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Deployment paths for Vehicle and Road Automation (Draft 1)

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1 Introduction

1.1 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.

1.2 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.
- Deployments paths: This chapter describes how different automation technologies will be deployed over time.

[1] This chapter will be done in later version of the document

- Business models: This chapter contain simple business model for some key application.[2]

- Conclusions: This chapter contains the general conclusion of the document.

1.3 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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1.4 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)
- Clarify, report and setup a plan of actions on legal, liability, insurance and regulatory issues in different member states (WP3.2)

[2] This chapter will be done in later version of the document

- Monitor and steer standardisation, compliance and certification for vehicle and road automation (WP3.3)

1.5 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.

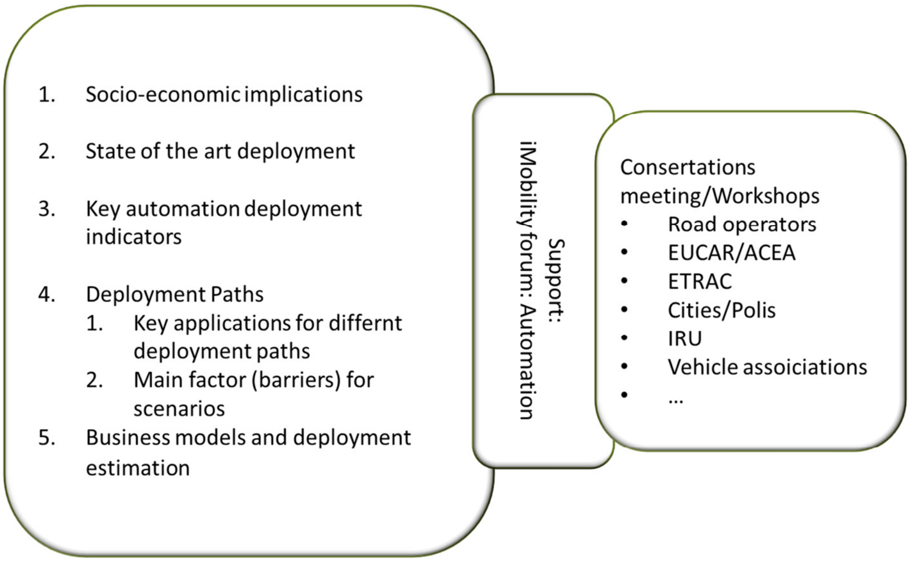

Figure 1: Methodology

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. 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

2 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 2: 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

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

• 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 Socio-economic implications

This chapter provide a preliminary overview on socio-economic implications and it will be extended in D3.1.1 Draft 2.

Relevant information in order to provide an overview of the socio-economic implications of Vehicle and Road Automation will be collected considering the output of current European Projects and other relevant studies or activities.

CityMobil2[4] project for instance has a specific Work package on the CityMobil2 socio-economic study (WP27). A Workshop specifically focused on expected impacts of vehicle automation has been planned at the end of March 2015.

Some aspects related to the evaluation of the socio economic/policy aspects and implementation will be also addressed by the US-EUEU – US Transport Research Symposium which will be held in Washington in April 2015. During this Workshop, there will be 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 will also 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[5]:

- 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.

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

[5] 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 care instead of two and new forms of shared mobility arise)
    - 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 will 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 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.

4.1 *Private and Commercial vehicles*

4.1.1 *Systems beyond human capability to act*

There are several systems on the market today that intervene 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.

4.1.2 *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 support 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.

4.1.3 *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.

4.2 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 char-acteristics: 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 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.

5.1 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 3: Forecast theory below. The result below is based on data between 1976 to 2013 (patents), 1971 - 2013 (publications). In annex "Patent and publication search" is a description on the input that was used in the patent and publication search[6]. The projections extends until 2030 and is based on Fisher-Pry modelling[7]

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

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.

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

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

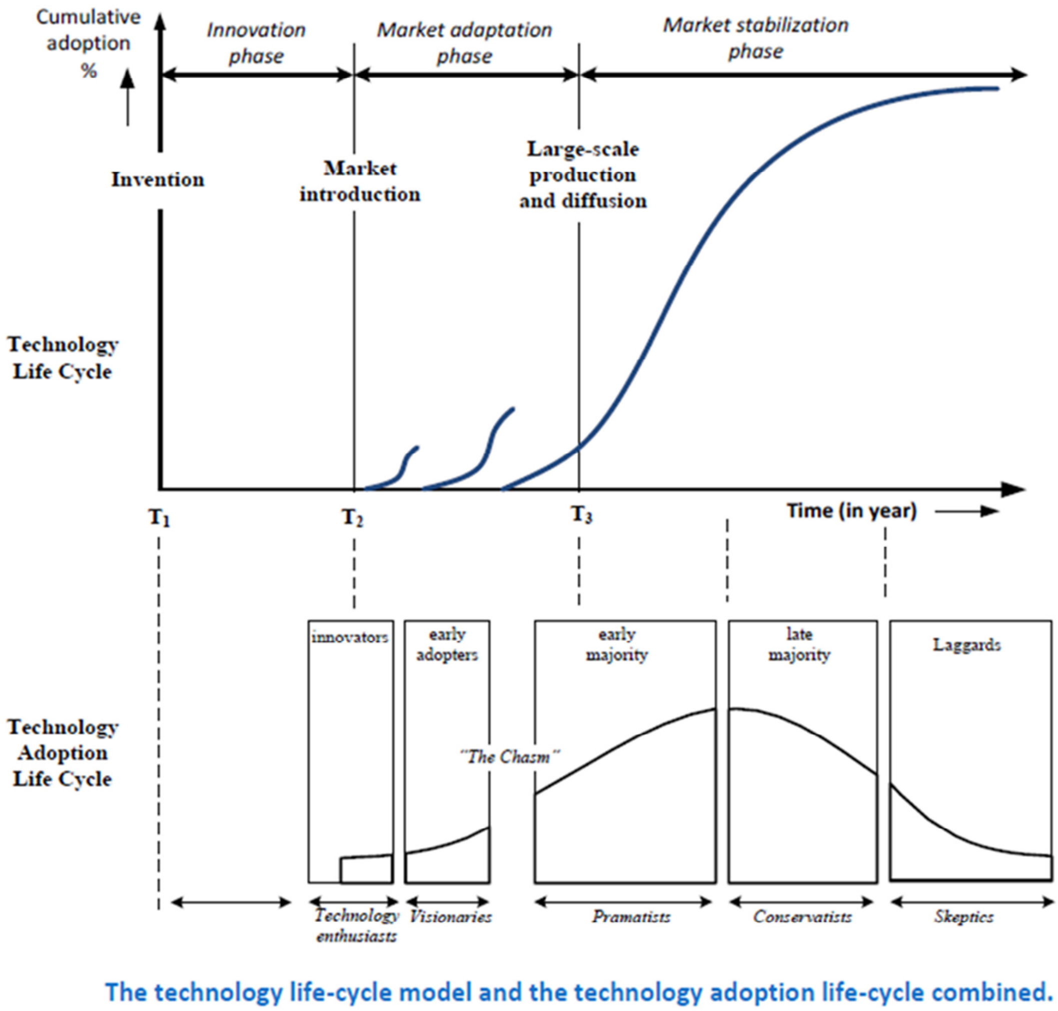

Figure 3: Forecast theory

5.1.1 *Patents*

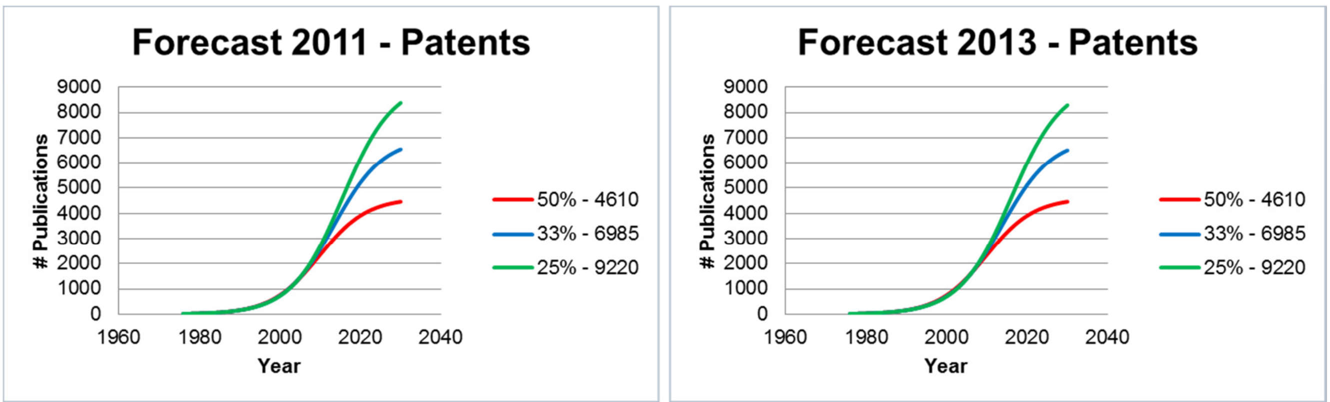

Figure 4: Patents forecast 2011 and 2013

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%)

5.1.2 *Publications*

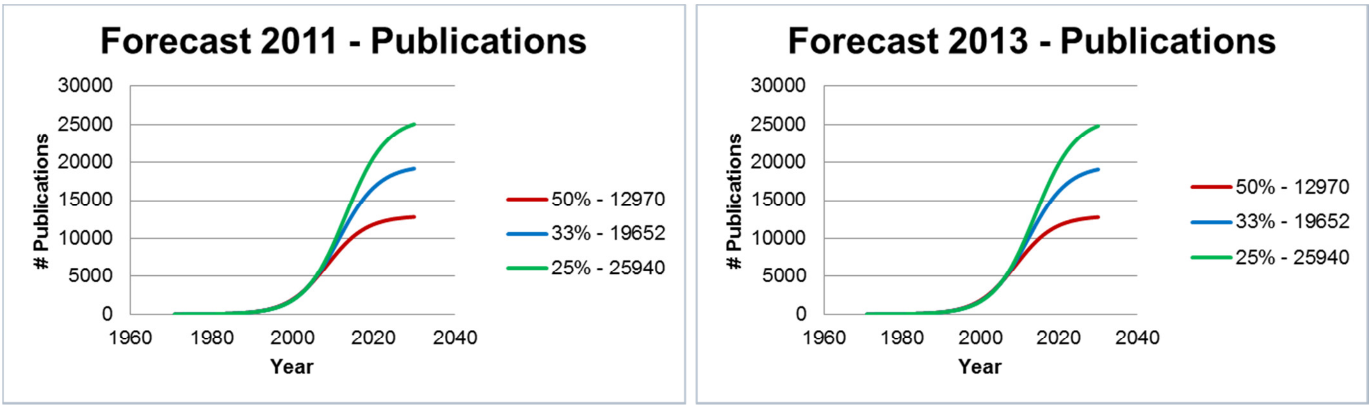

Figure 5: Publication forecast 2011 and 2013

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%)

5.1.3 *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.

5.2 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.

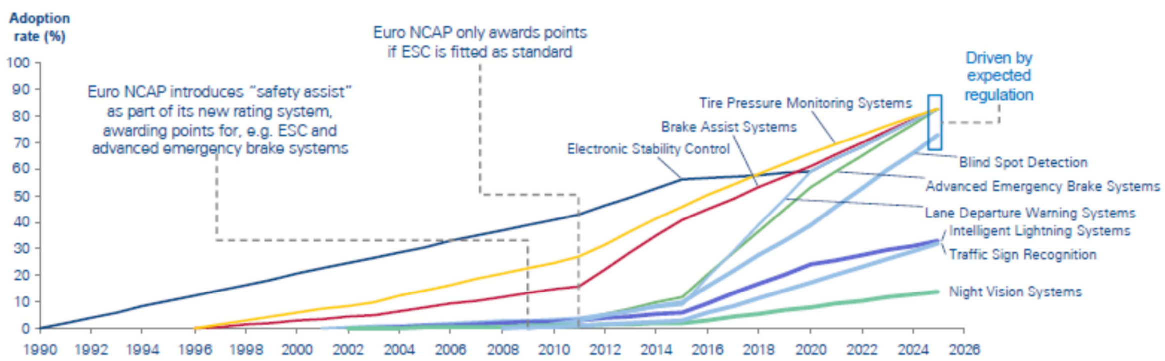

Figure 6: Global Penetration rates for active safety solutions in light vehicles[8]

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

[8] 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. No estimation on the likelihood and impact of the different paths will be included in this version of the document but will come in later versions.

The base for 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 comment EU view on the deployment following the methodology described in chapter 1.5.

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 5.2 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.

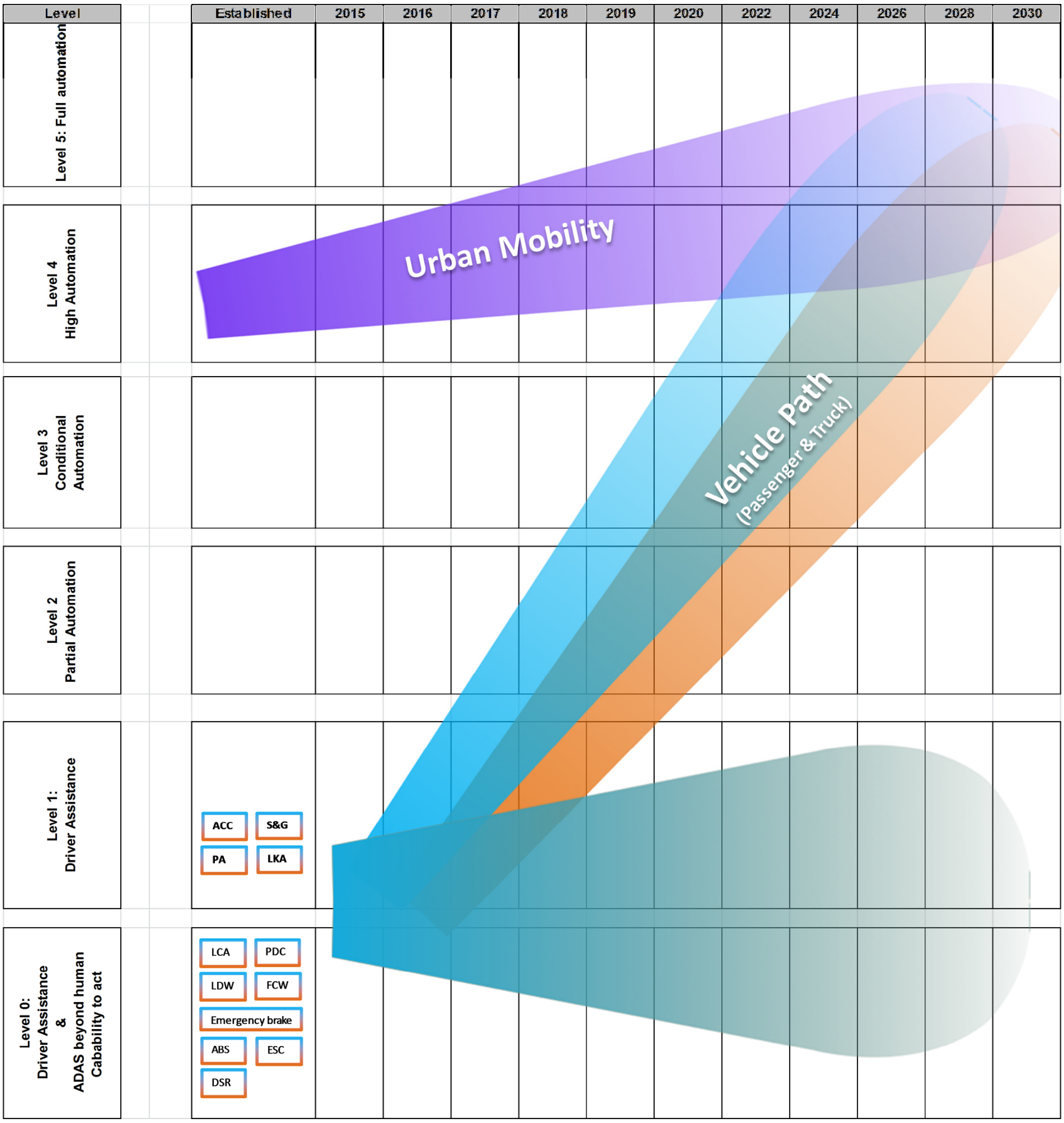

Figure 7: The main automation deployment paths

6.1 Urban Mobility Path[9]

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 late 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.

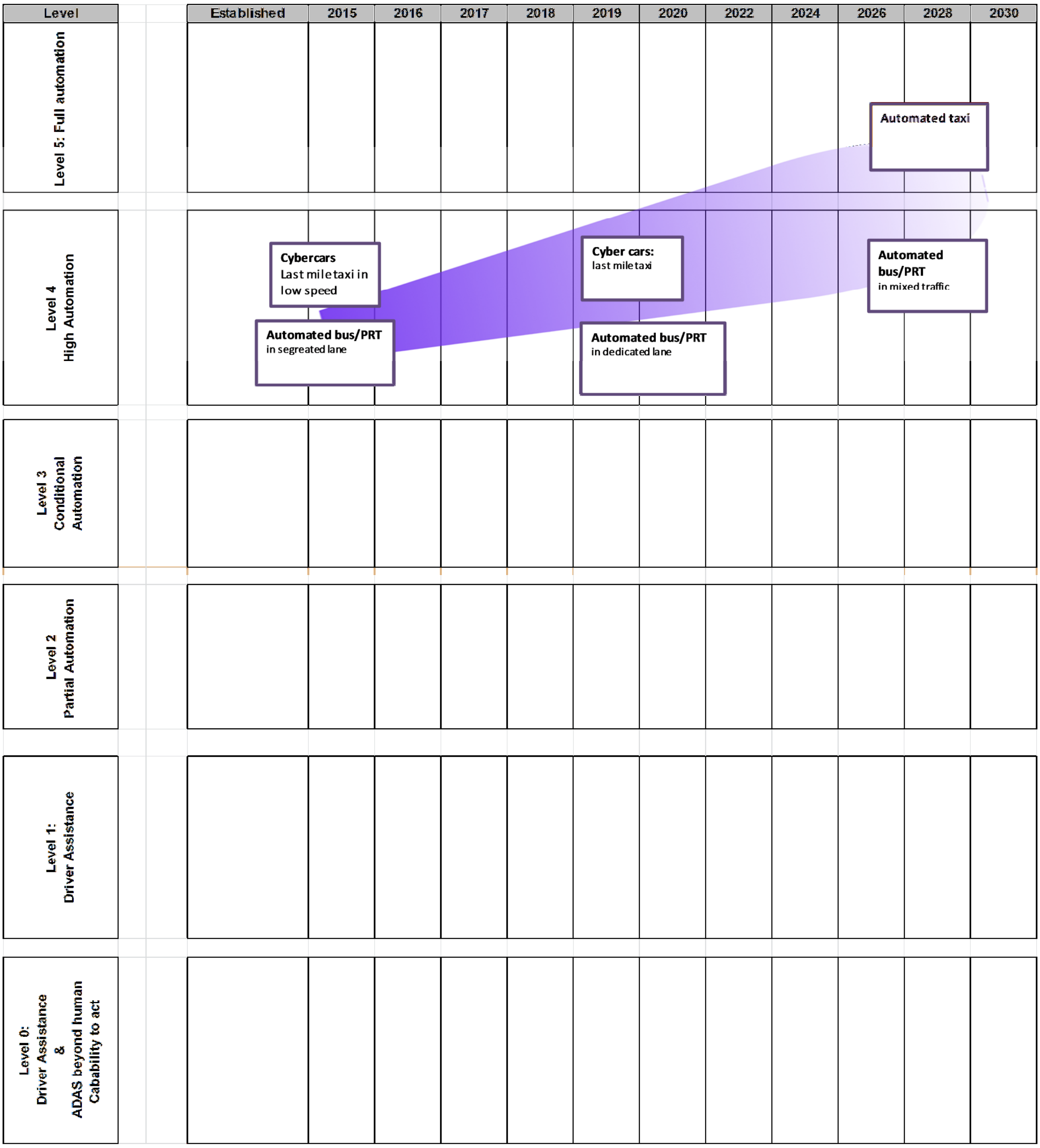

Figure 8: Low Speed High Automation Deployment Path

9 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 late 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 5.2.

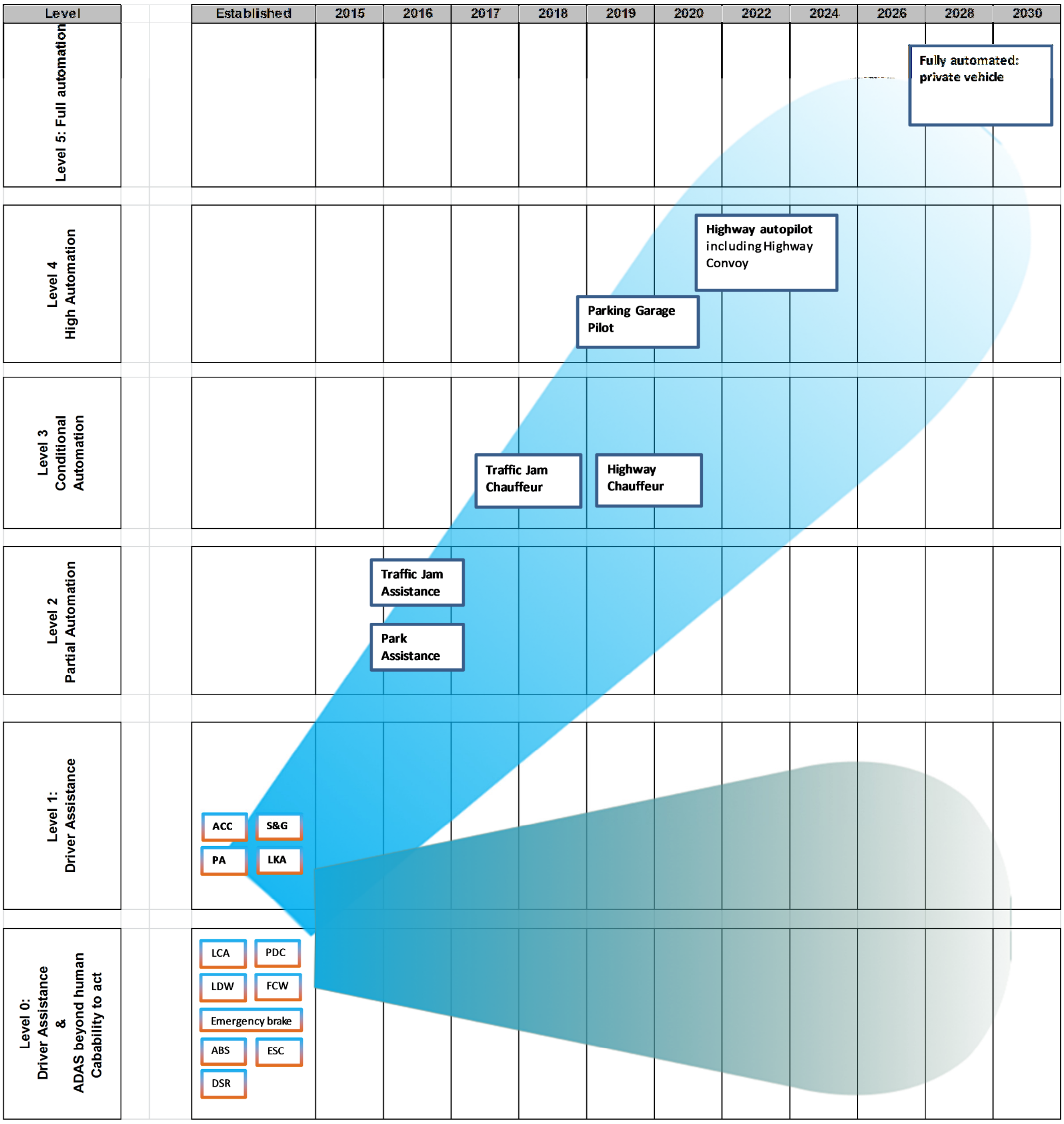

Figure 9: Automated Private Vehicle Deployment Paths

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 *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 late 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 5.2.

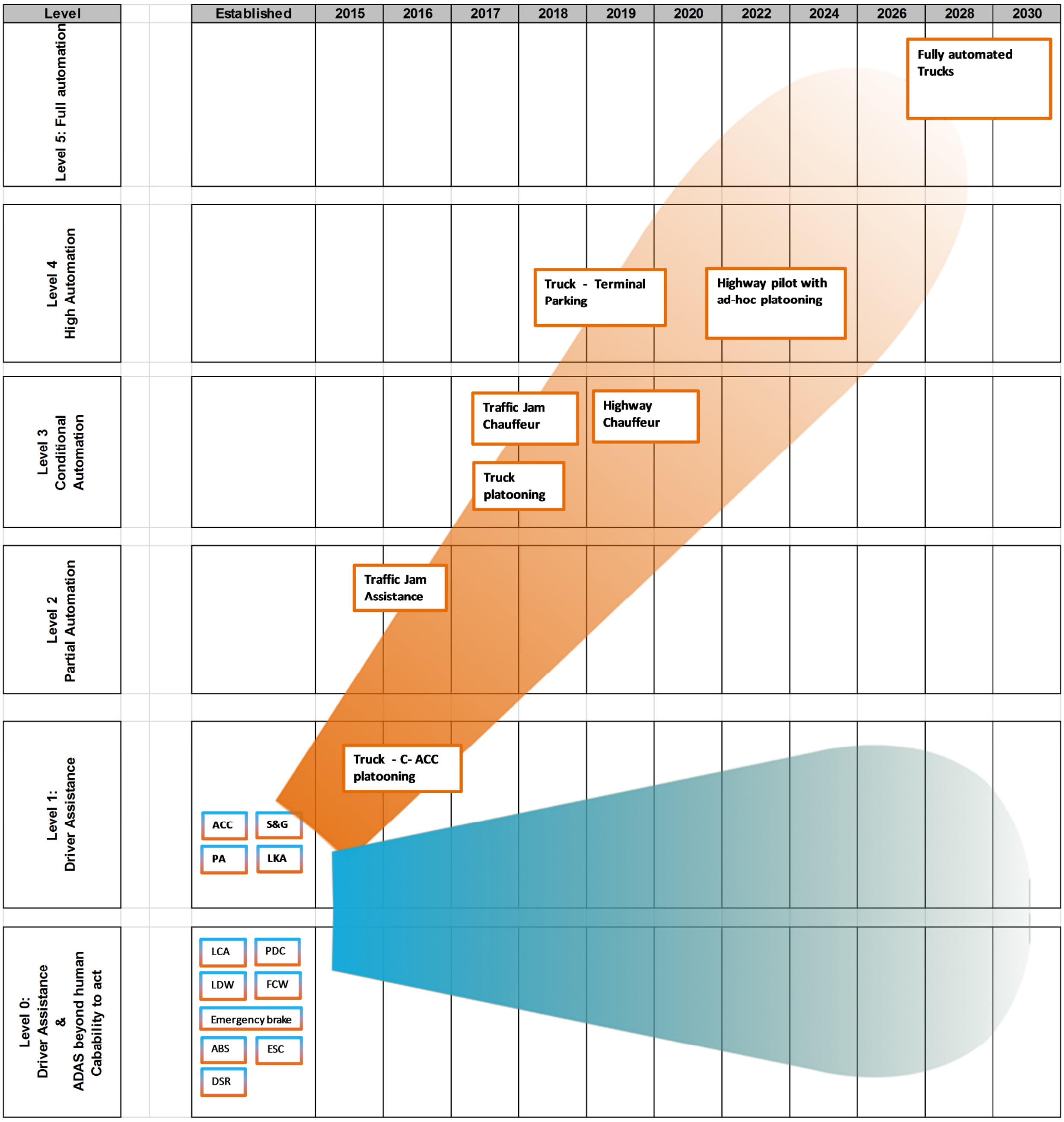

Figure 10: Commercial vehicles Automation Deployment Paths

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
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

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 D3.1.1 Draft 2.

Information in order to build the roadmap for the infrastructure will be collected from external sources. The following sources will be considered:

- FEHRL activities on Road Automation. The report "The Automated Road – A Roadmap for Research "[10] 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;

- 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 will be also collected considering the activity of TRAMAN 21[11]. 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

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

[11] http://www.traman21.tuc.gr/

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"[12] 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.

6.5 Main factors (barriers) for deployment

This chapter will be done in version 2 of the document

[12] http://www.traman21.tuc.gr/docs/wp1/TRAMAN21-D1-v4.pdf

7 Business models

This chapter will be completed D3.1.1 Draft 2 and it will contain a simple business model for some key applications.

8 Conclusions

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 main next step of the project is to have agreed estimates on market penetration of some key systems of each path. This is a key enabler for estimating the business case in chapter 7.

Annexes

Annex 1 – References

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

Patent and publication search

This chapter will be done in the second version of the document.