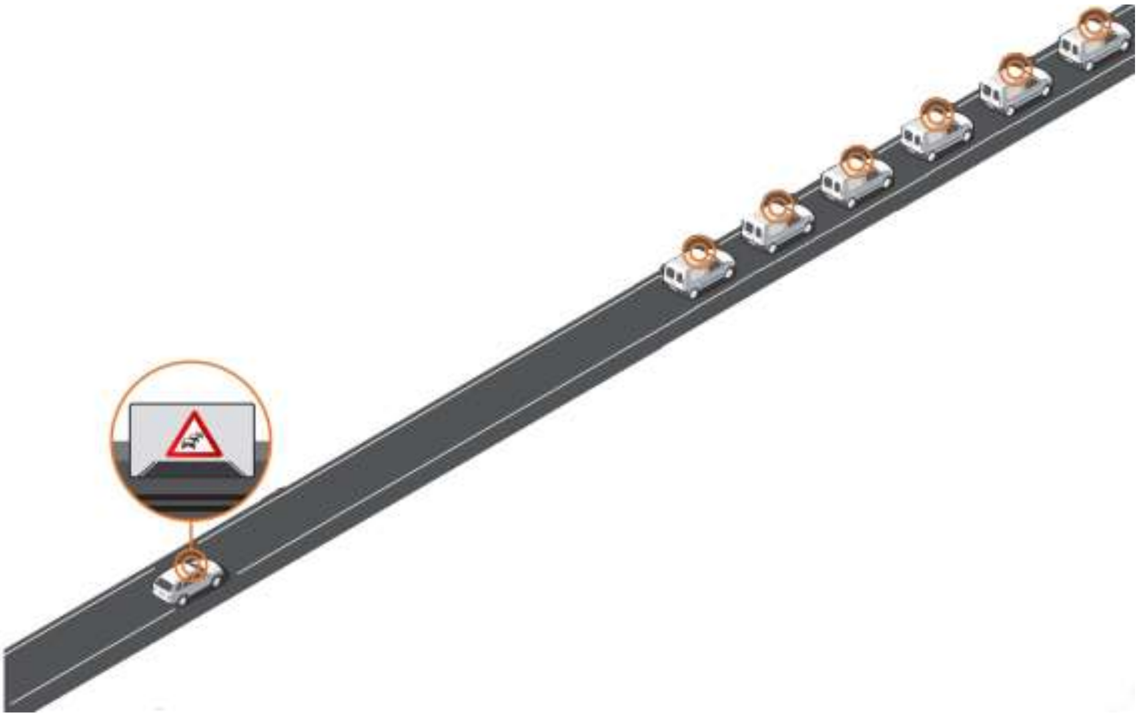

Figure 6: Traffic condition warning ilustration

10 Use case: Road works warning

10.1 Introduction use case

10.1.1 Background

Road works usually affect the road layout and driving regulations. Despite dedicated signage prior to road work zones, such changed conditions frequently come as a surprise to vehicle drivers. This may lead to unsafe situations and sometimes even accidents, which involve both road users and workers.

10.1.2 Objective (function)

To provide in-car information and warnings about road works, changes to the road layout and applicable driving regulations.

10.1.3 Desired behaviour

The vehicle driver adapts his/her driving behaviour compliant to the applicable driving regulations and any advice or guidance provided.

10.1.4 Expected impact

The primary expected impact is more attentive driving while approaching and passing a work zone, which improves traffic safety as it reduces (the severity of) accidents.

10.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **InterCor** EU-funded project
- **A58 Spookfiles** project (http://www.spookfiles.nl/)

10.2 Use case description

10.2.1 Situation

A vehicle approaches a road work zone:

Situation 1: Mobile road works

Planned slowly moving road works like cutting the grass or renewing the lane markings, usually secured by a moving trailer.

Situation 2: Short-term static

Planned stationary road works, e.g. one night, secured by one or more road works safety trailers and (an) optional pre-warner(s).

Situation 3: Long-term road works

Planned stationary road works for several days, weeks or months, usually having a large impact on the infrastructure layout.

Situation 4: Unplanned (ad-hoc) road works

Unplanned road works, e.g. emergency repairs / maintenance to the tarmac.

10.2.2 Actors and relations

- Vehicle driver: receives road work related information, warnings and/or guidance on the in-vehicle display.
- Road operator: approves and announces road works, and provides regulatory conditions.
- Service provider: disseminates road works related information, warnings and/or guidance to vehicle drivers.
- End user: trip planners may use road works information, and consequential expected delays, to optimise their trip planning.
- Vulnerable road user: n/a.
- Other: road workers or construction companies could provide information about the road works, e.g. location, start, end, etc.

10.2.3 Scenario

While approaching a road work zone, vehicle drivers receive road works related information, warnings and/or guidance on the in-vehicle display. Instructions may include to reduce the driving velocity, to change lanes, to prepare for a steering manoeuvre, etc.

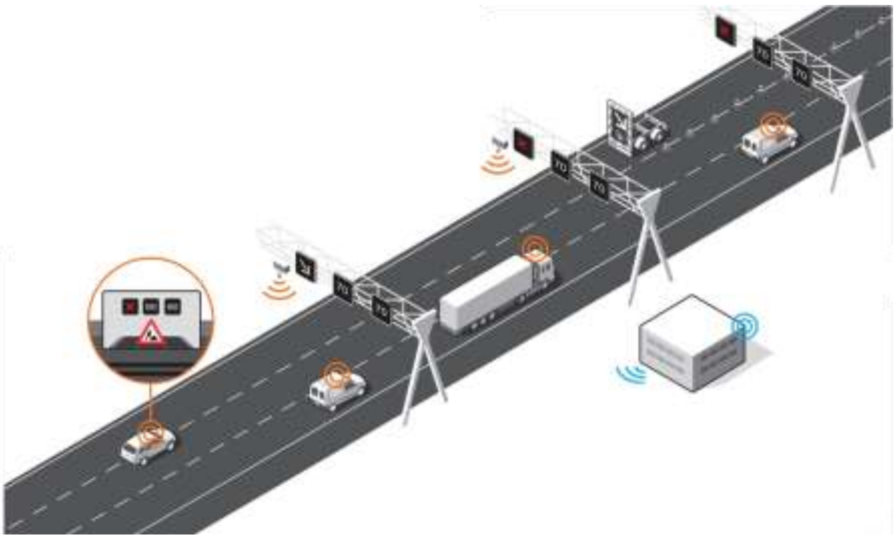

Figure 7: Road works warning illustration

11 Use case: Lane change, merge, and overtaking assistance

11.1 Introduction use case

11.1.1 Background

The lateral driving task, e.g. changing lanes, merging and overtaking, is particularly complex in dense traffic conditions. When not executed properly it is a cause for unsafe traffic situations and disturbance of traffic flow.

11.1.2 Objective (function)

To provide in-car collision risk warning for lateral manoeuvres.

11.1.3 Desired behaviour

The vehicle driver adapts driving behaviour compliant to any advice or guidance provided.

11.1.4 Expected impact

The primary expected impact is the reduction of the risk of lateral collision and thereby improve traffic safety. The secondary expected impact is to smoothen lateral manoeuvres and reduce any negative impact on traffic flow.

11.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)

11.2 Use case description

11.2.1 Situation

Situation 1: Lane change

A vehicle is driving on a dual-lane carriageway and the vehicle driver want to make a lane change (e.g. to prepare for a turning manoeuvre).

Situation 2: Merging

A vehicle is driving on an on-ramp and the vehicle driver wants to merge onto the main road.

Situation 3: Overtaking

A vehicle is driving on a dual-lane carriageway with traffic in two directions and the vehicle driver wants to overtake another (slow moving) vehicle.

11.2.2 Actors and relations

- Vehicle driver: receives driving assistance information and collision risk warning on the in-vehicle display.
- Road operator: may (temporarily) prohibited changing lanes or overtaking.
- Service provider: disseminates driving assistance information and collision risk warning to vehicle drivers.
- End user: n/a.

- Vulnerable road user: n/a.
- Other: n/a.

11.2.3 Scenario

When the vehicle driver commences the lane change / merging / overtaking manoeuvre he/she receives driving assistance information and collision risk warning if appropriate.

12 Use case: Regulatory / contextual speed limits notification

12.1 Introduction use case

12.1.1 Background

Traffic signs show current regulatory speed limits at a location. In addition, On a route circumstances may occur in (downstream) or from the (upstream) driving direction of the vehicle that make it necessary to adjust the speed. Despite dedicated (dynamic) signage and driver training, vehicle drivers frequently fail to anticipate to changing situations and fail to maintain a safe driving velocity.

12.1.2 Objective (function)

To provide in-car information about regulatory / contextual speed limits to ensure that vehicle drivers can always be aware of the regulatory / appropriate driving velocity and can timely anticipate to the changing circumstances downstream.

12.1.3 Desired behaviour

The vehicle driver adapts his/her driving behaviour compliant to the applicable regulatory / contextual speed limits.

12.1.4 Expected impact

The primary expected impact is more attentive driving, which improves traffic safety as it reduces (the severity of) accidents.

12.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **Smartwayz** – Smart Mobility programme (http://www.smartwayz.nl/)
- **A58 Spookfiles** project (http://www.spookfiles.nl/)

12.2 Use case description

12.2.1 Situation

Situation 1: Shockwave damping

A motorway section with a traffic jam that dissolves at the ‘head’ of the traffic jam and grows at the ‘tail’ of the traffic jam.

Situation 2: Weather condition

A vehicle approaches a road section with adverse weather conditions.

Situation 3: Hazardous location

A vehicle approaches a hazardous location (e.g. slippery road section, pothole, bumps, ramps, spilled load, etc.)

Situation 4: Emergency vehicle

A vehicle is driving while upstream (i.e. from the back) an emergency vehicle is approaching.

12.2.2 Actors and relations

- Vehicle driver: receives information about regulatory / contextual speed limits on the in-vehicle display.
- Road operator: defines policies on regulatory / contextual speed limits.
- Service provider: disseminates information on regulatory / contextual speed limits to vehicle drivers.
- End user: n/a.
- Vulnerable road user: n/a.
- Other: n/a.

12.2.3 Scenario

While driving, vehicle drivers receive actual information about regulatory / contextual speed limits on the in-vehicle display. Generally, to reduce speed in anticipation of e.g. weather conditions or the condition of the road surface. In case of a shockwave the speed recommendations are such that: 1) the speed of growth of the traffic jam reduces and/or 2) the dissipation of a traffic jam is accelerated.

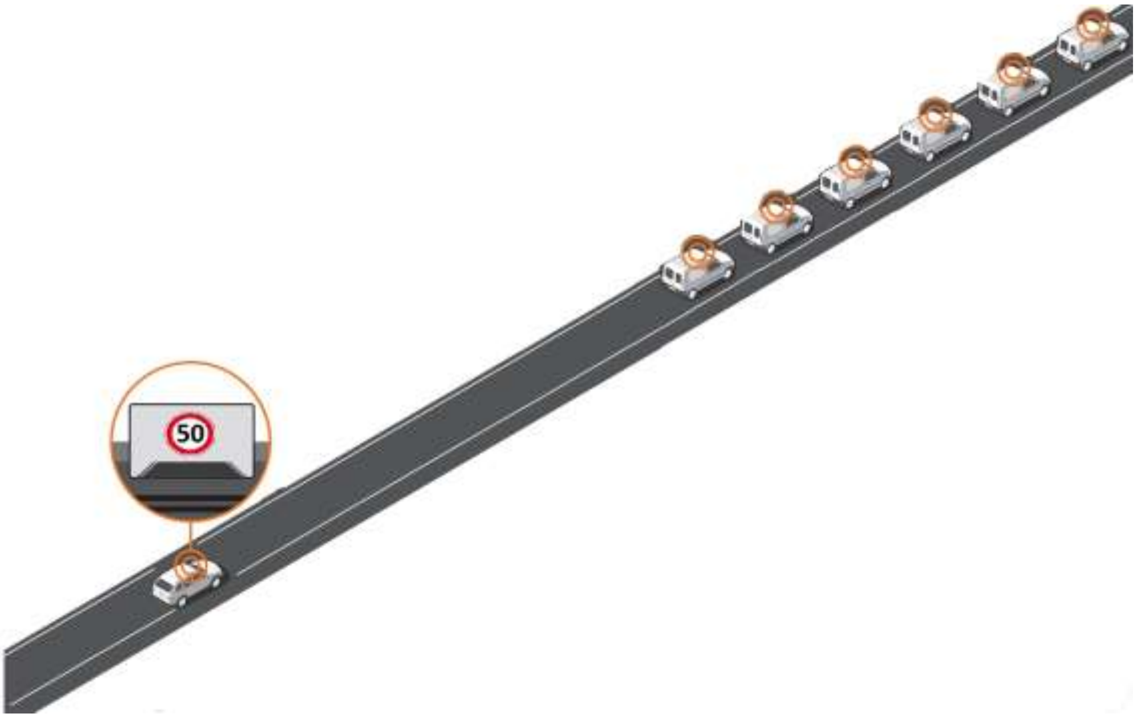

Figure 8: Regulatory / contextual speed limits notification ilustration

13 Use case: Traffic light optimal speed advisory

13.1 Introduction use case

13.1.1 Background

Based on information on the phases and timing of traffic lights, speed change advisory can be offered to vehicle drivers or vehicle controls on the approach of and departure from a signalised intersection.

13.1.2 Objective (function)

To calculate a speed advice based on signal phase and timing information, to enable a vehicle or platoon to pass a signalised intersection in the most efficient manner.

13.1.3 Desired behaviour

The vehicle driver or vehicle controls comply to the speed change advice, maintaining that speed while passing the signalised intersection.

13.1.4 Expected impact

The primary expected impact is a smoother vehicle trajectory while passing a signalised intersection, which reduces stops and emissions. In case of a stop, the start delay is expected to decrease as the start of the green phase is known in advance.

Secondary impacts may result from interaction with other use cases like 'Traffic Signal Optimisation'. As the driving speeds and the signal phases and timing could be optimized synchronously, the delay times at the signalised intersection are expected to decrease.

13.1.5 Known Dutch realisations (or planned)

- Helmond as part of the **Compass4D** EU-funded project (http://www.compass4d.eu/)
- Eindhoven as part of the **ODYSA In-Car** SRE-funded project (http://www.odysa.nl/ODYSA_In-car.aspx)
- Helmond as part of the **C-TheDifference** EU-funded project, being a follow-up of Compass4D
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- Helmond, Tilburg and Breda as part of the **InterCor** EU-funded project
- **Smartwayz** – Smart Mobility programme (http://www.smartwayz.nl/)

13.2 Use case description

13.2.1 Situation

Situation 1: Time-to-green information and speed advice

A vehicle approaches a signalised intersection while the traffic light is red or will arrive at the stop line during the red phase.

Situation 2: Time-to-red information and speed advice

A vehicle approaches a signalised intersection while the traffic light is green or will arrive at the stop line during the green phase.

13.2.2 Actors and relations

- Vehicle driver: receives speed advisory information on the in-vehicle display.
- Road operator: n/a.
- Service provider: disseminates the speed advisory information to vehicle drivers.
- End user: n/a.
- Vulnerable road user: speed advisory information may be offered to cyclists too. Crossing vulnerable road users may affect the validity of the speed advisory information.
- Other: n/a.

13.2.3 Scenario

While approaching a signalised intersection, vehicle drivers receive speed advice information. There are four possible scenarios:

1. As indicated by the speed advice a vehicle maintains the current speed and arrives at the intersection during a green phase.
2. As indicated by the speed advice a vehicle increases the current speed (never beyond the legal speed limit) and arrives at the intersection before the end of a green phase.
3. As indicated by the speed advice a vehicle decreases the current speed and arrives at the intersection at the start of a green phase.
4. As indicated by the speed advice a vehicle gradually decreases speed and stops to wait for the next green phase. The vehicle receives a speed (acceleration) advice as soon as the light switches to green in order to minimize the start delay.

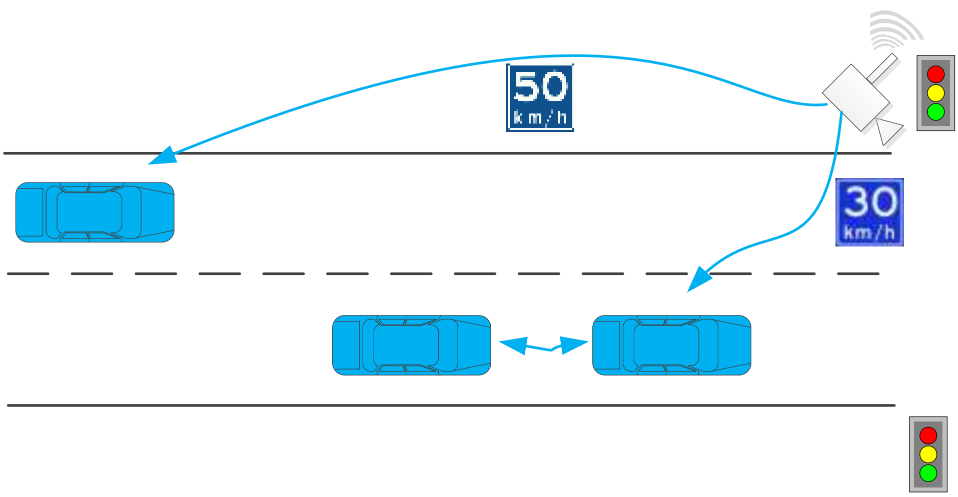

Figure 9: Traffic light optimal speed advisory ilustration

14 Use case: Basic probe vehicle data

14.1 Introduction use case

14.1.1 Background

Modern vehicles know their own position, speed and direction and often other vehicle properties (e.g. windscreen wiper status, ABS, ESP, collision sensors, etc.) as well. Vehicles can broadcast these data when in range of an R-ITS-S. This will provide the road authority with information about traffic, road surface and environment conditions around R-ITS-Ss.

14.1.2 Objective (function)

To collect data about traffic conditions, road surface conditions and the surroundings.

14.1.3 Desired behaviour

The collected data gives insight in the traffic situation and surroundings. These are used as input for monitoring & evaluation (e.g. for policy making) and other use cases such as traffic condition warning, hazardous location notification and adverse weather condition.

14.1.4 Expected impact

The primary expected impact is expected from indirect effects through other use cases. The collected data proves as a basis for other applications which are improved or possibly impossible otherwise. Impact of such applications include, safer road conditions (e.g. traffic jam/collision alert and adverse weather condition warnings), less CO2 emissions (resulting from a more stable traffic flow) and faster travel times (because of more optimal rerouting of traffic).

14.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **InterCor** EU-funded project
- **Praktijkproef Amsterdam** (http://www.praktijkproefamsterdam.nl/)

14.2 Use case description

14.2.1 Situation

A vehicle is driving along a road and transmitting a message (e.g. CAM, DENM) when in range of a R-ITS-S.

14.2.2 Actors and relations

- Vehicle driver: drives the vehicle along R-ITS-Ss and possibly gives its consent regarding sharing the vehicle's data.
- Road operator: collects the data via R-ITS-Ss
- Service provider: uses the information derived from the data to provide warnings and advice.
- End user: receives warnings to avoid dangerous situations and advice to change the driving behaviour (brake, accelerate, change routes, etc.)
- Vulnerable road user: n/a.
- Other: OEMs may act as a service provider, but also as an intermediate between the

service providers and the end users.

14.2.3 Scenario

In range of an R-ITS-S a vehicle broadcasts information/a message (e.g. CAM, DENM) containing information about the vehicle and its surroundings. The data received by the R-ITS-S is collected in a central system and then redistributed among third parties (OEMs, service providers) for other applications. Examples are:

- While approaching a slippery (oil) spot a driver receives a warning about a slippery road surface which was determined and broadcasted by a previously passing vehicle.
- A vehicle closing in on a traffic jam tail receives a warning based on the slow-moving vehicle in the tail which broadcasted its speed and location.

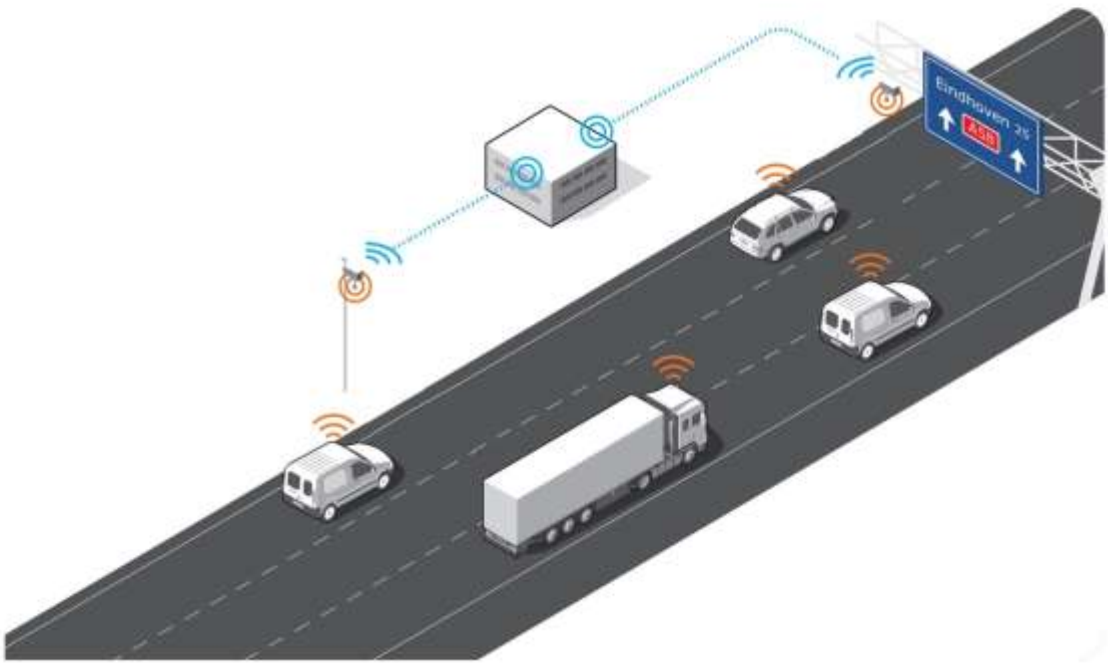

Figure 10: Probe vehicle data ilustration

15 Use case: Extended probe vehicle data

15.1 Introduction use case

15.1.1 Background

Modern vehicles know their own position, speed and direction and often other vehicle properties (windscreen wiper status, ABS, ESP, collision sensors, etc.) as well. Vehicles can collect and store that information for a short while. Then, when in range of an R-ITS-S, the vehicles can broadcast the stored information. This will provide the road authority with detailed information about traffic, road surface and environment conditions with a relatively large coverage.

15.1.2 Objective (function)

To collect data about traffic conditions, road surface conditions and the surroundings.

15.1.3 Desired behaviour

The collected data gives insight in the traffic situation and surroundings. These are used as input for monitoring & evaluation (e.g. for policy making) and other use cases such as traffic condition warning, hazardous location notification and adverse weather condition.

15.1.4 Expected impact

The primary expected impact is expected from indirect effects through other use cases. The collected data proves as a basis for other applications which are improved or possibly otherwise impossible. Impact of such applications include, safer road conditions (e.g. traffic jam/collision alert and adverse weather condition warnings), less CO2 emissions (resulting from a more stable traffic flow) and faster travel times (because of more optimal rerouting of traffic).

15.1.5 Known Dutch realisations (or planned)

- Dutch **C-ITS Corridor** (https://itscorridor.mett.nl)
- **InterCor** EU-funded project
- **Praktijkproef Amsterdam** (http://www.praktijkproefamsterdam.nl/)

15.2 Use case description

15.2.1 Situation

A vehicle is driving along a road and stores messages containing information about the vehicle and its surroundings and transmits those messages (or the information contained in those messages) when in range of a R-ITS-S.

15.2.2 Actors and relations

- Vehicle driver: drives the vehicle along R-ITS-Ss and possibly gives its consent regarding sharing the vehicle's data.
- Road operator: collects the data via R-ITS-Ss
- Service provider: uses the information derived from the data to provide warnings and advice.
- End user: receives warnings to avoid dangerous situations and advice to change the

driving behaviour (brake, accelerate, change routes, etc.)

- Vulnerable road user: n/a.
- Other: OEMs may act as a service provider, but also as an intermediate between the service providers and the end users.

15.2.3 Scenario

In range of an R-ITS-S a vehicle broadcasts stored information/messages (e.g. CAMs, DENMs) containing information about the vehicle and its surroundings. The data received by the R-ITS-S is collected in a central system and then redistributed among third parties (OEMs, service providers) for other applications. Examples are:

- While approaching a slippery (oil) spot a driver receives a warning about a slippery road surface which was determined and broadcasted by a previously passing vehicle.
- A vehicle closing in on a traffic jam tail receives a warning based on the slow-moving vehicle in the tail which broadcasted its speed and location.

16 Use case: Traffic signal priority request

16.1 Introduction use case

16.1.1 Background

Traffic lights interrupt traffic flow and therefore cause delay and emissions. For emergency, safety, environmental, traffic flow efficiency and business reasons it may be advantageous to give priority at traffic lights to specific classes of road users.

16.1.2 Objective (function)

To give priority at traffic lights to specific classes of road users.

16.1.3 Desired behaviour

The traffic signal is green when the vehicle arrives at the intersection and the vehicle can pass the intersection with no (control) delay.

16.1.4 Expected impact

The primary expected impact is reduced delay and less stops (therefore less emission) for the priority classes. These classes are expected to have reduced travel times and fuel consumption.

16.1.5 Known Dutch realisations (or planned)

- Helmond as part of the **Compass4D** EU-funded project (http://www.compass4d.eu/)
- Helmond as part of the **C-TheDifference** EU-funded project, being a follow-up of Compass4D
- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- Helmond, Tilburg and Breda as part of the **InterCor** EU-funded project
- **Smartwayz** – Smart Mobility programme (http://www.smartwayz.nl/)

16.2 Use case description

16.2.1 Situation

Situation 1: Priority Public Transport

A public transport vehicle (e.g. a bus) is approaching a signalised intersection.

Situation 2: Priority Trucks

A truck is approaching a signalised intersection.

Situation 3: Priority vehicle platoon

A platoon of vehicles is approaching a signalised intersection.

Situation 4: Priority group of cyclists

A group of cyclists is approaching a signalised intersection.

Situation 5: Pre-emption for emergency vehicle

An emergency vehicle is approaching a signalised intersection.

16.2.2 Actors and relations

- Vehicle driver: receives acknowledgement of priority.
- Road operator: defines the policy objectives and priorities.
- Service provider: implements the traffic signal priority service.
- End user: fleet owners and fleet operators may amend routes based on priority rules.
- Vulnerable road user: n/a.
- Other: n/a.

16.2.3 Scenario

A priority vehicle approaches a signalised intersection. Vehicle information such as the vehicle class, load properties and punctuality is provided to the signal controller. Subject to the applicable priority policies, the vehicle is given priority green and therefore can pass the intersection unhindered.

17 Use case: Traffic signal optimisation

17.1 Introduction use case

17.1.1 Background

The availability of data from vehicles (like vehicle type, position, driving direction and speed) can help form a good picture of traffic flows, which makes it possible to improve signal optimisation (i.e. the signal phase and timing), especially if good in-car information provision enables advisory of speed, route, etc. This combination allows to control traffic even more efficiently.

17.1.2 Objective (function)

To better optimise the signal phase and timing of traffic signals using cooperative vehicle data. This includes: minimisation of waiting times, journey times, stops, etc. by adjusting the signal phase and timing for all or a selection of modalities and/or driving directions.

17.1.3 Desired behaviour

Optimal or near-optimal operation of a traffic signals, expressed by common key performance indicators.

17.1.4 Expected impact

Less delay and emission, higher throughput and use of capacity.

17.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **Praktijkproef Amsterdam** (http://www.praktijkproefamsterdam.nl/)

17.2 Use case description

17.2.1 Situation

Situation 1: Traffic lights

A signalised intersection.

Situation 2: Ramp metering

A traffic signal controlling an motorway on-ramp.

17.2.2 Actors and relations

- Vehicle driver: experiences the operational performance of the traffic signal.
- Road operator: defines the policy objectives and constraints.
- Service provider: implements the traffic signal optimisation service.
- End user: n/a.
- Vulnerable road user: experiences the operational performance of the traffic signal.
- Other: n/a.

17.2.3 Scenario

Traffic is approaching a traffic signal controlled intersection or on-ramp. A portion of the vehicles provides cooperative vehicle data, others are detected through conventional sensors (e.g. loop detectors) or not detected if no other sensors are present. The traffic signal optimisation logic calculates the most optimal signal phase and timing given the current traffic flow, vehicle characteristics and policy objectives and constraints.

18 Use case: Traffic information and route guidance

18.1 Introduction use case

18.1.1 Background

Traffic efficiency might be improved through better navigation. The main challenge in navigation is to provide accurate and detailed information about the current traffic situation.

18.1.2 Objective (function)

To provide accurate, actual and detailed in-car traffic information and route guidance to vehicle drivers.

18.1.3 Desired behaviour

The vehicle driver makes better route choice decisions based on the traffic information and adapts his/her route compliant to any advice or guidance provided.

18.1.4 Expected impact

The primary expected impact is reduced travel times for vehicle drivers. The secondary expected impact is less (cumulative) delay due to congestion and therefore reduced (average) travel times for all vehicle drivers.

18.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- Leidsche Rijn tunnel as part of the **InterCor** EU-funded project
- **Praktijkproef Amsterdam** (http://www.praktijkproefamsterdam.nl/)

18.2 Use case description

18.2.1 Situation

Situation 1: Bridge Open

Vehicle driver approaches an open bridge (road closed) downstream along the route that will hinder the driver.

Situation 2: Reduced speed due to event

Vehicle driver approaches a situation downstream along the route with reduced speed and less traffic flow due to an event.

Situation 3: Parking routes

Vehicle driver is travelling towards a parking facility which can be reached using different routes, each of these having other traffic conditions.

Situation 4: Eco-routes

The destination of the vehicle driver can be reached using ‘normal’ routes and routes with limited access to non-eco-friendly vehicles.

Situation 5: Limited access

Vehicle driver is approaching roads downstream along the route with vehicle restrictions (e.g. height, width, weight, transport mode, etc.) and/or road restrictions (e.g. road works, incidents, etc.).

Situation 6: Tunnel information

Vehicle driver is approaching a tunnel downstream along the route.

18.2.2 Actors and relations

- Vehicle driver: receives traffic information and route guidance on the in-vehicle display.
- Road operator: provides traffic information, route guidance and/or policy conditions and constraints.
- Service provider: disseminates traffic information and route guidance to vehicle drivers.
- End user: trip planners may use traffic information (e.g. expected delays), to optimise their trip planning.
- Vulnerable road user: n/a.
- Other: n/a.

18.2.3 Scenario

For each of the situations described above: the vehicle driver receives (in-car) traffic information and route guidance, both pre-trip and on-trip.

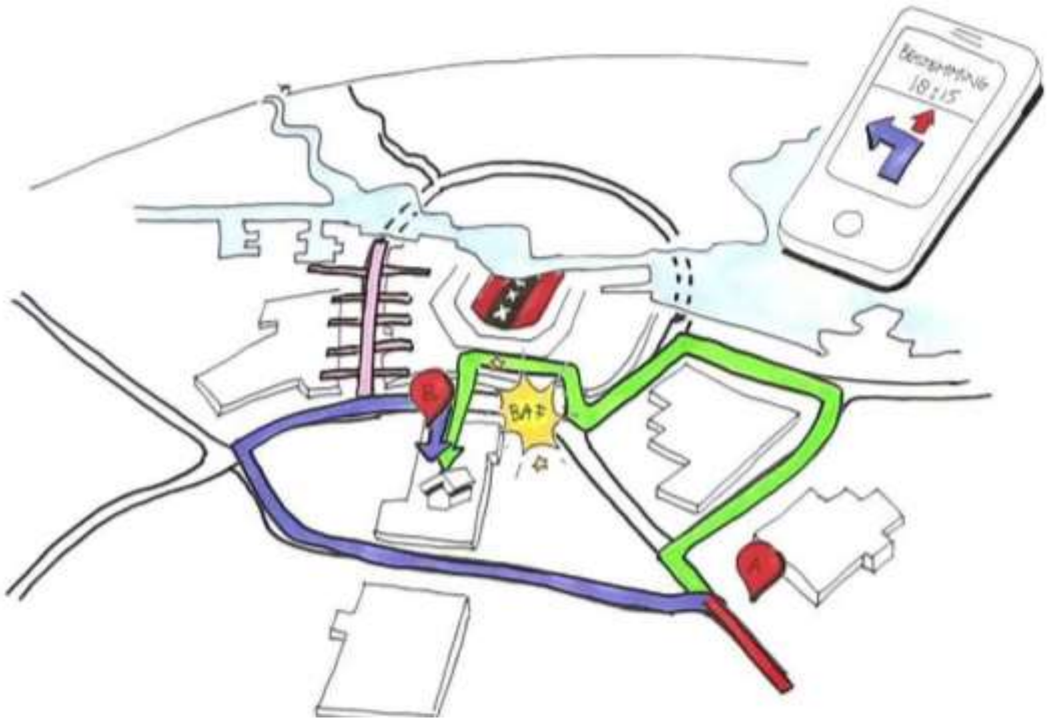

Figure 11: Traffic information and route guidance ilustration

19 Use case: Parking management

19.1 Introduction use case

19.1.1 Background

Parking place can be scarce and unawareness of the location of available and/or suitable parking spaces leads to 'searching' traffic, which causes unnecessary vehicle kilometres and emissions.

19.1.2 Objective (function)

To provide in-car information on the location, availability and suitability of parking places.

19.1.3 Desired behaviour

The driver chooses (on-trip or in advance of the trip) an available parking space or the truck fleet operator (in advance of the trip) chooses an available parking space.

19.1.4 Expected impact

The primary expected impact is a reduction of vehicle kilometres and emissions, and a better utilisation of the available parking spaces.

19.1.5 Known Dutch realisations (or planned)

- **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
- **Brabant In-Car II** ParckR project (http://www.parckr.com/en/)
- **Praktijkproef Amsterdam** (http://www.praktijkproefamsterdam.nl/)
- **InterCor** EU-funded project

19.2 Use case description

19.2.1 Situation

Situation 1: Off street parking information

The vehicle driver intends to park at an off-street parking facility.

Situation 2: On street parking information

The vehicle driver intends to park at an on-street parking facility.

Situation 3: Parking facilities at events

The vehicle driver intends to park at a temporary parking facility at an event.

Situation 4: Bicycle parking facilities

A cyclists intends to park at a bicycle parking facility.

Situation 5: Truck parking

A truck driver intends to park at a truck parking facility or the fleet operator plans trips taking into account truck parking facilities.

19.2.2 Actors and relations

- Vehicle driver: receives parking information on the in-vehicle display.
- Road operator: n/a.
- Service provider: disseminates the parking information to vehicle drivers, cyclists and fleet operators.
- End user: fleet operator receives parking information and plan trips taking into account the parking information.
- Vulnerable road user: in case of cyclist, receives parking information on mobile device.
- Other: parking exploiter provides parking information to service providers.

19.2.3 Scenario

The vehicle driver, cyclist or fleet operator receives (in-car) parking information, both pre-trip and on-trip. This information for example includes: location of the parking facility, parking space availability, parking rates, vehicle restrictions and opening hours.

20 Use case: Multi-modal cargo transport optimisation

20.1 Introduction use case

20.1.1 Background

Real-time information about (water – rail – road) traffic conditions and capacity of (water – rail – road) cargo transport can be offered to shippers and carriers.

20.1.2 Objective (function)

Optimising and increasing the efficiency of the cargo transport operations between different transport modes (synchro-modality), taking advantage of the data visibility from the logistics services and cooperative systems.

20.1.3 Desired behaviour

Shippers and carriers utilise the full range of transport modes.

20.1.4 Expected impact

The expected impact is a better balanced cargo transport over different transport modes. Thereby a better (water – rail – road) traffic flow is realised, which leads to lower travel times and less emissions.

20.1.5 Known Dutch realisations (or planned)

- **InterCor** EU-funded project

20.2 Use case description

20.2.1 Situation

A shipper or carrier plans to move goods from a certain origin to a certain destination. Connecting these destinations are water, rail and road transport options with multiple transfer options along the way.

20.2.2 Actors and relations

- Vehicle driver: n/a.
- Road operator: defines policy regulations, e.g. road tax and driving time restrictions.
- Service provider: disseminates real-time traffic information and availability and capacity of transport modes to shippers and carriers.
- End user: shippers and carriers use the multi-modal traffic and travel information to plan the movement of goods.
- Vulnerable road user: n/a.
- Other: n/a.

20.2.3 Scenario

Prior to transportation of goods, the shipper and carrier, choose the best mode(s) of transport to move their cargo to the desired (next) destination, considering the current and expected traffic conditions and capacity for all available transport modes.

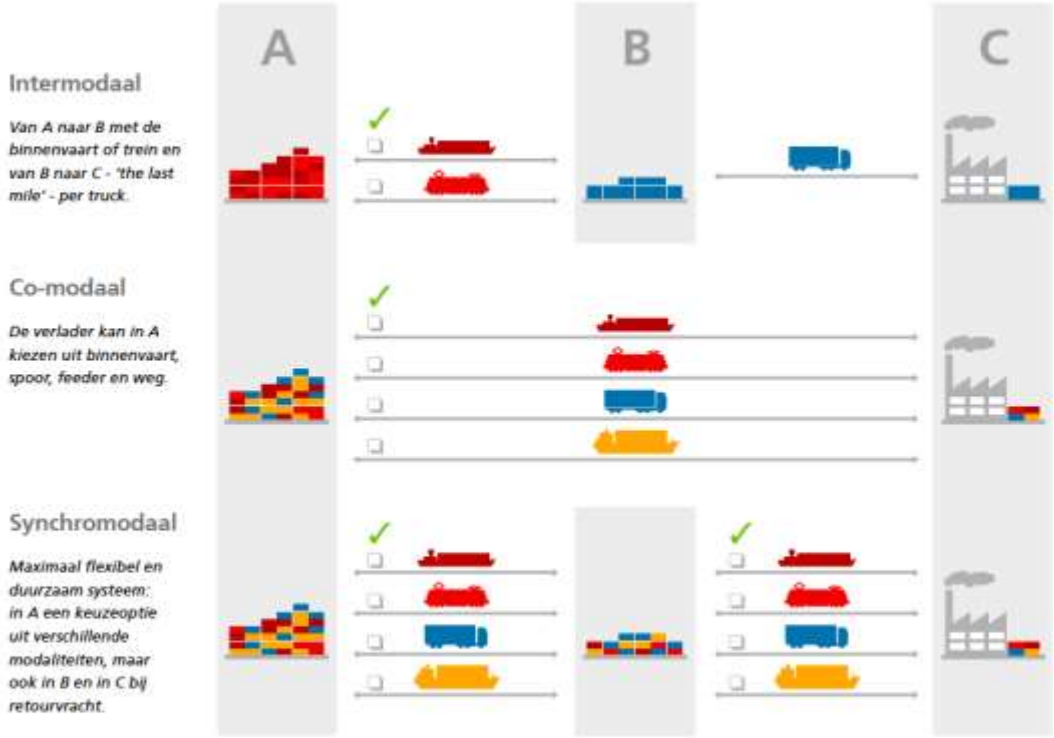

Figure 12: Multi-modal cargo transport optimisation