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VRA NETWORKING IN AUTOMATION

Support action for Vehicle and Road Automation network

Deployment paths for Vehicle and Road Automation (Draft 2)

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1 Executive Summary

The deployment of vehicle and road automation on the European roads may lead to substantial paradigm shifts in the way we live and use mobility. Vehicle and Road Automation will have a great impact on many aspects of the society from safety to productivity passing by the environment impact; the same way it had a huge impact on production, finance, telecom and other Information Technologies. The transition between today and tomorrow's situation happen gradually. Different step by step deployment scenarios will be investigated. For each of them the expected evolution on vehicles, infrastructure and management centres should be described. Based on these trends, the role and responsibilities of the different stakeholders involved into the value chain will be impacted: the vehicle manufacturers, the road operators and the fleet owners/mobility service providers. The value chain and related business models behind the deployment paths will be described.

In the first year of the project, the focus was on interaction with stakeholders in the iMobility Forum and EUCAR in order to build a solid base for future discussions. For the second year, the focus has been to interact with a larger group of stakeholders through ERTRAC. In the second year have also the business models started to be investigated for some functions.

The result from the first year in terms of deployment paths has been well received and minor changes on the timeline on some function have been added. In Europe today there is a common agreement on the different path and which order a certain application will be deployed. The views on the importance of different paths differ between different stakeholders.

The final year will focus on continue on detailing the business models.

2 Introduction

2.1 Purpose of Document

The deployment of vehicle and road automation on the European roads may lead to substantial paradigm shifts in the way we live and use mobility. Vehicle and Road Automation will have a great impact on many aspects of the society from safety to productivity passing by the environment impact; the same way it had a huge impact on production, finance, telecom and other Information Technologies. The transition between today and tomorrow's situation happen gradually. Different step by step deployment scenarios will be investigated. For each of them the expected evolution on vehicles, infrastructure and management centres should be described. Based on these trends, the role and responsibilities of the different stakeholders involved into the value chain will be impacted: the vehicle manufacturers, the road operators and the fleet owners/mobility service providers. The value chain and related business models behind the deployment paths will be described.

The WP3.1 has gathered the main experts and stakeholder to describe possible deployment paths for the different types of vehicle and road automation mentioned. The result is described in this document.

2.2 Structure of Document

The document will be released in three versions over the project period. Each release will add or complement existing chapters. In some chapters in the current version will be stated as 'To be done'.

The document consists of the following chapters:

- Introduction: This chapter introduce the purpose of the document and the methodology used.
- Definition of Automation levels: This chapter defines the levels of automation that will be used throughout the document.
- Socio-economic implications: This chapter aims to give an overview of what impact automation will have in term of safety, efficiency, etc when being deployed[1]
- State-of-the-art Deployment: This chapter gives an overview of the current deployed vehicle automation systems.
- Key automation deployment indicators: This chapter aim to identify key global indicator that shows the mature of the automation deployment.
- State-of-the-art Deployment: This chapter gives an overview of the current deployed vehicle automation systems.

[1] This chapter will be integrated in last version of the document linking to the Deliverables of WP3.7.1 on evaluation of benefits

- Deployments paths: This chapter describes how different automation technologies will be deployed over time.
- Business models: This chapter contain simple business model for some key application.[2]
- Conclusions: This chapter contains the general conclusion of the document.

2.3 VRA contractual references

VRA, Vehicle and Road Automation, is a Support Action submitted for the call FP7-ICT-2013-10. It stands for *Vehicle and Road Automation Network.*

The Grant Agreement number is 610737 and project duration is 42 months, effective from 01 July 2013 until 31 December 2016. It is a contract with the European Commission (EC), Directorate General Communications Networks, Content & Technology (DG CONNECT).

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2.4 Project Objectives

In the field of vehicle and road automation, VRA's main objectives are:

- To maintain an active network of experts and stakeholders
- To contribute to international collaboration
- To identify deployment needs
- To promote research and deployment initiatives

In practice, VRA will:

- Organise or support international meetings together with similar initiatives in US and JPN. (WP2.1)
- Support the iMobility Forum Automation WG and extend its role as a reference group for European activities on the topic eventually formulating common positions, especially at European level (WP2.2)
- Aggregate information on existing research or deployment activities in a shared wiki (WP2.3)
- Describe valid business models and deployment paths & scenarios and investigate the broad socio-economic implications of automation for the future societies (WP3.1)

[2] This chapter will be integrated in the final version

- Clarify, report and setup a plan of actions on legal, liability, insurance and regulatory issues in different member states (WP3.2)
- Monitor and steer standardisation, compliance and certification for vehicle and road automation (WP3.3)
- Contribute to the discussion on relevant topics for the deployment of Vehicle and Road Automation: Connectivity (WP3.4), Human Factors (WP3.5), Digital Infrastructure (WP3.6), Evaluation of Benefits (WP3.7) and Decision and Control Algorithms (WP3.8).

2.5 *Terminology*

2.5.1 *Definitions of Automation levels*

Throughout the document the SAE level of vehicle automation will be used in order to describe the level of automation of different systems. Within different forum in Europe the informal decision is to use these ones.

Summary of Levels of Driving Automation for On-Road Vehicles

This table summarizes SAE International's levels of *driving* automation for on-road vehicles. Information Report J3016 provides full definitions for these levels and for the italicized terms used therein. The levels are descriptive rather than normative and technical rather than legal. Elements indicate minimum rather than maximum capabilities for each level. "System" refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*, as appropriate.

The table also shows how SAE's levels definitively correspond to those developed by the Germany Federal Highway Research Institute (BASt) and approximately correspond to those described by the US National Highway Traffic Safety Administration (NHTSA) in its "Preliminary Statement of Policy Concerning Automated Vehicles" of May 30, 2013.

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**	-	

Figure 1: Automation Levels (http://cyberlaw.stanford.edu/blog/2013/12/sae-levels-driving-automation)

SAE International released standard J3016 with the goal of providing common terminology for automated driving. It offers taxonomy and definitions for terms related to On-Road Motor Vehicle Automated Driving Systems ranging in level from no automation to full automation.

As well detailed by the overview provided by the SAE International[3], it offers a harmonized classification system and supporting definitions that:

• Identify six levels of driving automation from "no automation" to "full automation"

• Base definitions and levels on functional aspects of technology

• Describe categorical distinctions for a step-wise progression through the levels

• Are consistent with current industry practice

• Eliminate confusion and are useful across numerous disciplines (engineering, legal, media, and public discourse)

• Educate a wider community by clarifying for each level what role (if any) drivers have in performing the dynamic driving task while a driving automation system is engaged.

[3] http://www.sae.org/misc/pdfs/automated_driving.pdf

3 Methodology description

This section aims to describe the methodology used to achieve the results in the different chapters. The general approach have been to have the general structure of the document, then use the VRA project and iMobility Forum of road automation as a first instance to get input and review the material. A set of workshops or concertation meetings has been the method to get other stakeholders view and feedback. This last set has mainly been used for chapter 6 Deployment paths.

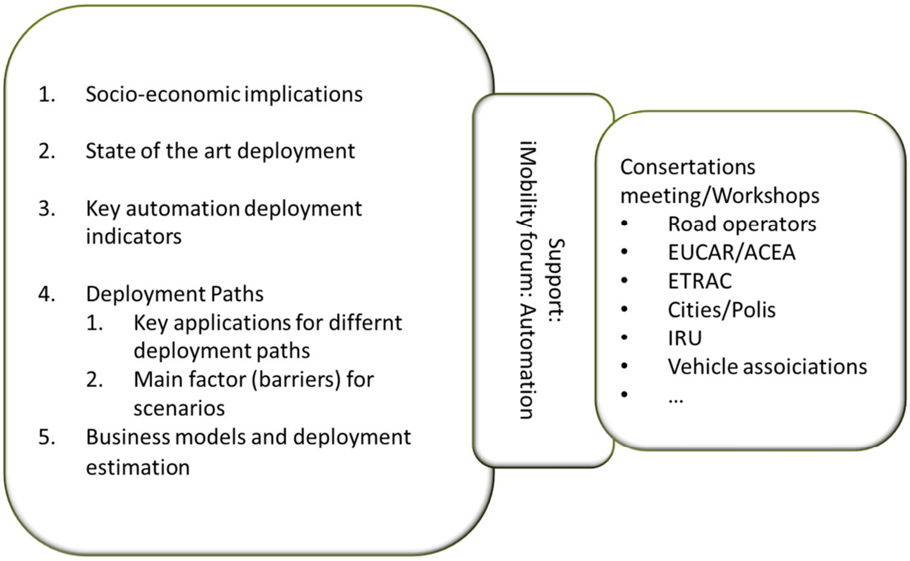


Figure 2: Methodology

Chapter 3-5: The result comes mainly from literature study or analysis of available data bases (e.g. patent data bases).

The result in chapter 6, deployment paths is basically the result from a set of workshops with selected stakeholders (see 3.2 for complete list). The main ones during 2014 have been:

- Jan 23-24: Brussels: kick-off of the work package in VRA and iMobility Forum of road automation and agreement on how to present the different deployment paths
- May 7-8, Antwerp: VRA, iMobility Forum of road automation and US-JP-EU Trilateral meeting: Workshop to have the first input on different paths
- July 7, EUCAR: Workshop within the EUCAR Automation Expert Group to get their view on functions and timeline on deployment
- July 18: US-JP-EU Trilateral meeting, presentation of current status
- October 8, ERTRAC Automation Task Force 2nd meeting: Workshop to get their view on functions and timeline on deployment
- Dec 12 VRA – iMobility Forum WG Meeting (Lausanne, Swiss)

During the second year of the project the focus has been on working with the ERTRAC stakeholders to update the deployment paths and to introduce the updated result into their roadmap. In addition there has also been iMobility Forum WG meeting and trilateral Automation WG meeting with focus on the socio-economic impacts.

- 2014 December 11, ERTRAC Task force workshop "Connectivity and Automated Driving", (Brussels)
- 2015 January 26, ERTRAC Task force workshop "Connectivity and Automated Driving",(Brussels)
- March 01 Trilateral Automation Working Group in Road Transportation meeting (La Rochelle, France)
- April 28 VRA – iMobility Forum WG Meeting (Brussels)
- July 01 VRA – iMobility Forum WG Meeting (Brussels)
- 2015 July 10, ERTRAC Automation workshop, (Brussels)
- Sept 23 VRA – iMobility Forum WG Meeting (Brussels)

In order to prepare the ERTRAC workshop there have been a small core group of 4 persons, with representatives from EUCAR, CLEPA, EPOSS and VRA. There have been about 10 of these meetings. The ERTRAC result is available on the ERTRAC website[4]:

3.1 Methodology for business models

A business model describes the rationale of how an organization creates, delivers, and captures value (economic, social, or other forms of value). The definition of a company's business model is a fundamental part of its business strategy. It is proposed to use the CANVAS business model framework developed by Alex Osterwalder and Yves Pigneur to ilustrate/capture the differents business models possibilities (see Figure 3).

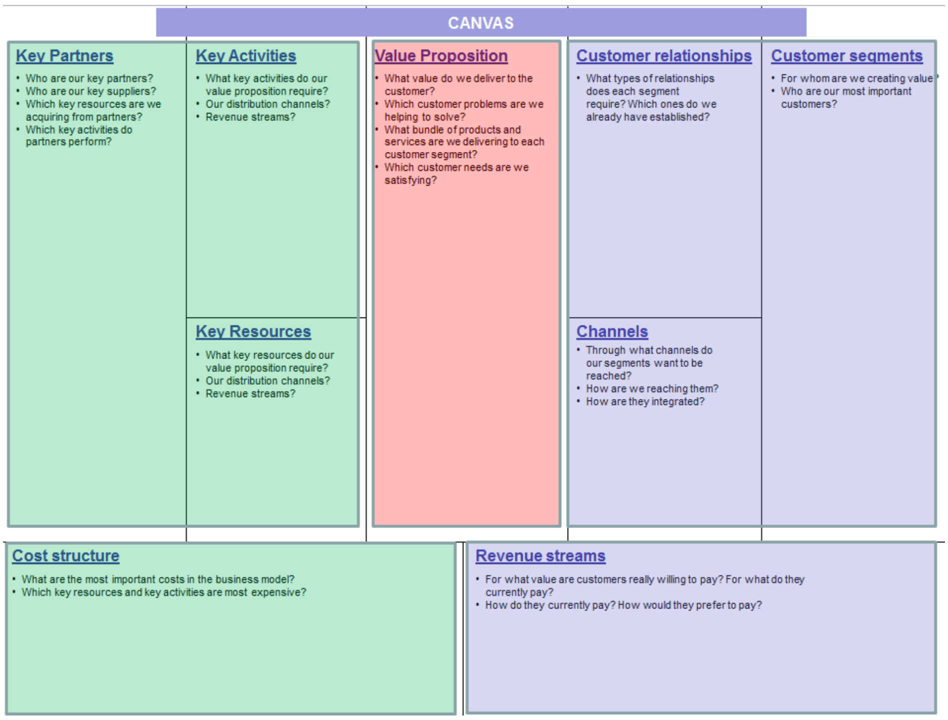


Figure 3: CANVAS template for business model analysis

[4]http://www.ertrac.org/uploads/documents_publications/Roadmap/Automated%20Driving%20Task%20Force/ERTRAC_Automated-Driving_v5-July2015-final.docx

Basic questions related to the Value Proposition and Customer Segments:

- How well your Value Proposition is getting your target customer's job done? (this question assumes, of course, that you know what the job is that your customer is trying to complete!)
- How many people or companies there are with a similar job-to-be-done. The answer to this question helps you define market size.
- How important this job really is for the customer and if he or she actually is going to spend on it.

The proposed business model analysis is made filling the template in Figure 3 with the business cases (see Annex 2) and a description is included in the body of the document in section 7. This description comprises the following elements:

- A **Value Proposition** is the way you create value for customers; it's the way a customer's problem is solved. This element of the business model is by far the most important. It can be defined as the unique flavour that no one else can copy.
- **Revenue streams** describe how you will make profits for your company while still providing value to the customer. Revenue model = price x volume. It also contains in a deeper analysis the cost structure (direct costs, indirect costs and economies of scale) and margin model (given the revenue and cost structure how much profit do we make).
- **Key activities**, Successful companies have operational and managerial processes that allow them to deliver value in a way they can successfully repeat and increase in scale.
- **Key resources**. The key resources are assets such as the people, technology, products, facilities, equipment, channels, and brand required to deliver the value proposition to the targeted customer. This will heavily influence your cost structure.

3.2 Stakeholders tree

Address key aspects to each stakeholder profile.

Stakeholder	Function	Key aspects
Policy makers and legislative bodies	Produce regulations and ensures compliance	• Key barriers identification for first deployment experiences • Partnership (public-private) and financing • Governance issues related to automated road transport, • Data use and ownership
Vehicle manufacturers	Manufacture and sell vehicles with a level of automation	• Industry updates • Automated vehicles vision towards future
Technology providers	Offer VRA related systems and applications for vehicles	• Interoperability with current and future systems • Technology reliability,

	and infrastructures	• Cyber security and privacy
Research companies	Provide new paradigms and application solutions. Can be considered as a part of the technology providers chain	• Human factors • Universal design and inclusive transportation
Service providers	Make business providing services based on vehicle and road automation	• Business models, potential market
Infrastructure operators	Explode roads and highways. Is a potential service provider	• How automation is seen: more a benefit than an issue? Operation and management issues • Impacts on safety and mobility
Users	Buyers of VRA technology (drivers, fleet owners, local authorities,…)	• Consumers acceptance, • Functional needs of travellers
Certification bodies	Homologation of vehicles, equipment and drivers for automation	• Certification of vehicles, infrastructures, drivers and operators • New standards and harmonisation needs (e.g. tri-lateral)
Insurance companies	Provide Insurance for automated vehicles. Safe mobility and responsibilities	• Liability and risk issues,

4 Socio-economic implications

Relevant information in order to provide an overview of the socio-economic implications of Vehicle and Road Automation have taken into account the output of current European Projects and other relevant studies or activities. This short paragraph takes into account the work of WP3.7, specifically focused of evaluation of benefits, reported in D3.7.1.

4.1 On-going European Projects and other initiatives

CityMobil2[5] project has a specific Work package on the *CityMobil2 socio-economic study* (WP27). A Workshop specifically focused on expected impacts of vehicle automation was held at the end of March 2015 (a short report is provided in D3.7.1).

Some aspects related to the evaluation of the socio economic/policy aspects and implementation have been addressed by then *EU–US Transport Research Symposium* held in Washington in April 2015. During this Workshop, there was a specific focus on the investigation of the long term effects of automation (in all its forms) on the traffic environment (e.g. less parking, more kiss and ride) and on local, national and world economies and employment.

The socio-economic implications can be derived by the activity of the *iMobility Forum WG on the evaluation of benefits*. The group has already established a list of potential direct and indirect socio-economic impacts and share efforts to attempt quantifying them at an early stage.

Following points have been reported from the discussion with the WG[6]:

- Comfort, Road Safety and Road capacity.
    - Automation should at least bring “smoother” driving for the better feeling of people on board; but in the highest automation levels it should also allow to spend better the time on board doing other tasks and not spending time controlling the vehicles; valet parking functions might also add comfort at the beginning and at the end of the journey
    - Main goal of automation is to have safer road transport
    - if shorter headway are safely kept thanks to automation the capacity of the single lane will increase. There are also positions that stated how full automation without cooperation between vehicle and opportune amendments to the road code might lead to higher gaps between vehicles with negative impact on road capacity. In a way or another capacity will be impacted by automation.
- Environment, affecting energy, land consumption and environment.

[5] http://www.citymobil2.eu/en/

[6] From Dr. Adriano Alessadrini presentation at the Trilateral WG meeting in San Francisco (18/07/2014) on Evaluation of Benefits sub-WG activity.

   - Automation will impact on the environment for three main reasons:
     - If shorter gaps are kept vehicle drag will be reduced decreasing fuel consumption
     - If congestion is relieved thanks to automation vehicles will consume less in less congested roads
     - If the driver is removed cars can be driven in a more eco-friendly manner
   - full automation might change the need for parking at facilities (shopping centres, airports, train stations, …) or in residential areas changing completely the rules with which the built environment is designed
- Society, impacting for instance on employment, security/privacy and quality of life:
   - Automation might lead (in the most advanced scenarios) to consider differently modal choice, housing choice, shopping habitudes and behaviour in general which will lead to a completely different lifestyle. This might be further enhanced by the fact that fleet sizes can be reduced (an household might need one car instead of two and new forms of shared mobility arise). For commercial vehicles (taxi's, trucks), automation will not necessarily lead to less employability, but the driver's role will change (from a chauffeur to a pilot). Chauffeurs may become pilots that besides monitoring of operating systems become the personal contact /ambassador of the service provider towards the customer).
   - full automation will make "cars" available for those parts of the population which have not access to it otherwise (impaired mobility users, elderly, …)

The socio-economic implications should also be considered in the context of other structural changes – e.g. the transition to low carbon mobility and electric vehicles, and the diffusion of transport sharing options and new lifestyles – that may heavily affect urban transport and the prospects for automotive industries in the coming decades.

4.2 Current assumption

As today there haven't been any stringent and holistic estimation of the implications above. The functions are evaluated by them self and the combined result are not possible to evaluate.

There is the general assumption is that 90% of all accidents are caused by human factors and that automation will have a large impact on traffic safety. Some studies suggest about 1 percent of current rates (in line with results from aviation and rail)[7] to and end goal of "crash less cars"[8]

[7] Hayes, Brian (2011). Leave the Driving to it. *American Scientist*. 99: 362-366

[8] KPMG and CAR (2012). Self-Driving Cars: The Next Revolution. Ann Arbor, MI.

Multiple studies have investigated the potential for automated transport systems to reduce congestion under differing scenarios. Under various functions of automation could smooth traffic flows by seeking to minimize accelerations and braking in freeway traffic. Figures shows that this could increase fuel economy and congested traffic speeds by 23 percent to 39 percent and 8 percent to 13 percent, respectively, for all vehicles in the freeway travel stream, depending on V2V communication and how traffic-smoothing algorithms are implemented.[9]

4.3 Future evaluation framework

Both in Europe and in the US have work started to identify the building blocks of a holistic evaluation framework in order to have that aims quantitative estimations.

U.S Dot have started to investigate and concluding the framework need to cover multiple spatial and temporal resolutions, where spatial ranges from vehicle-vehicle interactions to national impacts and temporal ranges from fractions of a second to years

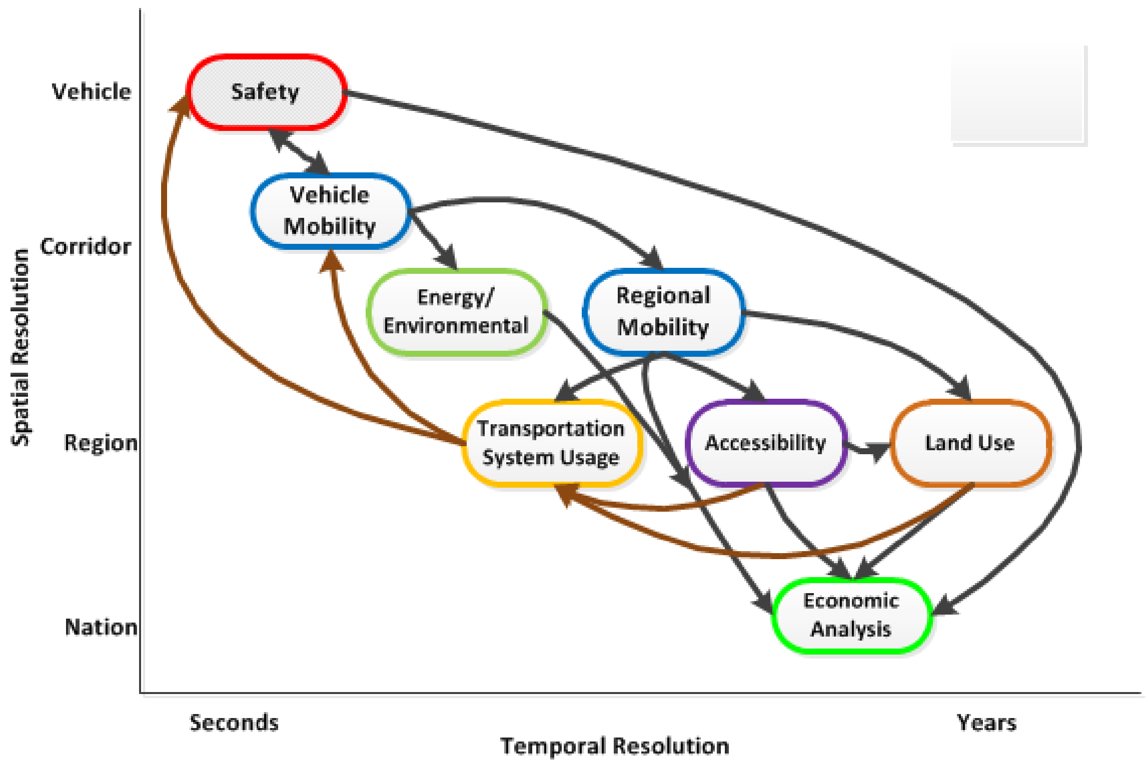


Figure 4: U.S. Evaluation framework

Key factors that have started to be analysed are:

- **Safety**: typically analyzed at a high level of detail, but also the mechanism on how the benefits are rolled up to a larger area/timeframe (e.g., crashes in a nation per year).

[9] ENO 2013 "Preparing a Nation for Autonomous Vehicles"

- **Vehicle mobility**: detailed analysis how the vehicle performs on the road e.g. car following, gap acceptance, etc. But also how the benefit estimation are rolled up to a larger area/timeframe
- **Energy / environmental**: estimate the environmental impact based on the vehicle mobility
- **Regional mobility**: evaluate the performance of a region in terms of congestion
- **Transportation system usage**: Investigate at how people respond to changes in the transportation system, e.g. more people using a road that has become less congested.
- **Accessibility**: evaluate the ability of people to reach desired destinations. This becomes very important for non-motorists at the higher levels of automation, i.e. no driver needed.
- **Land use**: evaluate the impact of land use due to automation, e.g. reduced parking requirements, possibly more sprawl, etc.
- **Economic analysis**: combine the factors above in order to evaluate the economic benefits: reduced crash, congestion, pollution and energy costs, increased ability for non-motorists to reach jobs

The key challenge will be in find the relation between the key factors for different applications of automation.

On the European side there are today no ongoing project that takes a holistic approach on the evaluation of socio-economic implications. There is a need for a project to evaluate the drivers and the consequences of the implementation of each deployment path (see chapter 6) would clarify whether the EU need to adopt any policy to facilitate one of the most promising ones and discourage the others.

5 State-of-the-Deployment

This section describes the current state-of-the-deployment automated functions for passenger and commercial vehicles as well as for the Fully Automated Road Transport systems.

5.1 Private and Commercial vehicles

5.1.1 *Systems beyond human capability to act*

There are several systems on the market today that intervenes when it is beyond the human capability to act, like ABS (Anti-Lock System), ESC (Electronic Stability Control) and emergency braking. These systems are only mentioned covered in detail here, but they are active safety systems that will be building block for high levels of automation and will facilitate deployment.

Future version of these systems will include emergency evasion and emergency stopping.

5.1.2 *Current and future vehicle Systems –Level 0*

Currently on the market (both for trucks and passenger vehicles) there is several assist system:

LCA – Lane Change Assist

The system monitors the areas to the left and right of the car and up to 50 metres behind it and warns you of a potentially hazardous situation by means of flashing warning lights in the exterior mirrors.

PDC: Park Distance Control

The Park Distance Control supports the driver to manoeuvre into tight spaces and reduce stress by informing him of the distance from obstacles by means of acoustic or, depending on vehicle, optical signals.

LDW: Lane Departure Warning

Lane Departure Warning helps to prevent accidents caused by unintentionally wandering out of lane, and represents a major safety gain on motorways and major trunk roads. If there is an indication that the vehicle is about to leave the lane unintentionally, the system alerts the driver visually and in some cases by means of a signal on the steering wheel.

FCW: Front Collision Warning

The Front Collision Warning monitoring system uses a radar sensor to detect situations where the distance to the vehicle in front is critical and helps to reduce the vehicle’s stopping distance. In dangerous situations the system alerts the driver by means of visual and acoustic signals and/or with a warning jolt of the brakes. Front Collision Warning operates independently of the ACC automatic distance control.

5.1.3 *Current Systems –Level 1*

ACC- Adaptive Cruise Control

The cruise control system with "automatic distance control ACC" uses a distance sensor to measure the distance and speed relative to vehicles driving ahead.

The driver sets the speed and the required time gap with buttons on the multifunction steering wheel or with the steering column stalk (depending on model). The target and actual distance from following traffic can be shown as a comparison in the multifunction display.

PA- Park Assist

Park Assist automatically steers the car into parallel and bay parking spaces, and also out of parallel parking spaces. The system assists the driver by automatically carrying out the optimum steering movements in order to reverse-park on the ideal line. The measurement of the parking space, the allocation of the starting position and the steering movements are automatically undertaken by Park Assist – all the driver has to do is operate the accelerator and the brake. This means that the driver retains control of the car at all times.

ACC including Stop & Go

Adaptive cruise control with stop & go function includes automatic distance control (control range 0–250 km/h) and, within the limits of the system, detects a preceding vehicle. It maintains a safe distance by automatically applying the brakes and accelerating. In slow-moving traffic and congestion it governs braking and acceleration.

LKA – Lane Keeping Assist

Lane Assist automatically becomes active from a specific speed (normally from 40 mph) and upwards. The system detects the lane markings and works out the position of the vehicle. If the car starts to drift off lane, the LKA takes corrective action. If the maximum action it can take is not enough to stay in lane, or the speed falls below 40 mph LKA function warns the driver (e.g. with a vibration of the steering wheel). Then it's up to the driver to take correcting action.

5.2 Urban mobility: Fully Automated Road Transport Systems

. In specific areas in Europe today high automation in transit areas exist but with low speed and/or dedicated infrastructure. This will be the base for going to higher and higher vehicles speeds and maybe less specific requirements on the infrastructure.

- **Cybercars.** These are small automated vehicles for individual or collective transportation of people or goods, with the following characteristics: a) fully automated on demand transport systems that under normal operating conditions do not require human interaction; b) they can be fully autonomous or make use of information from a traffic control centre, information from the infrastructure or information from other road users; c) they are small vehicles, either for individual transport (1-4 people) or for transport of small groups (up to 20 people); d) they can either use a separated infrastructure or a shared space.

- **High-Tech Buses**. These are buses on rubber wheels, operating more like trams than like traditional buses, with the following characteristics: a) they are vehicles for mass transport (more than 20 people); b) they use an infrastructure, which can be either exclusive for the buses or shared with other road users; c) they can use various types of automated systems, either for guidance or for driver assistance; d) they always have a driver, who can take over control of the vehicle at any time, allowing the vehicles to use the public road.

- **Personal Rapid Transit (PRT)**. This is a transport system featuring small fully automatic vehicles for the transport of people, with the following characteristics: a) PRT operates on its own exclusive infrastructure (there is no interaction with other traffic); b) they are fully automated systems that un-der normal operating conditions do not require human interaction; c) they are small with a capacity usually limited to 4 to 6 persons per vehicle; d) PRT offers an on-demand service, where people are transported directly from the origin station to the destination station without stopping at inter-mediate stations, without changing vehicles and ideally without waiting time.
- **Advanced City Cars (ACC):** new city vehicles integrating zero or ultra-low pollution mode and driver assistance such as ISA (Intelligent Speed Adaptation), parking assistance, collision avoidance, stop&go, etc. These vehicles should also incorporate access control coupled with advanced communications in order to integrate them easily into car-sharing services.
- **Dual-mode vehicles:** developed from traditional cars but able to support both fully automatic and manual driving. The first applications of automatic driving will be for relocation of shared cars using platooning techniques but these vehicles could become full cybercars in specific areas or infrastructures. Dual-mode vehicles represent the migration path from traditional cars to automatic driving.

5.3 Key automation deployment indicators.

This chapter aim to identify key global indicator that shows the maturity of the automation deployment. The main idea is to use these global indicators to cross verify the result in chapter 6. The current version of the document contains to indicators but others will be added in future version of the document.

5.3.1 *Maturity forecast on vehicle automation.*

The aim of this indicator is to estimate the technology maturity of vehicle automation to see if the mature is in-line with the expected deployment timeline in chapter 6.

The key idea with forecast theory is that new technologies follow a certain maturing model before it is ready for the market introduction, see Figure 5: Forecast theory below. The result below is based on data between 1976 and 2013 (patents), 1971 and 2013 (publications). In annex “Patent and publication search” is a description on the input that was used in the patent and publication search[10]. The projections extends until 2030 and is based on Fisher-Pry modelling[11]

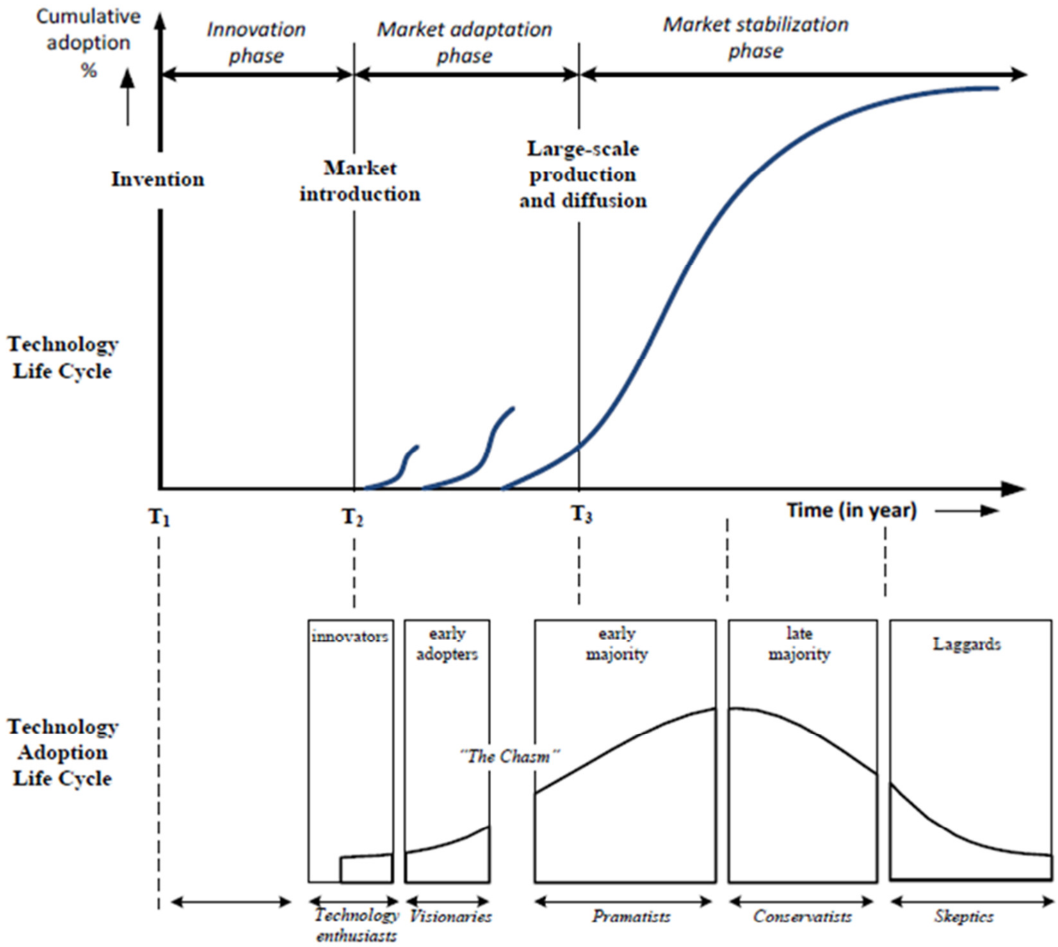
The key assumption made for the forecast is about what the total number of patents/publications will be during the technology lifetime [LMax]

[10] This will be done in the second version of the document.

[11] FISHER, J. C. AND R. H. PRY, "A Simple Substitution Model of Technological Change," Technological Forecasting and Social Change, 3 (March 1971), 75-88.

Since the assumption of LMax is somewhat of a qualified guess work, the following approach was made: Assume that the total number of documents available today (2011 resp. 2013) is representing 50%, 33% and 25% of the ultimate value.

The values given from the forecast are the projected years for when the maximum publication activity is to occur.



The technology life-cycle model and the technology adoption life-cycle combined.

Figure 5: Forecast theory

Patents

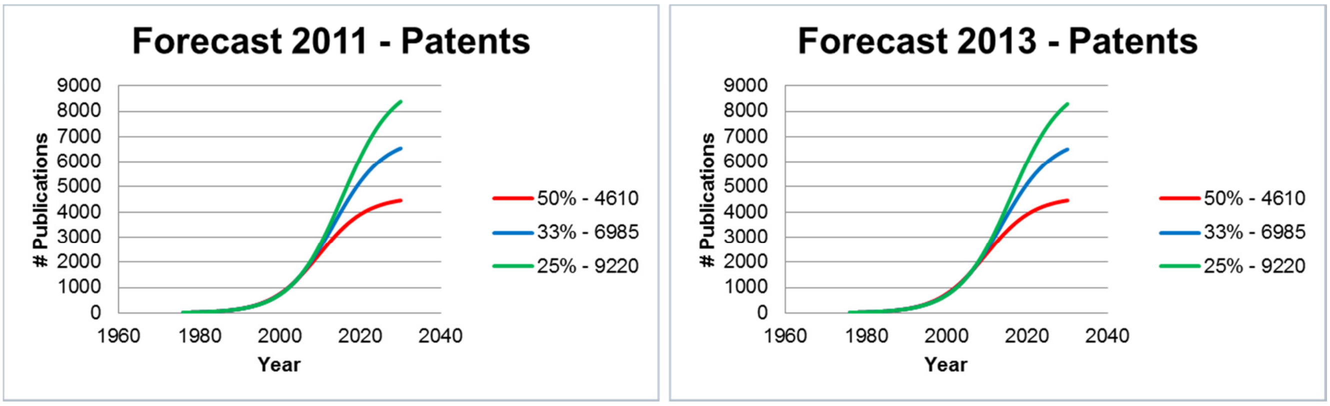


Figure 6: Patents forecast 2011 and 2013

Depending on the assumption on the inflection point will the mature date be different, but the 2013 forecast's predict a patent peak closer in time than originally forecasted in 2011, as shown in the table below.

Forecast based on 2011 data	Forecast based on 2013 data
2011,7 (50%)	**2010,9 (50%)**
2016,9 (33%)	**2016,1 (33%)**
2020,3 (25%)	**2019,5 (25%)**

Publications

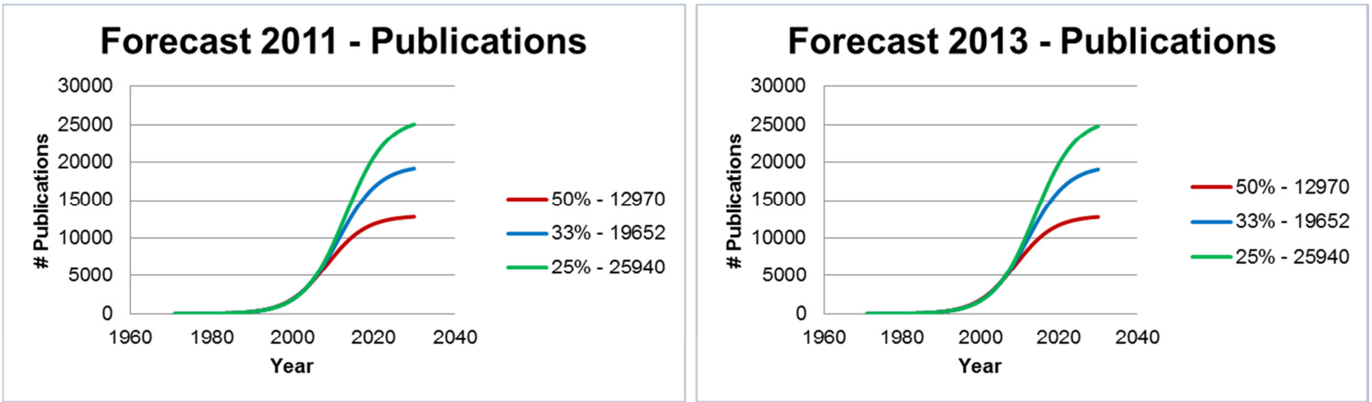


Figure 7: Publication forecast 2011 and 2013

Depending on the assumption on the inflection point will the mature date be different, but the 2013 forecast has the publication peak has moved forward somewhat, except for the 50% case which has moved slightly backwards.

Forecast based on 2011 data	Forecast based on 2013 data
2011,0 (50%)	**2010,9 (50%)**
2016,0 (33%)	**2016,3 (33%)**
2019,2 (25%)	**2019,8 (25%)**

Conclusions

There has been an increase in patent activity that has pushed the patent peak closer to the publication peak between 2011 and 2013. There is still an increasing amount of patent and published material that makes it impossible to see which timeline is the most realistic one but that trend is that the maturity phase is approaching faster.

5.3.2 *Deployment penetration estimation of current automation systems*

This chapter aims to show the current deployment situation of the automation systems that are on the market today and their estimated future penetration rate.

The figure below shows that systems like Advance emergency brake systems and lane departure systems will have a quite fast penetration between 2015 and 2020 reaching almost 50% penetration on the light vehicle market.

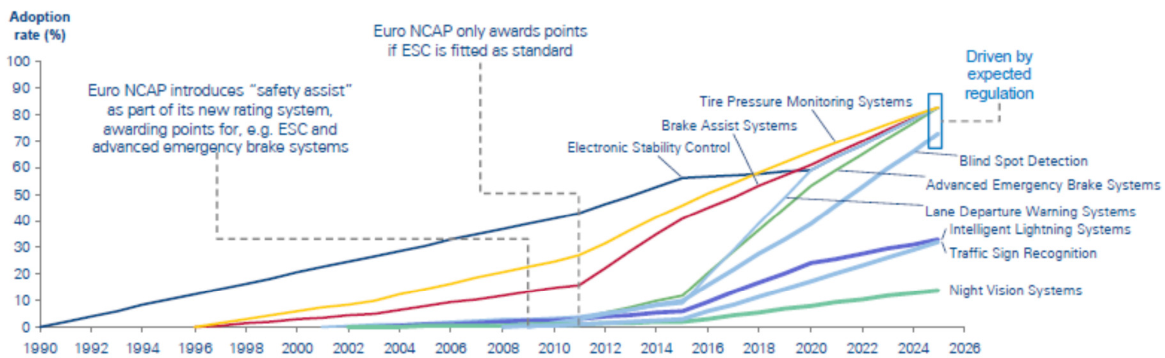


Figure 8: Global Penetration rates for active safety solutions in light vehicles[12]

[Note]: this chapter will be further developed in future version of the document

[12] Source: Arthur D. Little Analysis, Kepler Capital Markets, Euro NCP

6 Deployment paths

In this section different automation paths will be investigated, the focus is on automation level 2-5.

The base for the work has been the roadmap produced in the iMobility Forum automation working group 2013. There the focus was on the technology development and not the industrialisation (deployment). The aim has been to take that work and have wider and more detailed common EU view on the deployment following the methodology described in chapter 2.5. The timelines and the name of the functions correspond to the common view within the iMobility Forum, EUCAR and ERTRAC. Then the importance of different paths differs between different stakeholders and the exact deployment date of specific functions.

On the market today there are several systems in the automation level 0 and 1. They will be the base for building the vehicle path (both passenger and trucks) with a stepwise approach to higher and higher level of automation. These systems will in the coming year, with wider deployment, have a significant impact on driving efficiency and safety.

The existing systems will continue to be deployed and gaining market penetration. This is illustrated by the 'dark blue' path, see chapter 5.3.2 for details.

The main alternative path is the 'Urban Mobility' path. In specific areas in Europe today high automation in transit areas exist but with low speed and/or dedicated infrastructure. This will be the base for going to higher and higher vehicles speeds and maybe less specific requirements on the infrastructure.

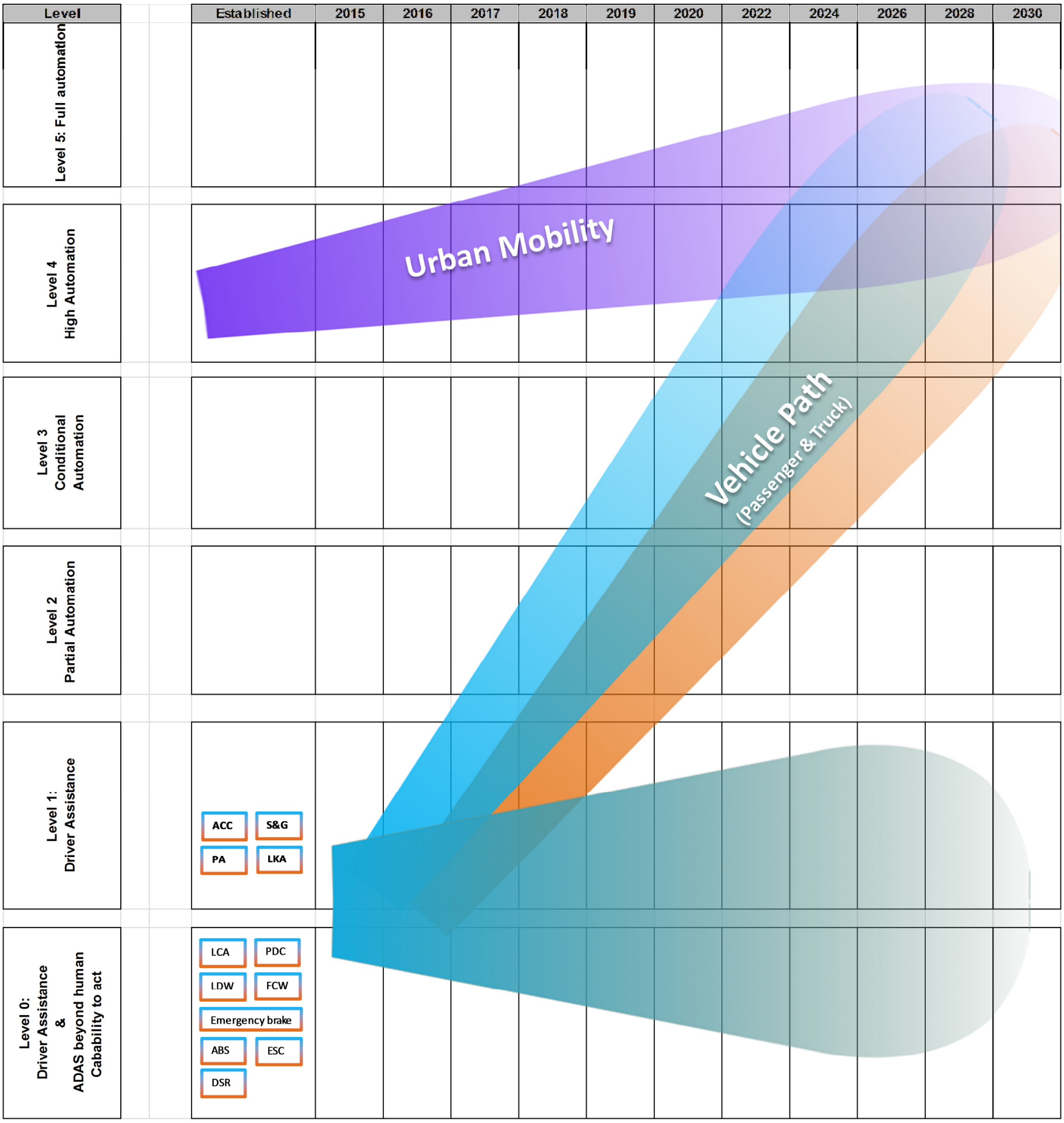


Figure 9: The main automation deployment paths

6.1 Urban Mobility Path[13]

The path is 'Low Speed High Automation'. The aim the 'purple' path is to highlight the insecurity in the estimation in time but also penetration. In later version is the aim that the width will represent the estimated penetration, making it possible to compare different path with each other in chapter 7.

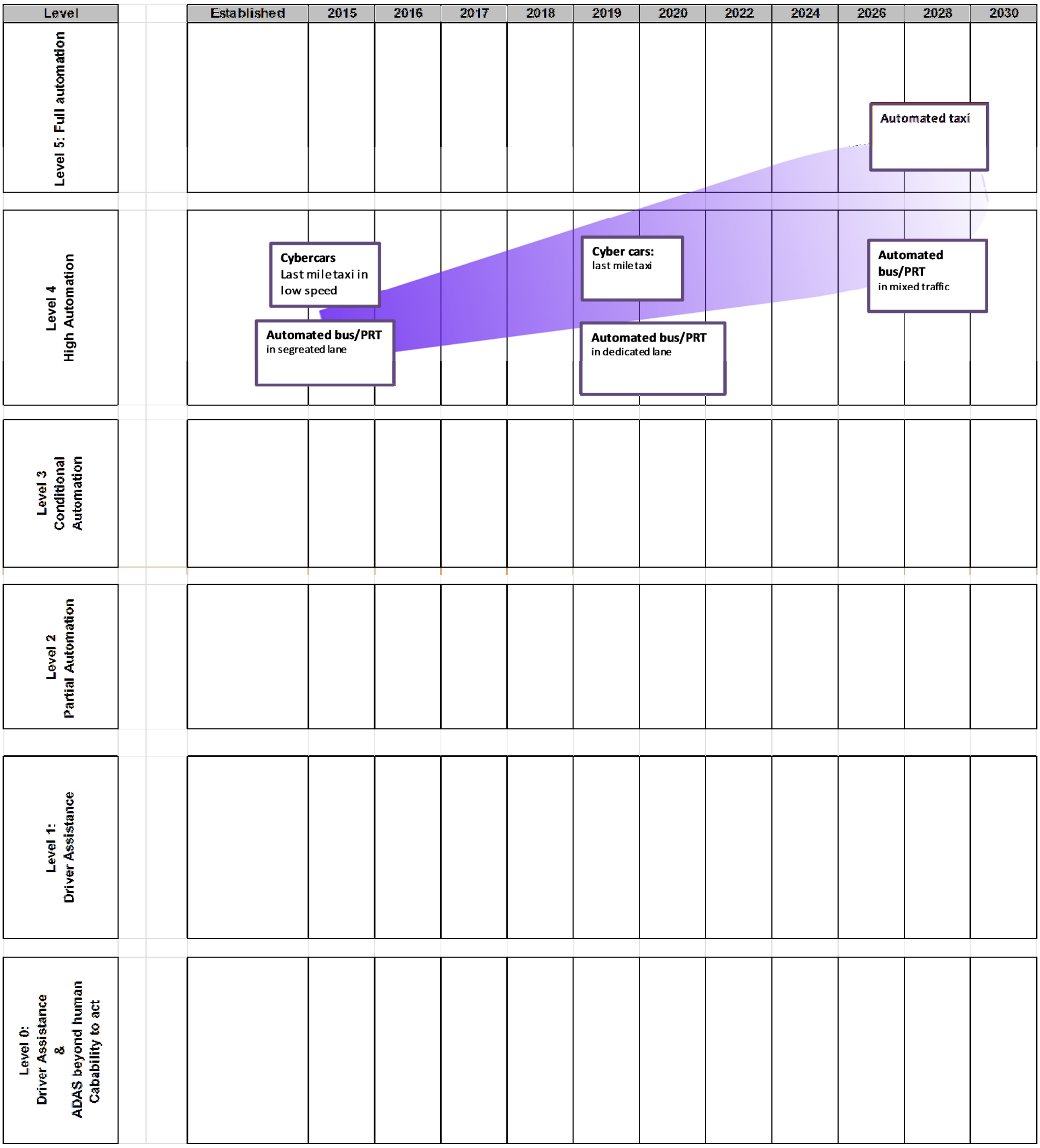


Figure 10: Low Speed High Automation Deployment Path

13 Based on result CityMobil2

6.1.1 *Last mile taxi*

Cybercars, Gen 1 (level 4)

The last mile taxi is fully automated in its area of operations taking a limited number of passengers with a maximum speed of 40 km/h. It operates in a specific area with dedicated infrastructure.

Cybercars, Gen 2 (level 4)

The last mile taxi is fully automated in its area of operations taking a limited number of passengers. It operates in a specific area with adapted infrastructure.

Automated Taxi (level 5)

Fully automated driving that can in principle take the passenger to all places. Note: no realistic time estimation exists on this system.

6.1.2 *Automated bus or PRT*

Automated bus or Personal Rapid Transit.

Automated bus or PRT in segregated lane, Gen 1 (level 4)

The automated bus drives in segregated bus lanes and dedicated infrastructure, with a maximum speed of 40km/h.

Automated bus or PRT in dedicated lane, Gen 2 (level 4)

The automated bus drives in dedicated bus lanes and supporting infrastructure with normal city vehicle speeds.

Additional functionality such as adaptive urban traffic control system that controls the traffic lights and gives speed advices and priority can be introduced when these systems reach the market.

Automated bus (level 4)

The automated bus drives in mixed traffic in the defined area of operation.

6.2 Automated Private Vehicle Paths

The path is ‘Automated Private Vehicle. The aim the ‘light blue’ path is to highlight the insecurity in the estimation in time but also penetration. In later version is the aim that the width will represent the estimated penetration, making it possible to compare different path with each other in chapter 7. The aim of the ‘dark blue’ path is to show that the penetration of the current systems on the market will continue, see chapter 5.3.2.

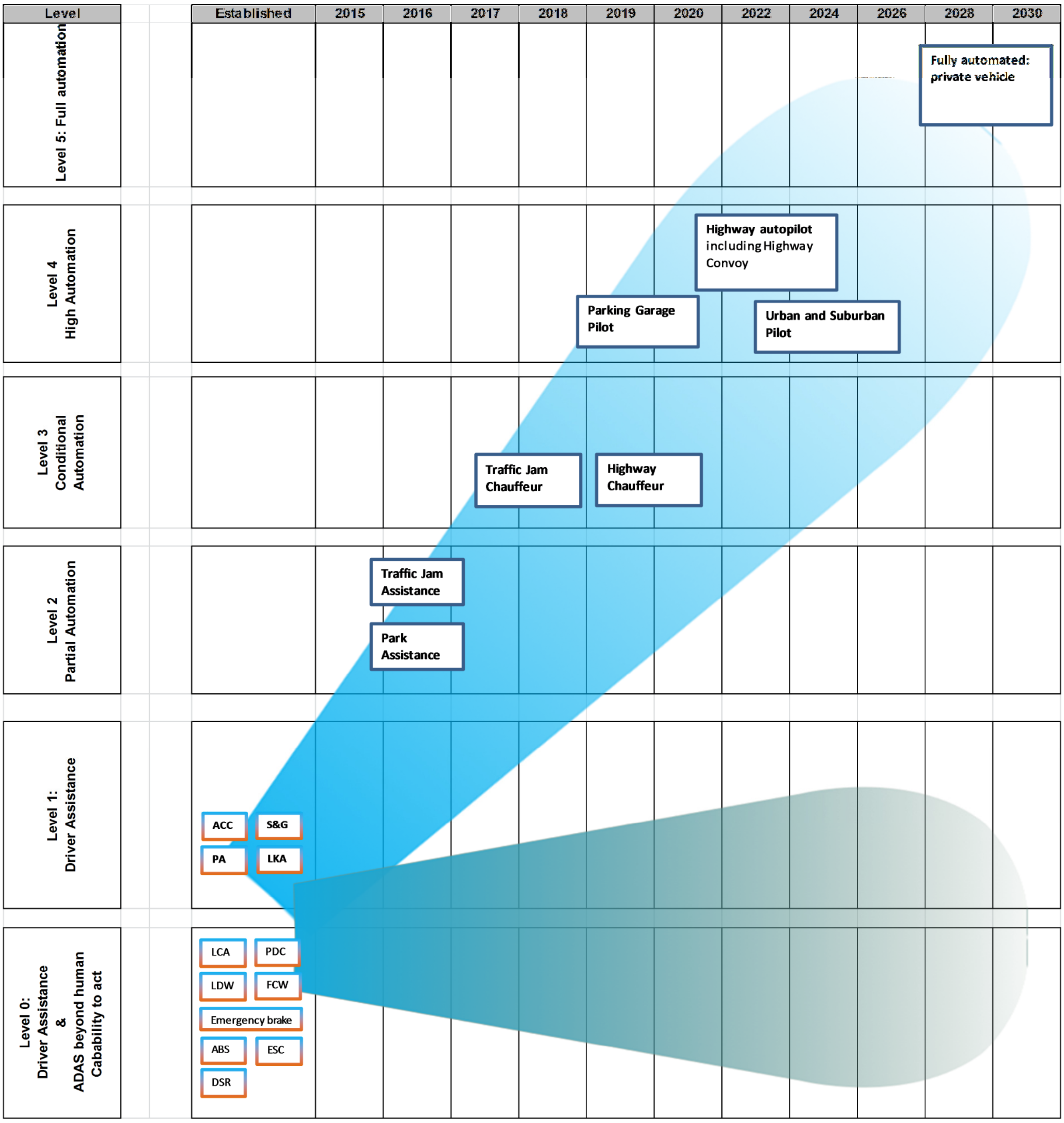


Figure 11: Automated Private Vehicle Deployment Paths

6.2.1 *Automated Parking Assistance*

Parking assistance is on the market today.

Park Assistance (Level 2)

Partial Automated Parking into and out of a parking space, working on public parking area or in private garage. Via smartphone or key parking process is started, vehicle accomplishes parking manoeuvres by itself. The driver can be located outside of the vehicle, but has to constantly monitor the system, stops parking maneuverer if required

Parking Garage Pilot (Level 4)

Highly Automated parking including manoeuvring to and from parking place (driverless valet parking) In parking garage the driver does not have to monitor the system constantly and may leave once the system is active. Via smartphone or key parking maneuverer and return of the vehicle is initiated

6.2.2 *Highway Pilot*

Traffic Jam Assist (level 2)

The function controls the vehicle longitudinal and lateral to follow the traffic flow in low speeds (<30km). The system can be seen as an extension of the ACC with Stop&Go functionality.

Traffic Jam Chauffeur (Level 3)

Conditional automated driving in traffic jam up to 60 km/h on motorways and motorway similar roads. The system can be activated, if traffic jam scenario exists. It detects slow driving vehicle in front and then handles the vehicle both longitudinal and lateral.

Driver must deliberately activate the system, but does not have to monitor the system constantly. Driver can at all times override of switch off the system. Note: There is no take over request to the driver from the system.

Highway Chauffeur (Level 3)

Conditional Automated Driving up to 130 km/h on motorways or motorway similar roads. From entrance to exit, on all lanes, incl. overtaking. The driver must deliberately activate the system, but does not have to monitor the system constantly. The driver can at all times override or switch off the system. The system can request the driver to take over within a specific time, if automation gets to its system limits.

Higway Pilot (level 4)

Automated Driving up to 130 km/h on motorways or motorway similar roads from entrance to exit, on all lanes, incl. overtaking. The driver must deliberately activate the system, but does not have to monitor the system constantly. The driver can at all times override or switch off the system. There are no request from the system to the driver to take over when the systems in normal operation area (i.e. on the motorway). Depending on the deployment of cooperative systems ad-hoc convoys could also be created if V2V communication is available.

6.2.3 *Urban and Suburban Pilot (level 4)*

Highly automated driving up to limitation speed, in urban and suburban areas.

The system can be activated by the driver on defined road segments, in all traffic conditions, without lane change in the first phase. The driver can at all-time override or switch off the system

6.2.4 *Fully automated private vehicle (level 5)*

The fully automated vehicle should be able to handle all driving from point A to B, without any input from the passenger. The driver can at all-time override or switch off the system. Note: no realistic time estimation exists on this system.

6.3 Commercial vehicles Automation Paths

The path is 'Commercial vehicles Automation. The aim the 'orange' path is to highlight the insecurity in the estimation in time but also penetration. In later version is the aim that the width will represent the estimated penetration, making it possible to compare different path with each other in chapter 7. The aim of the 'dark blue' path is to show that the penetration of the current systems on the market will continue, see chapter 5.3.2.

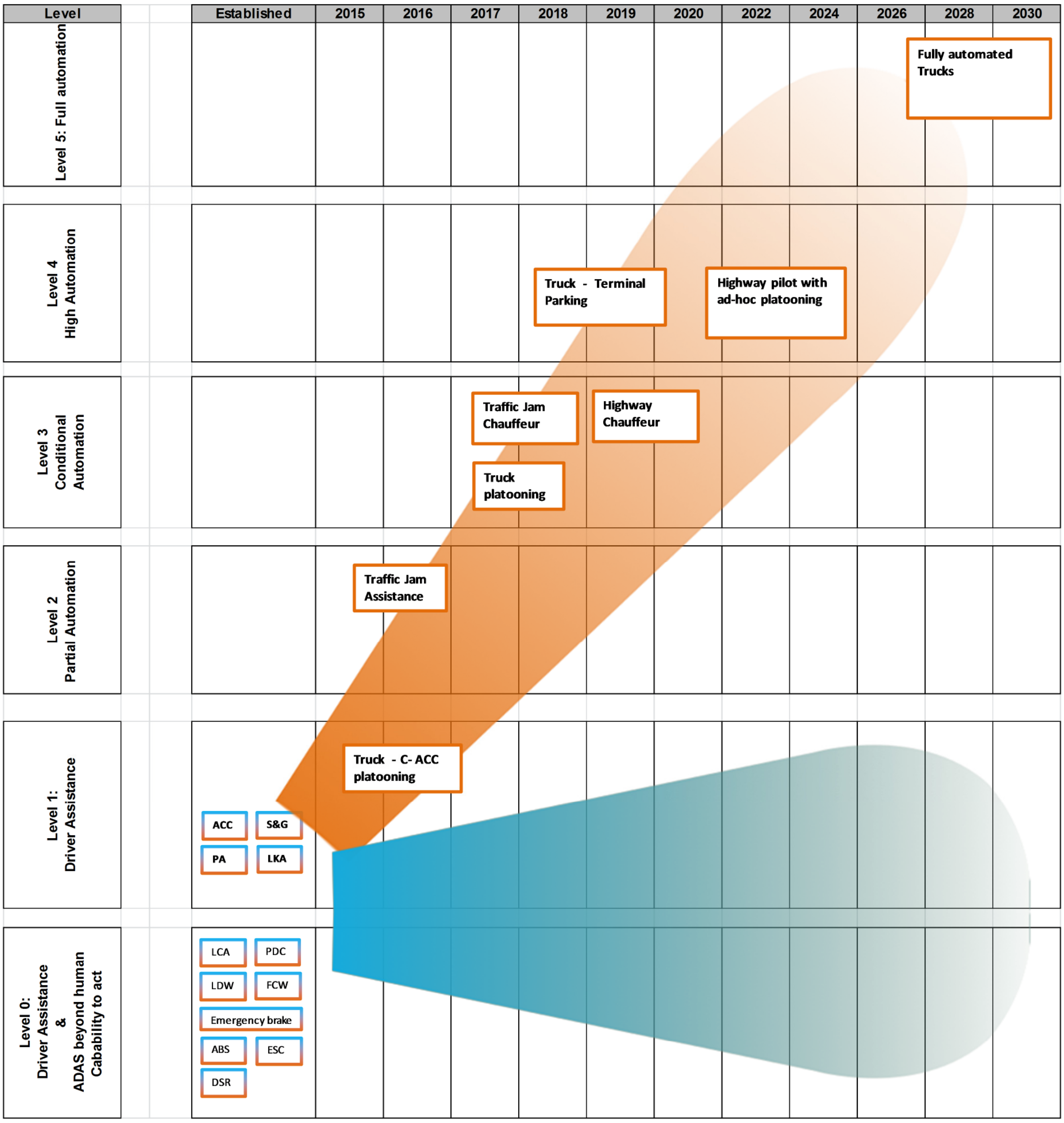


Figure 12: Commercial vehicles Automation Deployment Paths

6.3.1 *Platooning*

C-ACC Platooning

Partially automated truck platooning, in which trucks are coupled by cooperative ACC (CACC), implementing engine and brake control keeping a short but safe distance to the lead vehicle, while the drivers remain responsible for all other driving functions.

Truck platooning

This function enables platooning in specific lane. The vehicle should be able to keep it position in the platoon with a fixed distance or fixed time difference from the front vehicle. The behaviour of the first vehicle (e.g. braking and steering) should be transmitted be V2V communication. The function should also handle vehicle that wants to leave the platoon.

Up scaling and deployment can be reached as follows:

1. Start with trucks as there is a strong financial incentive due to 10% to 15% fuel savings (which also support the societal benefits, i.e. CO_2 reduction)
2. Start with small platoons of only 2 trucks and co-operation with fleet-owners in high density truck area.
3. Start with a system where drivers are still in the following truck, for legal reasons

Setup an (open) fleet management system for trip matching between equipped trucks of different fleet owners.

Organise the deployment step by step, increase functionality (of the system) and complexity of the operational environment (road network) stepwise, make sure that all relevant stakeholders are involved (authorities, industry (OEMs and TIERS), market players (logistics companies (hauliers and transport companies), service providers and insurance companies), RTDs and the end users (driver stakeholder groups).

6.3.2 *Highway Pilot*

Traffic Jam Assist (level 2)

The function controls the vehicle longitudinal and lateral to follow the traffic flow in low speeds (<30km). The system can be seen as an extension of the ACC with Stop&Go functionality.

Traffic Jam Chauffeur (Level 3)

Conditional automated driving in traffic jam up to 60 km/h on motorways and motorway similar roads. The system can be activated, if traffic jam scenario exists. It detects slow driving vehicle in front and then handles the vehicle both longitudinal and lateral.

Driver must deliberately activate the system, but does not have to monitor the system constantly. Driver can at all times override of switch off the system. Note: There is no take over request to the driver from the system.

Highway Chauffeur (Level 3)

Conditional Automated Driving up to 90 km/h on motorways or motorway similar roads from entrance to exit, on all lanes, incl. overtaking. The driver must deliberately activate the system, but does not have to monitor the system constantly. The driver can at all times override or switch off the system. The system can request the driver to take over within a specific time, if automation gets to its system limits.

Higway Pilot with ad-hoc platooning (level 4)

Automated Driving up to 110 km/h on motorways or motorway similar roads from entrance to exit, on all lanes, incl. overtaking. The driver must deliberately activate the system, but does not have to monitor the system constantly. The driver can at all times override or switch off the system. There are no request from the system to the driver to take over when the systems in normal operation area (i.e. on the motorway). Depending on the deployment of cooperative systems ad-hoc convoys could also be created if V2V communication is available, see 6.3.1.

6.3.3 *Fully automated truck (level 5)*

The fully automated Truck should be able to handle all driving from point A to B. no driver need to be in the vehicle. Note: no realistic time estimation exists on this system.

6.4 Evolution of the infrastructure

This chapter provide a preliminary overview on the evolution of Infrastructure and it will be extended in D3.1.3 (Final Version).

Information in order to build the roadmap for the infrastructure has been collected from external sources. The following sources have been considered:

- FEHRL activities on Road Automation. The report "The Automated Road – A Roadmap for Research "[14] released in January 2013, for instance, offers an overview on the main automated road elements which include for instance:
    - comprehensive, interoperable communications systems linking road, driver, vehicle and the operator
    - Advanced vehicle and user guidance, speed control and direction guidance, including in-road guidance to manage traffic
    - Integrated traffic control, monitoring of traffic and road conditions to improve reliability and efficiency.

  The roadmap proposed by FEHRL is based on the following two innovation themes:

  Intelligent Traffic Management Strategies (ITMS): This theme concerns management on a network level. The objective is to guide the road user through the (regional) infrastructure network as safely as possible, with a minimum loss of travel time and the least possible environmental harm.

  Advanced Roadside Systems (ARS): This theme is instrumental to enabling the ITMS. The application of these innovative technologies would predominantly be local. ARS for Automated Roads would be applied on specific corridors or segments in the road network;

[14] http://www.foreveropenroad.eu/?m=6&mode=download&id_file=14800

- The City Mobil 2 report on the deployment and test of Automated Transport Systems in several cities in Europe. The feedback of this project will support the investigation on the impact and required evolution of the infrastructure. A final report on this activity will be available by the end of 2015.

- Inputs have also been collected considering the activity of TRAMAN 21[15]. This project investigates the development of fundamental concepts and tools to support the future motorway traffic management research and practice that are indispensable in order to accompany, complement and exploit the evolving deployment of VACS (Vehicle Automation and Communication Systems). The TRAMAN21 work comprises the development of new traffic flow modelling and control approaches, on the basis of appropriate methods from many-particle Physics, Automatic Control and Optimisation, to consider and exploit the novel vehicle capabilities at a network-wide level. A report "Overview and Analysis of Vehicle Automation and Communication Systems from a Motorway Traffic Management Perspective"[16] has been recently published and it will be used with material from other projects and activities to provide an overview on the evolution of the infrastructure.

The concept of "High QoS Road" has been elaborated by IFSSTAR and it is illustrated in the next paragraph.

6.4.1 *Infrastructure: the concept of "High QoS Road"*

To move safely, vehicles will need an accurate knowledge of the state of the road on which they are travelling. Indeed, automated vehicles are expecting from infrastructure that it fulfils some requirement in order to maximize safety. Generally speaking, the infrastructure must be "readable" by the vehicle. This readability covers several aspects.

First at all, the infrastructure must provide the vehicle with high lane marking quality such as in- vehicle perception system will be able to detect them and then accurately locate the vehicle on the road.

But there are many other road features which are contributing to enhance or alter safety. It concerns:

- Road geometry: slope, cant, curvature
- Road surface degradation: ruts, potholes, ruptures, cracks,
- Road skid resistance,
- Geometric visibility (characterized by limitation of visibility distance due to road geometry)

Some of these features affect directly vehicles dynamics, other impact their ability to anticipate some potentially critical situation.

15 http://www.traman21.tuc.gr/

16 http://www.traman21.tuc.gr/docs/wp1/TRAMAN21-D1-v4.pdf

Consequently, an automated vehicle will move safely on a given road under the condition that the above mentioned features will have characteristics of which values are enclosed within some limits. This is what we call a "safe road" or a "High QoS[17] road".

Then, a vehicle arriving at the beginning of such a road will warn the driver that he can switch the vehicle driving mode from manual to automatic. Conversely, as soon as the "safe road" conditions are no more fulfilled, the vehicle must warn de driver to switch from automatic to manual.

This means that the infrastructure must provide in real time the vehicle with information that describes its current state. To achieve this goal many solution are possible depending of the road characteristics variability. Here, we could distinguish several class of variability:

1) "Static" road characteristics which are stable other the time, typically the road geometry, its nominal skid resistance (intrinsic to road pavement without influence of weather conditions)
2) "Dynamic" road characteristics that may vary over middle duration period (several days or weeks) due to degradation (e.g. road surface or lane marking degradation)
3) "Temporary" road characteristics that may vary over a short duration period due for example to bad weather condition (e.g. ice that affects skid resistance, snow that hide lane marking) or road works.

Concerning the first class, the road characteristics could be recorded under the form of attributes into digital map.

Regarding the second class, information could be transmitted from traffic management centres to the vehicles using I2V communication. Latency time seems not to be critical allowing then to rely on 2,5G or 3G media for instance.

Finally temporary road characteristics could be transmitted to vehicle using both I2V and V2V short range and low latency time communication.

A typical scenario could be as follows:

- A vehicle arrives at the entrance of a "safe road".
- The driver is notified to switch its vehicle from manual to automatic.
- In normal condition the automated mode will be kept until the end of the safe itinerary
- In abnormal condition (e.g. bad skid resistance condition) the vehicle receives the relevant information and asks the driver to switch back to the manual mode.

Last but not least, information on the current road status has to be collected and analysed by road network operator before to be sent to the vehicles. The classical approach consists in using road network operator services vehicles which periodically patrols along the itinerary. However a more innovative solution consists in using the automated vehicles themselves as probe vehicles. Indeed recent vehicles (and especially future automated vehicles) are equipped with many sensors that allow to measure road characteristics: lane marking quality, road surface condition, road pavement degradation, visibility distance etc.

As shown above, there is a strong link between the physical infrastructure, the digital infrastructure and the cooperative systems. The physical infrastructure must comply with

[17] QoS : quality of service

what is expected by the vehicle to ensure a given level of safety. In addition the digital infrastructure must reflect at any time the current state of the physical infrastructure. This is made possible thanks to cooperative systems.

From the road network operator point of view, there are several important challenges:

- To maintain the road at a high level of QoS,
- To detect as soon as possible any QoS degradation,
- To inform as soon as possible the concerned automated vehicles.

6.5 Main factors (barriers) for deployment

This chapter offers an overview of some of the main aspects has been identified as factors (barriers) for deployment and that are tacked in VRA WP3.

The EU funded Project CityMobil2, deploying Automated Road Transport Systems (ARTS) made of fleets of self-driving road vehicles operating in individual or collective mode, identified financial, legal and safety issues.

In particular, three main barriers have been identified:

- The transport authorities' lack of an implementation framework, which renders procurement and setup of these systems more complex than those of conventional systems
- The legal framework, which does not allow self-driving vehicles on public roads
- The uncertain socio-economic impact of their take-up. Hence, the following questions are investigated in CityMobil2:
    - Is the economic benefit from products and services that could be generated from automated vehicles and their take up a substitute for the consequent fall that would follow in the car-market?
    - Would, even more important, the technological edge Europe take over the rest of the world manufacturing the transport systems of the future help increasing Europe’s exports and boosting Europe’s economy?

With new legal frameworks popping up in various member states, the second point (legal framework) is starting to be addressed (see VRA WP3.2 deliverables). Subsequently, it is a challenge to make sure that harmonisation will take place, amongst those member states that are frontrunners in the introduction of new legal frameworks. Harmonisation is key to allow for deployment across borders. It is needed on policy level (legal), but also on many technical levels, like for instance standardisation of communication protocols (V2V) between vehicles (C-ACC and truck platooning). This is just one example, amongst many others.

7 Business models

This chapter will be completed D3.1.3 (Final Version). Currently it contains a simple business model for some key applications that will be discussed more in details in the next versions.

7.1 Truck Platoon

Since immediate benefits can be made, this model can be considered as the most likely to first adopt this type of technology. As the market penetration increases, this model opens up both for the pay-as-you-go model and for the monthly subscription model.

Customer value proposition

A more clean, safe and profitable fleet of commercial trucks implementing automation technology in the vehicles.

Revenue streams

Reduced fuel consumption can lead to large savings in the cost of transportation and a decreased CO2 footprint. From a commercial viability perspective, road trains are attractive mainly to truck companies. This model has the advantage that it can be quickly adopted and applied locally by, e.g., logistic companies when they upgrade their vehicles. Although the main driving force for commercial companies is the reduction in fuel consumption, there are also other potential benefits:

- Reduced fuel consumption, since distance between trucks is smaller improving aerodynamics. Fuel savings can be obtained at a normal following distance for ACC.
- Drivers exposed to less accidents while driving on highways. Reduced workload
- Increased productivity by rotating rested drivers and avoiding stationary trucks.
- Drivers are enabled to perform other working tasks while platooning.
- Flexibility in the delivery once the platoon is dissolved.

Key Activities

A series of key activities can be numbered, depending on two types of benefits that can be generated: from the main activity of the company and also additional activities derived from the new services that can be developed by the transport company as a result of the implementation of the automated technology. The following key activities are needed to boost the main activity of the transport company:

- Installation of road train technology in entire fleet. New vehicles or “automation kits” to transform conventional vehicles in automated ones.
- Collective training of drivers.
- Dissemination of the service among potential users
- Internal planning for KPI analysis

Additional services can be given, addressing drivers of automated passenger cars who can take advantage from stable commercial routes joining platoon in different modes:

- Subscription of road train usage: In the subscription model, it is assumed that passenger vehicles are paying a periodic fee (monthly, weekly,..) to get access to road trains for commuting. The road train is led by a truck driven by a professional driver of the transport company. The monthly subscription may either be paid by the user or by his/her company to either make the company more attractive to employees and/or to increase the efficiency of the employees by enabling them to work while being transported to work by the road train.
- Pay-as-you-go for joining the road train: The users pay a fee to the lead vehicle for joining the road train over a predefined route, e.g., over a distance of 400 km, or per distance of usage.

Key resources

Some features and functionalities (radar, camera, blind spot detection, electric power steering) can exist in the trucks, since can be offered in a package, e.g., with Active Cruise Control, Collision Avoidance, Lane Keeping Aid and Parking Assistance.

For all product solutions, there is an add-on cost for technology and communication. Equipment needs to be added for enabling the vehicles to interact with each other (V2V) and with the driver (touch display), but the main part of the add-on cost arises from technology needed for redundancy and functional safety, for example, redundant electronic power steering, redundant sensors (radar or lidar, camera) and redundant control module. For the V2V communication, there are additional costs linked to the usage of V2V (and for redundancy of communication) and to system for handling subscriptions, localizing the road train, pay-as-you-go fees, etc. Also additional application in the back office for coordination of the additional services.

7.2 Last Mile Distribution of People With Cybercars

The inclusion of private cars in public transport network is addressed in this business model.

Customer value proposition

Public transport companies include small electric vehicles in their fleets for last mile distribution of people complementing the bus transport, aiming a more clean and sustainable service, avoiding trips of big buses with few people onboard, considering also peak and flat hours regimes.

Revenue streams

In this case also, the reduction in fuel consumption can lead to large savings in the cost of transportation of people and a decreased CO2 footprint derived from the fact that flat hours with few passengers onboard can be shifted by using smaller electric vehicles. This is a new mobility concept that can be attractive for final users, since destination is reached with these vehicles (door to door service).

Transport authorities are also addressed, since a more rationale and sustainable transport network is achieved.

Key Activities

This service can be given by the same public transport company or a private company can take the lead of this business. Coordination of transport routes is needed defining the situations in which the cybercars are going to operate, interfaces with bus / tram or train lines to achieve a full integration of the service in the public transport network.

Coordination with local authorities for the preparation of the infrastructure needed to park the cars and to implement communication network elements.

Business models based on automation technology addressing open public and implying the use of public areas, as this case can be considered, need to develop awareness activities with the involved stakeholders (industrial park managers, town authorities, final users of the service …). Charging infrastructure for the vehicles needs also to be implemented if it doesn´t exist.

Maintenance of vehicles and infrastructure is a periodic activity and taking measures for KPI is crucial to monitor the business.

Key resources

The cybercar fleet acquisition with the required features of size, electric powertrain and a minimum capacity for baggage is the most important part of the business. The way these vehicles have been achieved for the business (purchase, renting, leasing …) is going to influence very much the profit and economic sustainability of the service.

In the infrastructure, V2x communications elements need to be installed and also a charging area for the cybercars in the parking reserved for them.

An app for reservations from public transport vehicles will be needed, affecting also bus stops. Mobile app also available.

8 Conclusions

In the first year of the project, the focus of VRA WP3.1 was on interaction with stakeholders in the iMobility Forum and EUCAR in order to build a solid base for future discussions. For the second year, the focus has been to interact with a larger group of stakeholders through ERTRAC. In the second year, there has been a specific focus on business models: WP3.1 started to be investigated them for some functions.

The result from the first year in terms of deployment paths has been well received and minor changes on the timeline on some function have been added. In Europe today there is a common agreement on the different path and which order a certain application will be deployed. The views on the importance of different paths differ between different stakeholders.

The final year will focus on continue on detailing the business models and tackling the other relevant aspects mentioned in this Deliverable.

Annexes

Annex 1 – References

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European Commission, CARS 21: A Competitive "Automotive Regulatory System for the 21st century"

D27.1 - Blueprint of Alternative City Cyber- mobility Take-up Scenarios

Patent and publication search

8.1.1 Patent

The Derwent World Patents Index was used as a source with the following seach key:

(ALLD=(autonomous OR unmanned OR driverless OR self ADJ driv*) AND (AIC=(G05D0001 OR G08G000116 OR B60W003008 OR B60W003009) OR MC=(T06-B01A OR X22J-05)) AND (AIC=(B62D OR B60W OR B60K OR B60R OR B60T OR B60L OR B60P OR F02D OR F16H) OR MC=(X21 OR X22))) NOT (AIC=(B62D0055) OR MC=(X22-P01 OR W06-C*))*

8.1.2 Publication:

The search string was:

Autonomous or unmanned or driverless or driverfree or selfdriv) ADJ (vehicle or car or bus or truck or lorry or robot car) NOT (underwater or aerial or uav or marine or moon or space or aerospace or railroad)*

And the following databases were used:

- ABI/INFORM® Professional Advanced
- Abstracts in New Technology & Engineering
- British Library Inside Conferences
- Civil Engineering Abstracts
- Computer and Information Systems Abstracts
- Current Contents
- Ei Compendex
- Gale Group PROMT®
- Inspec
- Mechanical & Transportation Engineering Abstracts
- NTIS: National Technical Information Service
- PASCAL
- Ricardo
- SAE
- SciSearch®: a Cited Reference Science Database
- Transport Research International Documentation
- Web of Science