Strategic roadmap

WITHIN THE INITIATIVE STRATEGIC VEHICLE RESEARCH AND INNOVATION (FFI)

Traffic safety and automated vehicles

03/11/2015

FFI Strategic Vehicle Research and Innovation

Table of Contents

1. Background, Objectives and Overall Objectives

This document describes in a comprehensive way the FFI programme's[1] link to the area Traffic Safety and Automated Vehicles. The document should be regarded as a strategic roadmap containing a description of the challenges, research and development needs, as well as the expected results.

The aim is to gradually contribute to an improved ability to jointly identify research and development activities that contribute to increased traffic safety and automation and strengthen competitiveness. In addition, the roadmaps will be an instrument for monitoring and evaluating, and for increasing understanding of the FFI programme by illustrating the correlation between the funded activities and the expected effects within the programme's area. The document therefore primarily attempts to clarify what needs to be done to achieve the overall objectives of the *programme within the area*, i.e. to contribute to:

- Technology is being developed with the potential to account for a third of the reduction of road deaths determined by society. At the moment, focus is on the intermediate target set by the Riksdag for the year 2020.[2]
- The Swedish automotive companies to remain world leaders in the development of safe vehicles and systems for vehicle safety.
- The Swedish automotive industry becomes a world leader in the development and implementation of automated vehicles and transport solutions

An attempt will also be made to look further into the future, in some cases as far forward as 2035. For natural reasons, this description will be less detailed, and uncertainty greater, the farther into the future we look.

2. The Status and Potential for Development within the Traffic Safety and Automation Area

Though the number of deaths in road accidents has decreased considerably in Sweden over the last decades, far too many are still killed and injured on our roads. In Sweden, around 300 persons die annually and many more people suffer serious injuries in traffic.

FFI is to contribute to further steps towards a long term vision of zero deaths, in particular by promoting the development of increasingly safer vehicles on modern road infrastructure.

The EU has 25,000-30,000[3] deaths on roads each year and the number injured is about one and a half million. In addition to the great personal suffering this entails, traffic accidents also have a significant social cost. In the EU, this amounts to approximately €130 billion annually, which is estimated to correspond to 2 per cent of EU GDP[4]. More and more regions are aware of the growing motorisation in the rest of the world and the forecasts of a doubling of the number of road accident victims by 2030 unless strong measures are taken.

Riksdagen, the Swedish parliament, has decided on an intermediate target for road safety that means that the number of traffic deaths must be halved and the number of serious injuries decreased by one quarter from 2007 to 2020. Equivalent targets at the EU level are a halving of the number of road deaths between 2010 and 2020.

[1] *http://www.vinnova.se/sv/ffi/*
[2] *Measures include better speed compliance, fewer drunk drivers, enhanced seat belt use and safer roads in cities and rural areas.*
[3] *http://ec.europa.eu/transport/road_safety/pdf/observatory/trends_figures.pdf*
[4] *http://ec.europa.eu/transport/road_safety/pdf/news/nl11_en.pdf*

Increasingly safer vehicles, roads and other infrastructures are a large part of the success with traffic safety in Sweden. Progress in areas such as electronics, communication technology and software open up opportunities now and in the future for achieving new levels in vehicle and traffic safety, e.g. through support systems that help drivers avoid accidents in critical traffic situations. The intelligent vehicle of the future allows various degrees of increasingly automated solutions. It interacts with, and adapts to, the driver, the traffic situation, the infrastructure, other road users and vehicles. Accidents will continue to occur in the foreseeable future and new technological opportunities will be developed into leading collision safety features that include protection for individuals both inside and outside the vehicle.

Automated systems need to be designed to provide a positive net contribution to traffic safety. Fewer accidents, smoother traffic flow (speed) and reduced distance between vehicles can reduce journey times and increase the capacity of the traffic system, while at the same time reducing its environmental impact. This is of particular importance in areas with high traffic intensity and frequent queues, such as the densely populated areas of Central Europe, access routes to major cities, huge metropolises in Asia and so on. In many of these areas it will be difficult to expand infrastructure due to lack of space, which will be a further impetus for automated systems. Automated vehicles, new vehicle concepts and business models will help address climate and environmental challenges and are assumed to have a high level of safety.

Automated vehicles will both be used within restricted areas and settings and eventually will also be found in “normal” traffic settings. Developing higher levels of vehicle automation will occur within limited areas since changes in regulations and infrastructure are relatively easy in those areas. It is, therefore, essential for Swedish stakeholders to focus on limited areas where the technology can be developed to migrate to the public roads. Research will help to create laws and liability regulations that contribute to achieving the full potential of automated vehicles, and Sweden can become a country in the forefront of this field.

3. General Considerations

3.1. Approach

It is possible to describe FFI activities in many ways and the perceived results are influenced by the approach taken. The programme committee has chosen to start from the following two aspects when drawing up the roadmap:

1. Description of possible concepts and associated milestones, and
2. The programme areas of the traffic safety and automated vehicle programme

The first aspect tries to identify a number of safety-oriented concepts that are fully possible to introduce on the market by 2035. The description stays at a generic level. The reasons for this is to simplify manufacturing (e.g. the same concept for passenger cars as for heavy goods vehicles) and to respect the needs of companies for confidentiality when it comes to technology and product plans. These concepts are linked to a “milestone”, that is to say a time when the necessary research, testing and demonstration activities must be completed to allow the start of an industrialisation phase, outside the FFI.

The second aspect is based on the programme areas of the sub-programme:

- Analysis, knowledge and enabling technology
- Basic vehicle safety characteristics
- Collision safety
- Driver support and related interfaces between the driver and the vehicle, as well as interfaces with other road users
- Intelligent and collision avoidance systems and vehicles
- Automated vehicles in the transport system

The above areas partially overlap and a particular project may very well cover several programme areas. Regardless of the breakdown of the selection in a presentation like this, there will be a need to handle such overlaps and demarcation problems. In the presentation below there is both a focus on technology and an approach that views traffic safety from a systems perspective. We are also considering other aspects in addition to traffic safety for automated vehicles. Among these, environmental and efficiency are worth special mention. The role of humans, their behaviour and their interaction with automated traffic are another key aspect of research. The primary focus is describing aspects that the FFI programme can directly affect. Other factors (such as the need for new standards, new legislation, financial incitements) are also identified but without a detailed description of their form and content.

3.2. Principle outline

A sustainable, focused and systematic approach will be required to achieve the desired results in the current milestones. Development within the FFI is a learning process. Adaptations and modifications are natural development stages that are based on acquisition of new knowledge and new experience.

The FFI permits a wide range in the types of results produced. For some of innovative or fundamental results, it may take decades before it is technically and economically feasible to take advantage of relevant knowledge. And because they often involve risky projects, some will never successfully be implemented in products and services. On the other hand, results produced using a scientific approach can immediately make an impact on product and service development. Combinations of both of these forms are common, e.g. in the form of a long-term project with a great deal of research elements in which new knowledge spills over an ongoing basis into corporate pre-development or product development departments or is incorporated into research and education at universities and university colleges. This allows parts of the work needed to reach a specific milestone useful long before the intended market introduction of the finished concept.

The figure below illustrates the above reasoning graphically.

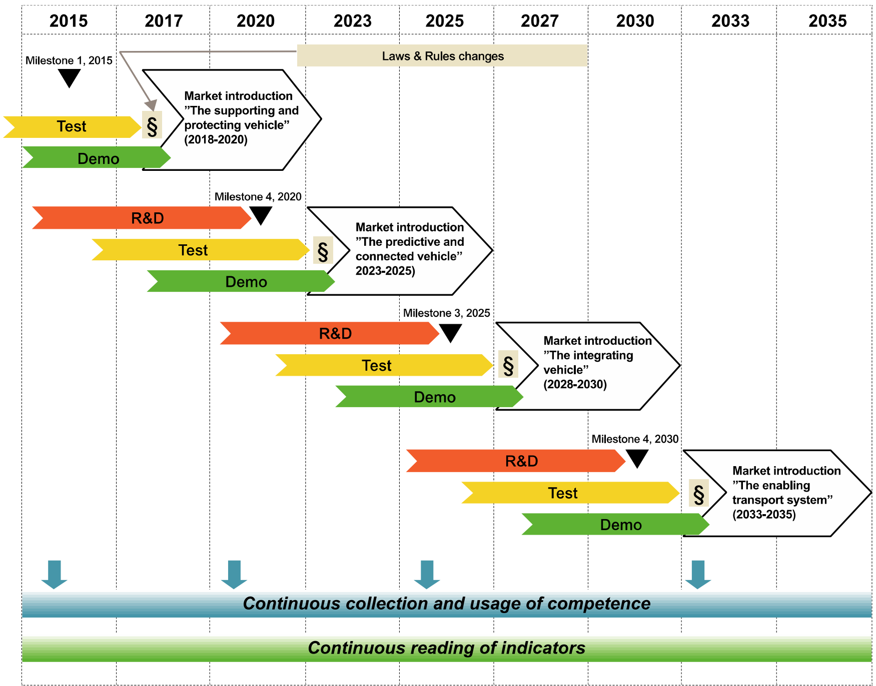

***Figure 1**: Principle outline of research, testing and demonstration activities within FFI Research and development are followed by a comprehensive programme of testing of system components or parts to end, in some cases, with demonstration of the concept in real use. In some cases, traffic and liability legislation also need to be modified to allow*

for new technology. As shown in the diagram above, there is overlap between the different phases. Pure product development work, i.e. going from concept to industrial production, is outside the scope of the FFI.

When it comes to the results of the programme, FFI is part of the EU Commission initiative entitled “Innovation Union” and shares its ambition to “get more innovation from our research to catch up with our main competitors”. It is not just that more knowledge in general must be gained but also that research results need to be translated much faster into practical applications. [5]

The board of FFI, alongside its programme committees, must fund pioneering initiatives directly. It is primarily a question of projects which, if they succeed, will lead to major leaps of technology or other crucial changes with relevance for the area. This type of project may also be run by the programme committee. The programme committee also supports projects that are best described as refining (the work of developing further an already used concept or approach) or enabling (activities of a knowledge-building or general nature).

4. Solutions for the Future and Milestones in Traffic Safety and Automation

FFI is to contribute to reducing the number of deaths and injuries in traffic. Since the initials FFI stand for “vehicle strategic research, development and innovation” in Swedish, it is natural that it focuses its efforts mainly on vehicle-oriented activities in the early phases of development by taking into account factors in our surrounding world and changes in infrastructure design – both for roads and information and communication technologies (ICT). The results will be used by the participating companies in their development of new or improved products and services. In projects involving academia, the new findings will be utilised in graduate-level research and as new instructional material.

To illustrate what development supported by the FFI can lead to, four different future safety solutions and associated milestones have been defined in figure 1.

The different steps are described in more detail in the following sections and for each concept.
An overall road safety objective *is specified for each concept.* This is a theoretical measure and a rough estimate of the effect if *all vehicles and all infrastructure take full* advantage of the technology that belongs to the relevant milestone and if the rest of society actively works to develop safer infrastructure, policies and traffic behaviour.

“Objectives for safety solutions” in this text refers to an objective that that FFI is *striving towards*. The objective is at the societal level and requires more factors or stakeholders working in the same direction than those at FFI’s disposal. The overall objectives also assume that road users use vehicles and road transport systems in accordance with the intentions of the current regulations.

4.1. Safety concept 1: The supporting and protecting vehicle

The first milestone in the roadmap, which was issued in 2011, has been “The supporting and protecting vehicle”. Research and development for realizing the milestone has been completed for the most part and any outstanding issues have been transferred to future milestones. The centre of gravity of the remaining work is now in the industrialisation of the results and bringing products to market, i.e. activities outside the FFI. The focus of this updated roadmap has thus been moved to milestones 2020, 2025 and the new milestone in 2030.

Safety Concept 1 in its original form can be found in appendix 1.

[5] *“Innovation scoreboard 2010”. http://ec.europa.eu/research/innovation-union/pdf/iu-scoreboard-2010_en.pdf*

4.2. Safety and automation concept 2: The predictive and connected vehicle

Objective (2025)

Vehicles that are available in Swedish traffic settings have a safety performance equal to *zero deaths and serious injuries* (both in and by the vehicle). In addition, the vehicles have properties that have *significantly reduce the number of* accidents. The cost, understanding and acceptance of new technologies will enable a greater impact on the market.

Automated vehicles are available that in Swedish traffic settings *offer level three to four* on the following 5 degree scale[6]:

1. The driver drives and monitors the vehicle on his or her own
2. Driver support systems are fitted in the vehicle
3. Partial automation (the vehicle has control over its position on the road and can, to a certain extent, check the steering and speed, the operator is always ready to take over on his or her own)
4. A high degree of automation (e.g. vehicles convoys or other types of highly automated driving in selected but normal traffic settings). The driver does not always have to monitor the system but must be prepared to intervene after a certain time delay
5. Full automation with functionality in urban environments as well

Indicator/measurement: The number of deaths and serious injuries in and by vehicles with the highest safety level per year and the number of such vehicles in accidents *reported to the police*.

Milestone 2:1 - 2020

The predicting and connected vehicle is available in concept form for testing and verification.
Indicator: An assessment of the concept's ability must indicate that it has the potential to meet the overall objective of Safety Solution 2.

Milestone 2:2 - 2025

The predicting/connected vehicle is present in products on the market.
Indicator: The concept's potential to meet the overall objective of Safety Solution 2 can be verified.

Market introduction

2023 to 2025.

Prerequisites: The infrastructure provides support with safe, optimised and reliable roads, road markings and traffic information and provision of reliable information systems for vehicles and road users. The vehicle has its own identity in the communication network.

Characteristic features

Vehicles that offer the same functionality as Safety Solution 1, "The supporting and protecting vehicle", but in a refined form and which also offer:

- The option for real time transmission of safety-critical information via vehicle to vehicle communication
- Real time transmission of safety-critical information through vehicle to infrastructure communication in particularly *accident-prone areas* of the street and road network
- Systems that protect against and prevent accidents with unprotected road users
- Partially automated systems for momentary reaction in exceptional situations with the risk of collision
- Business models that encourage and support wide introduction
- Systems that address and reduce disabling injuries

[6] *Levels of driving automation, SAE international standard J3016*

4.3. Safety and automation concept 3: The integrating vehicle

Objective (2030)
Vehicles are available in Swedish traffic settings that, under “normal” conditions, do not the cause accidents that are likely to cause personal injury. Concepts and knowledge will enable high penetration rates for Swedish safety solutions on the global market.
Vehicles and systems are designed to largely interact with drivers and other road users.
Vehicles and solutions for automated driving in accordance with *levels four to five* on the following five-degree scale are available and used frequently in Swedish traffic settings:

1. The driver drives and monitors the vehicle on his or her own
2. Driver support systems are fitted in the vehicle
3. Partial automation (the vehicle has control over its position on the road and can, to a certain extent, check the steering and speed, the driver is always ready to take over on his or her own)
4. A high degree of automation (e.g. vehicles convoys or other types of highly automated driving in selected but normal traffic settings). The driver does not always have to monitor the system but must be prepared to intervene after a certain time delay
5. Full automation with functionality in urban environments as well

Indicator/measurement: Number of injuries in and by vehicles with the highest safety level in accidents reported to the police/STRADA accidents. The number of automation functions (level 4 to 5) available on the market and penetration rates in new vehicles.

Milestone 3:1 - 2025
The integrating vehicle with permanent functions is available in concept form for testing and verification. Indicator: An assessment of the concept's ability must indicate that it has the potential to meet the overall objective of Safety Solution 3.

Milestone 3:2 - 2030
The integrating vehicle is present in products on the market.

Market introduction
2028 to 2030.

Prerequisites: The infrastructure provides support with safe, optimised and reliable roads, road markings, traffic information and digital infrastructure, with provision of reliable information systems for vehicles and road users. A significant part of the vehicle fleet is connected in a communications network. Any legal obstacles have been removed (e.g. in the case of liability issues from automated driving).

Characteristic features
Vehicles that offer the same functionality as Safety Solution 2, “The predicting and connected vehicle”, but in a refined form and which also offer:

- Real time transmission of safety-critical information through vehicle to infrastructure communication in *significant* areas of the street and road network
- Real time transmission of safety-critical information through vehicle to vehicle communication for a significant part of the vehicle fleet
- Vehicles that, under certain conditions, take over driving and do it in a way that means increased safety.

4.4. Safety and automation concept 4: The enabling transport system

Objective (2035)
Road users and vehicles with different degrees of automation integrate into different traffic settings so that no accidents involving personal injury occur and the efficiency of the transport system is increased. Some of the “limitations” in concepts 1, 2 and 3 above have been addressed. The vehicles can be driven abroad while maintaining functionality and thus have a net positive effect on road safety.

Indicator/measurement: The number of accidents reported to the police/STRADA accidents, the number of automation functions (level 5) available on the market and the penetration rates in new vehicles.

Milestone 4:1 2030
The enabling vehicle is available in concept form for testing and verification.

Milestone 4:2 2035
The enabling transport system has been realised. Vehicles are available on the market that offer safe and comfortable transport for all in an environmentally sustainable way. Automated vehicles are fully operational during, for example, different types of weather and road conditions.

Market introduction: 2030-2035

Prerequisites: The infrastructure provides support with safe, optimised and reliable roads, road markings, traffic information and digital infrastructure, with provision of reliable information systems for vehicles and road users. A significant part of the vehicle fleet is connected in a communications network. Any legal obstacles have been removed (e.g. in the case of liability issues from automated driving).

Characteristic features: Real time data transmission that covers the entire transport system.

5. Examples of Important Areas of Research

The table below provides examples of important areas of research. The nature of many of these areas is such that knowledge about them must be, more or less, continuously developed. An area listed under 2020 is not necessarily "fully researched" by 2025 or 2030. The focus of the programme is expected to evolve over time and may change to newly defined areas at any given point.

5.1. Programme area A. Analysis, knowledge and enabling technology

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
To safeguard the development of traffic safety, a better understanding is required of why incidents and accidents occur, and how best to design new safety systems to have the desired effect in all kinds of traffic settings. New technologies and new areas of knowledge need to be studied to see how they can be used for systems in a competitive manner to help increase road safety. This includes ensuring that automated driving has a net positive effect. Balance between automation/human. (Should the optimal traffic planning algorithms be developed or should drivers be given support to make the best decisions? From a societal standpoint, it might be better to let people manage the system). Use of big data for the development of systems and concepts, for automated testing of existing systems, and improved models for more realistic conditions. Aspects of costs, competitiveness and marketing introduction also need to be studied to enable the results to gain the greatest possible dissemination, utility and effect.	• Methods for data collection and safety analysis. • Harmonised accident databases at national and international levels. • Studies and analyses of incidents and accidents also at the system level. • Safety studies of new vehicle and transport solutions. • Field operational tests (FOT) for the analysis of the safety effects of advanced safety solutions • Driver studies and the interaction between drivers – vehicles – infrastructure. • Studies of the essential input to automated and semi-automated systems, especially with regard to HMI and various driver roles. • Studies and methods for the evaluation of automated systems at different levels: - the effect of how automated vehicles affect the behaviour of drivers - safety benefits - co-road users, drivers' and society's acceptance and adaptation • Development of log and other systems to check different systems' function and logging of human interaction with them.	• Continued knowledge-building in the areas under column 2020. • Definition of safety critical information that permits evaluation of the "The predictive and connected vehicle". • Wider field trials supported by ITS solutions – vehicles on the market as probes. • Field operational tests (FOT) for automated vehicles and systems. Methods and instruments to measure the effect of how automated cars influence driver behaviour. • Traffic safety data as input to real-time adjustment of V2V, V2I and taking over control.	• Continued expansion of knowledge in the areas under column 2025. • Definition of safety-critical information that permits evaluation of the "The integrated vehicle".

5.2. Programme area B. Basic vehicle safety characteristics

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
Steering, braking and good visibility will lay the foundations for a vehicle that is safe to drive. Electronic stability systems have proven effective from a traffic safety perspective. The area still has substantial potential for development. Future demands for increased transport efficiency may mean a longer modular transport system for heavy vehicles in remote and regional transport. Safety aspects of these combinations of vehicles will have to be studied with regard to, e.g., manoeuvrability in critical situations and their integration in the traffic system.	• Adaptive, optimised vehicle dynamics and manoeuvrability. • Actuators and sensors to enable intelligent and collision-avoiding control of vehicles. • Systems that facilitate manoeuvrability and integration of new vehicle concepts and combinations. • Cooperative systems that prepare drivers and vehicles for upcoming events or conditions, such as traffic jams, slippery roads or accidents. • Development of braking, steering and tyre systems. • Systems for status monitoring of safety-critical systems.	• Continued expansion of knowledge in the areas under column 2020.	• Continued expansion of knowledge in the areas under column 2025.

5.3. Program area C. Collision safety

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
There is a potential to improve the collision properties of traditional vehicles and to reduce the risk of serious injury to occupants and vulnerable road users. Predictions include more densely populated cities with more unprotected road users, increased number of public transport vehicles and traffic settings where vehicles with varying degrees of automation meet. Add to this the challenge of ensuring safety for future vehicles with alternative power trains, lower weight and with new energy storage systems. Furthermore, active and passive safety systems will need to interact in an optimal way for all occupants.	• Development of lightweight, optimised energy-absorbing zones, method development, calculation, • New types of protection concepts and vehicle structures that protect the occupant and unprotected road users during the progress of the accident. • Integrating safety solutions (active, passive, post). • Human modelling for CAE tools that also include the elderly and children. • Evaluation of priority injuries using human models (pre-crash + crash). • Development of virtual testing methods for new vehicle and safety concepts. • Intelligent post-crash solutions with detailed vehicle information and individual-related information that enables realistic risk assessment and prioritisation of private and public emergency reactions in connection with detected accidents.	• Continued expansion of knowledge in the areas under column 2020. • Integrated protection systems that takes into account and are optimised for future vehicle load cases that will change with active and automated systems. • Optimised collision safety for automated vehicles that are run into. • Safety systems that take into account all types of road users (young people, the elderly, the obese and so on). • Inclusion of the user's current vital data in the vehicle support system via vehicle-based “non-intrusive” registration or “wearables”.	• Continued expansion of knowledge in the areas under column 2025. • Optimised integrated protection systems for new types of vehicle concepts in future traffic.

5.4. Programme area D. Driver support and related interfaces between the driver and the vehicle, as well as interfaces with other road users

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
Changes in the technical complexity of vehicles and road systems, information available to the vehicle and driver, and management of such information systems as telephones, navigation and route planning systems will change the role of the driver. The challenge is to deal with this new role. The vehicle's ability to support the driver in safety-critical situations will increase. Vehicles of different levels of automation will be introduced gradually. Society expectations and demands on the driver in partially or fully automated vehicles – aspects of driver behaviour needing consideration and how they should be addressed.	• Criteria for the evaluation of cognitive load and safe interaction. • Systems for the prevention of accidents related to reduced ability. • HMI for new vehicle concepts, minimised driver distraction, varying driver capabilities, cooperative systems, connected portable devices and different degrees of automation. • Intuitive adaptive multi-modal interfaces and technologies. • Understanding and management of the interaction between road users and vehicles with different degrees of automation. • Methods and technologies for ensuring the integration of external applications, information services and cooperative driver support systems. • New interactive ways of increasing driver awareness, driver coaching and related service solutions. • Development of driver models for verification and validation, as well as integration into the safety system.	• Continued expansion of knowledge in the areas under column 2020 • Principles and business models for individualised interfaces. • Methods and technologies for ensuring the integration of external applications, information services and cooperative driver support systems.	• Continued expansion of knowledge in the areas under column 2025.

5.5. Programme area E. Intelligent and collision avoidance systems and vehicles

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
Intelligent transport systems and modern information and communication technologies, in principle, offer a chance to build a transport system without accidents. To achieve the accident-free transport system, development of location and positioning with high precision, secure communication (V2X) and sensor fusion are required. The vehicle's interaction with other road users requires good object detection, classification and trajectory estimation. Based on the level of automation, different degrees of redundancy are also required. Furthermore, development and improvement of the current system is required. Methods for and requirements on data that ensure reliable data access and maintenance that are required for safe and efficient automated driving. Physical and digital infrastructure that supports a gradual transition to automated traffic – both in urban and rural settings. Management of the transition period up to full automation.	• Understanding of the increasing levels of automation in both low and high speed scenarios and in different settings (both public and restricted areas). • Development of vehicles with various levels of automation and their associated strategies and technologies, from assisted driving to highly automated vehicle and transport solutions. • Assessment, validation and verification of intelligent, collision-avoiding and automated systems and vehicles. • Development of functions for: - Semi-automated vehicles on the road - Fully automated vehicles within a defined area - Automatic control • Development of methods for verification and validation of autonomous vehicles. • Development of sensors and sensor fusion technology for enhanced safety.	• Continued expansion of knowledge in the areas under column 2020. • Cost-effective solutions for intelligent systems. • Models and systems for the management of various external factors (rain, fog, vision, light, infrastructure, degree of access by other road users and so on). • Development of simulation tool for component and system development in traffic settings. • Implementation of automated vehicles in mixed environments. • Cooperating vehicles at different automation levels. • Development of functions for highly automated vehicles in selected but normal traffic settings.	• Continued expansion of knowledge in the areas under column 2025. • Concepts and systems that operate globally and in non-optimised environments. • Development of functions for fully automated vehicles in urban environments.

5.6. Programme area G. Automated vehicles in the transport system

Background description and challenges	R&D => 2020 **The predictive and connected vehicle** Possible market intro => 2020-2025	R&D => 2025 **The integrating vehicle** Possible market intro => 2025-2030	R&D => 2030 **The enabling transport system** Possible market intro => 2030-
Framework for qualifying automated traffic as safe in traffic (“boundary conditions”). Development of automated functions for which the main driving force is efficiency and/or the environment (road safety boundary conditions must be taken into account and must be met).	• Perform system level research on the effects of automation of the transport system. • Development of functions for: - Semi-automated vehicles on the road - Fully automated vehicles within a defined area - Automatic control • Development of methods for verification and validation of autonomous vehicles.	• Continued expansion of knowledge in the areas under column 2020. • Implementation of automated vehicles in mixed environments. • Cooperating vehicles at different automation levels. • Development of functions for highly automated vehicles in selected but normal traffic settings.	• Continued expansion of knowledge in the areas under column 2025. • Development of functions for fully automated vehicles in urban environments.

Enablers for the different concepts			
As information (not part of the FFI programme)	Concept development and commenced implementation of the intelligent supporting infrastructure. Method and verification platform for future safety systems. Interaction with a broad range of stakeholders in the road system.	Intelligent supporting infrastructure (roads as well as ITS solutions) for testing and validation of concepts and systems on both normal roads and test tracks. Reliable and 100% coverage by wireless networks. International coordination and standards.	

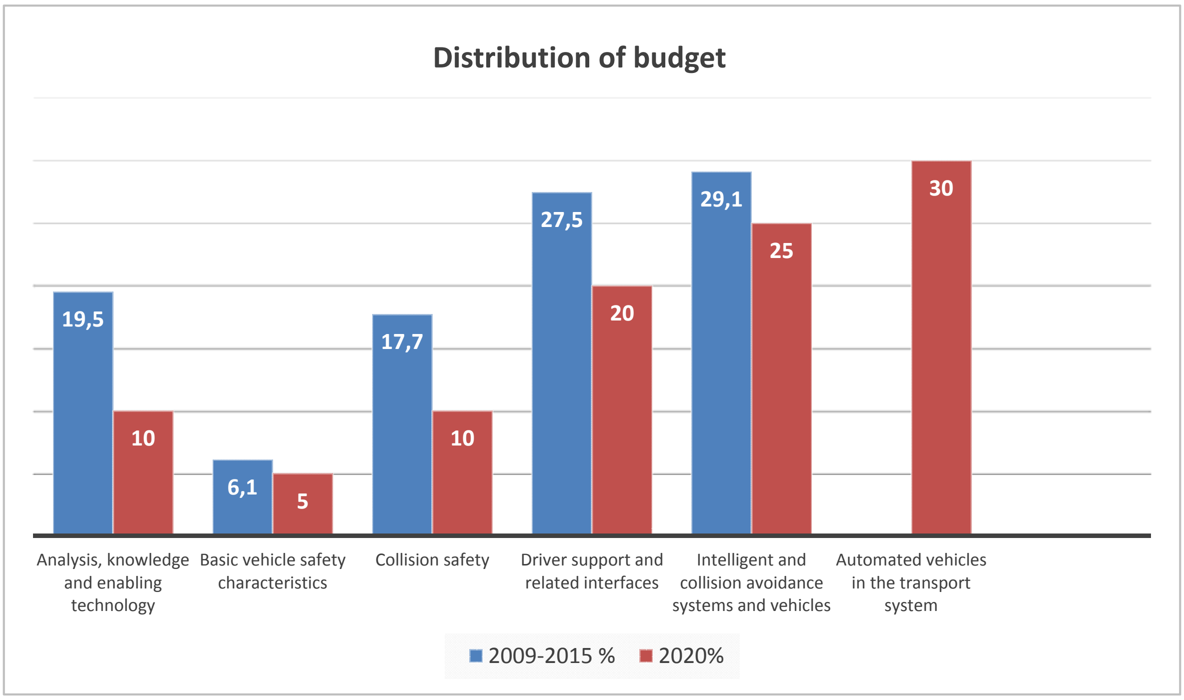

Fig. 2. The programme committee's depiction of how the project portfolio will change over time.

6. Conclusion

The Programme Committee for Road Safety and Automated Vehicles hopes that this “abridged” roadmap will be a mutual instrument for making strategic choices relating to research and development, and that it will be valuable in following up the programme and conveying an overall picture of FFI and its importance for road safety and automation. The roadmap will need to be updated regularly, probably at least every two years.

Applications to FFI should, as far as possible, document the way in which the project will contributes to the objectives of the programme, both at a general level and in relation to the areas identified in this document.

7. Appendix 1

Safety Solution 1: The supporting and protecting vehicle

Concept/safety solution: The supporting and protecting vehicle

Objective (2020)

Vehicles that are available as in Swedish traffic settings have a safety performance equal to *near* zero fatalities and seriously injured (both in and, *to a significant degree*, by the vehicle).
Indicator/measurement: The number of deaths and serious injuries in and by vehicles with the highest safety level per year (estimated and actual).

Milestone 1:1 - 2015

The supporting and protecting vehicle is available in concept form for testing and verification.
Indicator: An assessment of the concept's ability must indicate that it has the potential to meet the overall objective of Safety Solution 1.

Milestone 1:2 - 2020

The supporting and protecting vehicle is present in products on the market.
Indicator: The concept's potential to meet the overall objective of Safety Solution 1 can be authenticated.

Market introduction

2018 to 2020.

Prerequisites: The infrastructure provides support with safe, optimised and reliable roads, road markings and traffic information and provision of reliable information systems for vehicles and road users. Any legal obstacles have been addressed.

Main elements/characteristic features:

- *The vehicle:* Optimised independent safety systems for vehicles and infrastructure
- *The driver:* Active and rested drivers and operators in terms of road safety
- *Man Machine Infrastructure, MMI:* Adapted and easily understandable interfaces between the driver, the vehicle and the infrastructure
- *ICT/ITS:* Robust and useful techniques and systems for road and traffic safety information. First generation V2V/I systems will be introduced.

Challenges for Safety Solution 1

The future traffic system must be safe, but also easily accessible and attractive to use and must have an affordable price. Progressively better understanding of why accidents occur must gradually be developed to develop such a system and new improved safety systems must be cheaper to achieve sufficient dissemination. As an example at Milestone 1, we should be able to see/have vehicles and vehicle systems that:

- Stabilise the vehicle in the event of critical manoeuvres
- Support the driver's attention around the vehicle through good visibility and systems that support good attention
- Assist the driver to avoid collisions through warning or active intervention
- Activate safety systems in the face of an imminent collision
- Avoid or alleviate the consequences of accidents in many situations including unprotected road users.
- Optimise passive safety systems
- Detect and are activated at reduced driving ability
- Offer an easily understandable and easy (although advanced) interface between the driver, the vehicle and the infrastructure
- Information systems that minimise distraction.