D7.6 – Initial Exploitation Plan & Report

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Table of Contents

1 Introduction

Automation in passenger cars is constantly increasing. Many automated functions have been developed for enhancing safety and efficiency of driving in the past. In order to continue this trend current roadmaps of OEMs and suppliers predict automated vehicles on highways by 2020. Fully and highly automated driving comprising also rural roads and inner-city situations will follow within the next decades. Nevertheless, humans will remain part of the system for a long time due to several reasons. First of all, at least in the next 10 years automation cannot cope with highly complex traffic situations, e.g. dense urban traffic.

In this context, the top-level objective of AUTOMATE is to develop, evaluate and demonstrate the "TeamMate Car" concept as a major enabler of highly automated vehicles. This concept consists of viewing driver and automation as members of one team that understand and support each other in pursuing cooperatively the goal of driving safely, efficiently and comfortably from A to B.

The results issued from Automate project will provide results and solutions:

- For flexible, gradual and smooth distribution of tasks between driver and automation to better handle critical driving situations.
- To monitor, understand, assess and anticipate the driver, the vehicle and the traffic situation.
- To allow the TeamMate Car to plan and execute driving maneuvers in a human expert-like way.
- To assess and guarantee safety of all manual and automatically generated maneuvers at any time.
- To optimize human-machine interaction.

This solutions will lead to many individual and collective results that should be further exploited by the partners to improve existing products or develop new products.

This deliverable is a preliminary version of project exploitation plan. It will address the following topics

- The Main project results and innovation potentials (see section 2). This section provides a first list and description of the partners results achieved during the first part of the project.
- The Market observation (see section 3), this section gives an overview of the AUTOMATE potential market considering automation road map, technological road maps, new comers, policies and Market share.
- The identification of potential customers (see section **Error! Reference source not found.**), presents the potential final customers, the vision of industrial partners (EOMS, Tier1, Tier2) but also from the VEDECOM innovation ecosystem
- The IPR management (see section **Error! Reference source not found.**) Presents a summary of project IP rules and an overview of the current IP status
- The exploitation strategy (see section 6), introduces a preliminary global consortium exploitation strategy and individual exploitation strategy
- The business Plan (see section 7) gives an preliminary overview about the Automate project business plan

2 Main project results and innovation potentials

According to the AUTOMATE description provided into the DOW, AUTOMATE is structured around six enablers, each of these enablers providing opportunities for innovations which are then focusing on:

- Driver & Situation Monitoring, Understanding, Assessment & Anticipation defining assessment as probabilistic recognition of the current state, and anticipation as prediction of the possible future states of driver, vehicle and situation (enablers 1,2,3)
- Adaptive & Safe Driving Strategies, considering the developments of algorithms for maneuver planning, execution & learning (Enabler 4) and the online risk assessment (Enabler 5).
- The development of techniques for driver-automation interaction and cooperation to ensure that the automation is perceived as the driver's transparent and comprehensible cooperative teammate (Enabler 6).

An overview of those results and innovation potentials is provided in Table 1 while a detailed description of these results and innovation is written in the next sections.

No.	Self-descriptive title of the result	Category A, B or C*	Partner(s) owning the result(s) (referring in particular to specific patents, copyrights, etc.) & involved in their further use
E1-1	Driver state monitoring including drowsiness, and visual attention	A	Continental Automotive CRF for applicative use
E1.2	V2X communication including V2X-based bird-eye view (Virtual HMI) and ITS infrastructure configuration	A	BIT
E2.1	Driver intention recognition	A	OFF
E2.2	Driver Cognitive Model (DCM) to select the appropriate maneuver	B	CRF
E2.3	Semantic Situation Enrichment (SSE)	A	DLR
E2.4	Drive Task Modelling (DriveGOMS)	A	DLR
E3.1	Situation and vehicle model	A	OFF - DLR
E3.2	Road Boundary based Safety Corridor (RBSC)	A	DLR

E4.1	Planning and execution of safe maneuver	A	ULM - VED
E4.2	Learning of intention from the driver	A	HMT - OFF
E5.1	Online risk assessment	A	OFF HMT
E6.1	Interaction modality	A	ULM
E6.2	Instrument Cluster	A	REL
E6.3	Audio HMI	A	REL
E6.4	Central Display	A	REL
E6.5	Ambient lights	A	ULM - REL
E6.6	Augmented Reality	A	HMT
E6.7	HUD	A	REL

Table 1: Project result overview

* A: results usable outside the consortium / B: results usable within the consortium / C: non usable results

2.1 Description of the result "Driver state monitoring"

This chapter provides an overview of the results which gives the reader an immediate impression of their nature, their relevance and potential benefits. Moreover, it briefly describes the current status/applications of the results.

No.	Self-descriptive title of the result
E1.1	Driver state monitoring including drowsiness, visual intention and cognitive distraction

WP	2

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Specific Result URL	

SUMMARY

The driver's state system developed by Continental is a vision based system which processes the video flow of the driver's face provided by one camera. From the image analysis the system detects and track facial features (eyelid, eye corners, mouth, etc.). The dynamics of these features are then analysed to determine online the following driver's state models:

1. Drowsiness
2. Visual Inattention/Distraction

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	x
Guidelines, methodologies, technical drawings	x
Software code	x
Database, Data Source	
Experimental development stage (laboratory prototype)	x
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 2.2	CO

2.2 Description of the result "V2X communication including V2X-based bird-eye view (Virtual HMI) and ITS infrastructure configuration"

No.	Self-descriptive title of the result
E1.2	V2X communication including V2X-based bird-eye view (Virtual HMI) and ITS infrastructure configuration

WP	2

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SUMMARY

The application developed by BroadBit is based on V2X communication and the information sharing mechanism of that. Information from both the vehicles and infrastructure elements are received, processed and presented directly to the driver through HMI as an upper, bird-eye view. The bird-eye view presents some relevant information about the ego vehicle (speed, heading, acceleration, geo-coordinates etc.), the environment of the ego vehicle and the relative distances of other communicating traffic participants. Important notification or warning messages are also shown (e.g. road works ahead), if any is received.
The HMI application will not be directly part of the vehicle's information system, it will run on a mobile device (e.g. tablet) and will be connected remotely to the V2X communication component on a wireless interface (e.g. Wi-Fi) through a gateway application.
The application is in specification phase, initial component developments are already started.

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ◻

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	X
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 2.2, Deliverable 2.3, Deliverable 2.4	PU

2.3 Description of the result "Driver intentions recognition"

No.	Self-descriptive title of the result
E2.1	"Driver intention recognition

WP	2

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Specific Result URL	

SUMMARY

This module provides the TeamMate vehicle with information about the probable overtaking resp. lane change intentions of a human driver in the current traffic situation. If the driver is in control, the module can be used to adapt the TeamMate HMI with context-dependent information, and trigger warnings resp. interventions. If the TeamMate vehicle is in control, the module can be used to enable the TeamMate vehicle to comply with the usual behavior of the driver and communicate when such compliance cannot be achieved.

The module is realized as a Dynamic Bayesian Network that models the statistical relations between potential maneuver intentions and the traffic situation. During runtime, the module performs probabilistic inference to calculate the probability distributions over different maneuver intentions given observed information about the current traffic situation provided by the TeamMate vehicle's sensor platform. The module is implemented as a C++ dynamic linked library, currently interfaceable with the OFF and ULM driving simulator in rural road scenarios (the Peter scenario), to be migrated to other driving simulators and scenarios.

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ☐

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	X
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 2.2, Deliverable 2.3, Deliverable 2.4	PU

2.4 Description of the result "Driver Cognitive Model"

No.	Self-descriptive title of the result
E2.2	Driver Cognitive Model

WP	3/5

CONTACT PERSON FOR THIS RESULT

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Specific Result URL	---

SUMMARY

The cognitive model is the central part of the driver model able to implement the Eva scenario according to description provided in AutoMate-Part_B-Section_1_2_3-Vs1.0 . In fact, this block assesses the traffic situation around the host-vehicle (HV) and then decides the optimal maneuver to act, providing at each step the information on the trajectory (to be followed) to the lateral and longitudinal components.
There are three "questions" that a decision module has to answer:

1. Is it intended to change lane?
2. Is this maneuver safe?
3. Is this maneuver necessary?

In our case we considered specifically the first two questions, while the third is related to motorway exits or when a braking action is not possible anymore.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	x
Guidelines, methodologies, technical drawings	x
Software code	x
Database, Data Source	
Experimental development stage (laboratory prototype)	
Prototype/demonstrator available for testing	X
Results of demonstration trials available	X
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
To be provided yet	Deliverable D5.3	CO

2.5 Description of the result ”Semantic Situation Enrichment”

No.	Self-descriptive title of the result
E2.3	Semantic Situation Enrichment (SSE)

WP	2

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SUMMARY

The semantic situation enrichment module extends scene objects provided by the perception layer with semantic information. This semantic information describes interaction between scene objects. Furthermore vehicles allowed manoeuvers are inferred. In this project we use ontology with logical rules and a reasoner to address this task. The ontology contains the taxonomy and relation of relevant scenes objects as pedestrian, road, vehicle, traffic light and signal. The logical rules describe basic traffic rules in urban scenes. We implement the *JNIOWLBridge* module to access the ontology and the reasoner in a C++ function, since the available OWL API and reasoner are only java implementation. The *JNIOWLBridge* therefore build a bridge between the available java OWL API and reasoner and our C++ module.

CURRENT STAGE OF DEVELOPMENT

□

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	x
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 2.4	PU

2.6 Description of the result" Drive Task Modelling"

No.	Self-descriptive title of the result
E2.4	Drive Task Modelling (DriveGOMS)

WP	2

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Specific Result URL	

SUMMARY

DriveGOMS is an empirical based formal description method of driver behavior. It can be used to analyze empirical driver behavior, to model interactions between drivers and automation or assistance systems, and driver performance.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	x
Guidelines, methodologies, technical drawings	x
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 2.4	PU

2.7 Description of the result" Situation and vehicle model "

No.	Self-descriptive title of the result
E3.1	Situation and vehicle model

WP	2

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SUMMARY

This module is used to predict the near future (e.g. the next ten seconds) temporal and spatial evolution of the traffic situation. Given the observed information about the current traffic situation provided by the TeamMate vehicle's sensor platform and a map of the road network, the module uses a combination of physical motion (i.e., vehicle) models and driver models to probabilistically predict the nonlinear evolution of the state of each traffic participant in the vicinity of the TeamMate vehicle.

The prediction of the temporal and spatial evolution of the traffic situation is a prerequisite for online risk assessment and is currently investigated for its potential to improve the driver intention recognition. The module is implemented as a C++ dynamic linked library, currently interfaceable with the OFF and ULM driving simulator in rural road scenarios (the Peter scenario), to be integrated in the ULM real vehicle demonstrator in future iterations.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	X
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

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Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 3.3, 3.5	PU

2.8 Description of the result" Road Boundary based Safety Corridor"

No.	Self-descriptive title of the result
E3.2	Road Boundary based Safety Corridor (RBSC)

WP	3

CONTACT PERSON FOR THIS RESULT

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SUMMARY

This module estimates the ego-vehicle safety corridor based on road and lane marking. The system first extracts map data from a map file in OpenDrive format. In the second step the ego-vehicle pose is matched into the map to get the ego-vehicle lane. Depending on the lane marking type, road boundaries polygons are sampled from the ego-vehicle lane. The ego-vehicle pose uncertainty is used as the uncertainty of the ego-lane center. After that we samples 2 lanes by shifting the ego-lane center with quantiles z_{δ_V} and $z_{1-\delta_V}$ of the given collision probability threshold δ_V and $1-\delta_V$. At the end we generated the Safety Corridor from road boundaries by sampling respectively the closest left and right lane markings from the 2 lanes sampled above.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	x
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 3.5	PU

2.9 Description of the result" Planning and execution of safe maneuver"

No.	Self-descriptive title of the result
E4.1	Planning and execution of safe maneuver

WP	3

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SUMMARY

This module will calculate trajectory to guide a vehicle safely and comfortable through the environment. The trajectory consists of six states and will be sent to the vehicle controller after calculation. The concept consists of a local continuous optimisation problem, the solver routine is written by ULM, and this has the big advantage that we have insight in the whole code, what is very advantageous for debugging issues. The code is written in C++ and currently still in progress.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	x
Database, Data Source	
Experimental development stage (laboratory prototype)	
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 3.3, 3.5	PU

2.10 Description of results ” Learning of intention from the driver”

No.	Self-descriptive title of the result
E4.2	Learning of Intentions from the Driver

WP	3

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Specific Result URL	

SUMMARY

The Machine Learning Algorithm is able to learn preferences of drivers for various driving manoeuvres, e.g. overtaking manoeuvres (e.g. gap size). It enhances driver intention recognition by adaptive capabilities.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	X
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 3.3, 3.5	PU

2.11 Description of the result "Online Risk Assessment"

No.	Self-descriptive title of the result
E5.1	" Online Risk Assessment"

WP	5

CONTACT PERSON FOR THIS RESULT

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Specific Result URL	

SUMMARY

This module transforms the prediction of the temporal and spatial evolution of the traffic situation into safety corridors that specify regions in which the TeamMate vehicle can travel without risk of collisions. These safety corridors can be used by the TeamMate vehicle to plan safe and feasible trajectories and/or assess the safety of potential trajectories in respect to potential collisions with other traffic participants.

The module is implemented as a C++ dynamic linked library, currently interfaceable with the OFF and ULM driving simulator in rural road scenarios (the Peter scenario), to be integrated in the ULM real vehicle demonstrator in future iterations.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	

Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	X
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 5.3, Deliverable 5.5	PU

2.12 Description of the result "Augmented Reality"

No.	**Self-descriptive title of the result**
E6.6	" Augmented Reality HMI"

WP	**6**

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Specific Result URL	

SUMMARY

To follow the TeamMate approach, it is necessary to provide a shared understanding of the current situation between the driver and the automation. Though current HUD only display information, next generation HUD will make use of Augmented Reality to project information in such a way that it looks like it is part of the real environment. The main objective of the Augmented Reality HMI is to improve the cooperation between the automation and the driver. This means that the Augmented Reality HMI should provide a better situation understanding so that the driver understands the behavior of the automation. The information of the HMI helps the driver to understand the current situation and why the automation acts in a certain manner.

HMT uses the Augmented Reality HMI in different contexts, to extend the perception of a driver and to increase the confidence in the actions of autonomous vehicles. At this moment, the Augmented Reality HMI works only in autonomous mode and supports the driver. In the next cycle, the scope of the Augmented Reality HMI is extended by the integration with the Head-Up Display and integration into manual mode.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	X
Prototype/demonstrator available for testing	
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

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Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Preliminary description	Deliverable 5.3, Deliverable 5.5	PU

2.13 Description of the result "Overall HMI concept", including Instrument Cluster, Audio HMI, Central Display (or external tablet) and HUD

No.	Self-descriptive title of the result
E6.2 – E6.3 – E6.4 – E6.5 – E6.7	Overall HMI concept, including Instrument Cluster, Audio HMI, Central Display (or external tablet) and HUD

WP	4

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Specific Result URL	

SUMMARY

The HMI concept designed and developed in AutoMate allows to both team members (i.e. drivers and automation) to complement each other during the cooperation. In fact, in addition to the traditional warning-based HMI used by the automation to support the driver (e.g. by providing warnings when then driver is distracted to bring him/her back into the loop), the innovative HMI concept of AutoMate applies a negotiation-based paradigm of interaction that allows the automation to ask for support to the driver if needed (i.e. when it is about to reach its limits). By applying this novel concept, Automate prevents the safety-critical situation (known as "disengagement") in which the automation unexpectedly hands over the control to the driver because it is not able to deal with the complexity of the real world.

The overall HMI strategy has been developed by considering different components that have specific roles to implement the cooperative HMI concept, in both direction of support (from the driver to the automation and from the automation to the driver):

- *Instrument Cluster: to adapt the information according to the driving mode - in manual mode the cluster is mainly used to support the driving, while in automation mode, the cluster will be used to highlight the approaching to critical situation the automation may not be able to deal efficiently (e.g. roundabouts).*
- *Audio HMI: to allow the automation to ask for support in a human-like style that does not distract the driver from the main driving task.*
- *Central Display (or external tablet): to provide safety-critical information on a secondary display the driver is using in automation mode (when he is not expected to monitor the Instrument Cluster).*
- *HUD: to deliver situation-related information without distracting the driver from the main driving task (the HUD is used as an alternative to the Augmented Reality developed by HMT).*

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	x
Guidelines, methodologies, technical drawings	x
Software code	x
Database, Data Source	
Experimental development stage (laboratory prototype)	x
Prototype/demonstrator available for testing	x
Results of demonstration trials available	
Other (please specify.):	

DOCUMENTATION AND INFORMATION ON THE RESULT

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Description of 1st version	Deliverable 4.2	PU
Description of 2nd version	Deliverable 4.4	PU

3 Market Observation

AUTOMATE addresses the market of safety enhancing vehicle automation systems. The TeamMate Car technology will significantly increase drivers' acceptance of and trust in highly automated systems. This will boost the willingness to buy such systems accelerating the market development for such technologies. Many factors can influence the Driver assistance and vehicle automation market, considering that it is very dynamic and rapidly changing market. National and EU policies are strongly focusing on the improvement of road safety and efficiency. New regulations provided by National government and EU are of course one of the major factors for the deployment of more and more sophisticated assistance function. (e.g. From 1 November 2015, all new trucks and buses must also be equipped with advanced emergency braking systems as well as lane departure warning systems).
The European evaluation program for Automotive (EURONCAP) and its star rating system is also strongly pushing forward the car manufacturers to integrate ADAS technologies into the new automobiles as far as they want, mainly for marketing and differentiation issues, to achieve the highest rating.
Moreover new actors are now involved in that market. This new players are pulling forward innovations and introduction of more and more automated vehicles on the road (Google, Tesla…).
Last and not least, the ADAS and autonomous vehicle market is supported by technological breakthrough and driven by very ambitious road maps provided by both car manufacturers and suppliers.

3.1 Automation road maps

There is no doubt that Autonomous driving is a strategic objective for automobile contributors. Some journalist may talk about a market of more than 500 billion of euros in 2035. Others talk about a future with only Automated Driving. As Henrik Christensen, director of the University of California San Diego's Contextual Robotics Institute, who has prophesied for the next generation: "My own prediction is that kids born today will never get to drive a car." His forecast, which he shared in December 2016 in an interview with The San Diego Union-Tribune, is rooted in signs that the auto industry is racing toward a driverless future. "Autonomous, driverless cars are 10, 15 years out," he said. "All the automotive companies—Daimler, GM, Ford—are saying that within five years they will have autonomous, driverless cars on the road."
Meanwhile, analysts expectations are often less enthusiastic with, for example, a production of only 21 million autonomous vehicles to reach the roads by 2035.

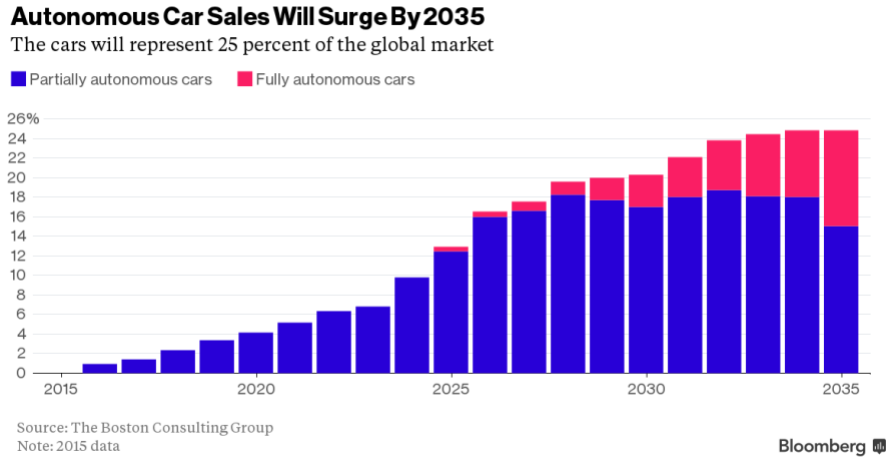

Figure 1: The Boston Consulting Group

It is, therefore, a race between manufacturers and equipment manufacturers that spans over a period of more than 20 years (≈ 2005-2035).
The Society of Automotive Engineers (SAE) was giving the next road map (link) in 2013.

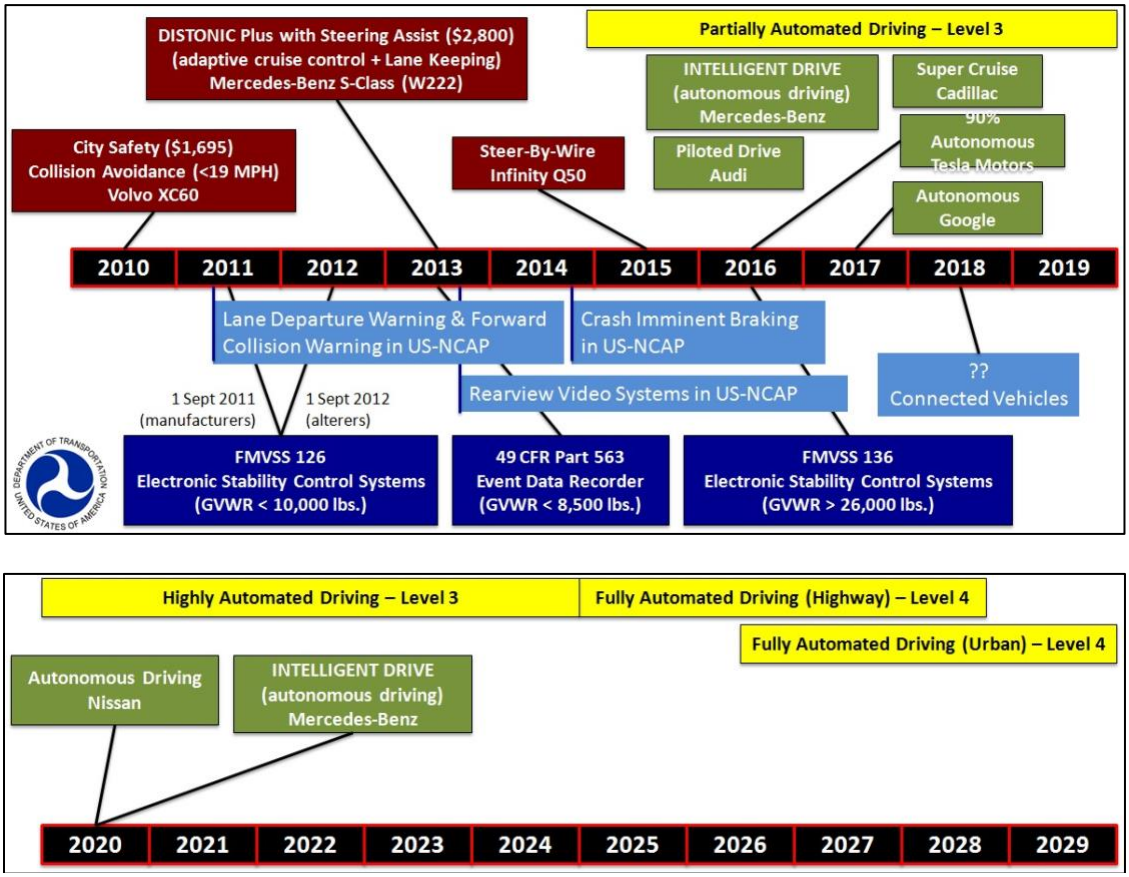

Figure 2: RoadMap given by the SAE

In order to have a better comprehension of the current road map, we propose the next press review to quickly see the global expectations of those who are implicated in the Autonomous Driving race.

Quick press review

It is interesting to note that some manufacturers will proceed by an incremental or gradual implementation (L2>L3>L4) like Audi ; Tesla ; Mercedes ; BMW ; Groupe PSA ; Nissan…
While others talk to skip Level 3 and directly jump from Level 2 to Level 4, like Ford ; Volvo ; Honda… Link - Linkedin
For the next quick press review, we identified a non-exhaustive list of 24 companies developing road going self-driving vehicles. They are a diverse group of players, ranging from automotive industry stalwarts to leading technology brands and telecommunications companies.
We show their different forecasts and due date for the Autonomous Driving.
This list is organized alphabetically, and mainly comes from the following link: Link - cbinsights (May 2017).

Apple: Apple's "Project Titan" has been a perennial favorite within the automotive rumor mill. Initial reports suggested the project was targeting an advanced electric vehicle, but the initiative suffered setbacks in early 2016, with the departure of project head Steve Zadesky and a rumored hiring freeze, as well as strategic uncertainty over the vision of the project.
July 2016, the project said to be prioritizing the development of an autonomous driving system. In **April 2017**, details emerged confirming this pivot, with Apple documents detailing an "automated system" and the company hiring robotics experts from NASA.

Audi: Audi has revealed several autonomous vehicle prototypes derived from their A7- and RS7 models, including consumer-oriented test vehicles.
Audi plans to commercialize its technology in its next-generation A8 flagship, although the vehicle's SAE Level 3 (conditional) automation will have limited availability pending regulatory approvals.

Autoliv and Volvo: The Geely-owned Volvo car brand has also made progress with self-driving passenger vehicles. The company has stated that it will accept full liability when its vehicles are in autonomous mode, and has announced plans to expand its pilot program to China and the United States. Volvo has followed rivals like BMW in setting 2021 as a target deployment date.
After searching for collaborators to work with, Volvo announced a self-driving joint venture with Swedish supplier Autoliv in January 2017. Dubbed Zenuity, the joint venture is aiming to commercialize its first driver assist systems by 2019, also making them available to other automakers.

And more recently, a new partner is name of NVIDIA also joined Zenuity.

Baidu:In June 2016, Baidu CEO Robin Li disclosed a five-year goal for the mass production of driverless vehicles. The search giant has opened a Silicon Valley AI research lab, although Andrew Ng (its chief AI scientist) departed the company in March 2017.

BMW: BMW has begun aggressively pushing its autonomous strategy, showing off an autonomous i8 concept at CES 2016 and announcing a formal initiative to promote automation in its vehicles under the banner BMW iNEXT, a pivot of its BMW i EV sub-brand.

The Munich-based automaker followed this announcement by securing an alliance with Intel and Mobileye. The coalition plans to create an open standards-based platform for bringing self-driving cars to market, aiming to put vehicles on the road by **2021**.
In May 2017, Delphi also joined the alliance, followed by Continental and Fiat in August 2017.

Bosch: The company has projected that self-driving cars will be in action by **2020**, at least on highways.
Since April 2017, Mercedes and Bosch have joined forces to develop Level 4 (high automation) and 5 (full automation) vehicles, with Mercedes having two years of exclusivity on the co-developed system before it can be offered to competing automakers.

Continental AG: The company committing to a "**2020s**" timeframe for its products, and preferring to gradually roll out driver-assist technologies such as its "Cruising Chauffer."

Ford: In early 2015, Ford announced its "Smart Mobility Plan" to move the company forward on innovation, including vehicle connectivity and autonomous vehicles. The company plans to roll out highly autonomous vehicles within pre-mapped, geofenced areas by **2021**.
Its biggest move yet came in February 2017, when Ford announced that it would take a majority stake in AI startup Argo.

General Motors: GM and Lyft are planning to deploy thousands of self-driving Bolts beginning in **2018**. However, despite GM's investment and deepening partnership, the relationship is not exclusive, with Lyft and Waymo inking a separate deal in May 2017 to collaborate on their own self-driving pilot projects.
Separately, GM has also been developing its own semi-autonomous technology in-house, with its delayed Super Cruise finally slated for launch in the **2018** Cadillac CT6.

Chinese telecommunication giant Huawei has shifted resources toward the development of autonomous vehicles.
Huawei partnered with Vodafone to demonstrate some of their latest innovations at the 2017 Mobile World Congress in Barcelona, including cellular technology used to connect cars called Cellular V2X (C-V2X).

Nissan/Renault: At April's New York Auto Show, Chairman and CEO of Nissan and Renault Carlos Ghosn promised that the group would have 10 vehicles on sale by **2020** with "significant autonomous functionality." Nissan unveiled its first public prototype in 2013 at the Nissan 360 event in California, and has since been testing an autonomous Nissan LEAF on the roads of Tokyo. Nissan and Toyota also announced a joint effort to develop standardized "intelligent" maps, perhaps in response to German automakers' acquisition of the mapping company HERE.

Samsung: The Korean tech giant secured a May 2017 permit from South Korea's transport ministry to begin testing self-driving cars on the nation's public roads. Samsung's self-driving cars are based on Hyundai vehicles equipped with cameras and sensors.

PSA Groupe: In April 2016, French PSA Groupe (including Peugeot, Citroën and DS) announced that two Citroën cars had driven "eyes off" from Paris to Amsterdam. The vehicles navigated over 300 km (186 miles) without supervision on "authorized stretches" of road, with PSA claiming the cars had achieved Level 3 Automation in this mode. The "eyes off" mode is slated to arrive by **2021**, while semi-autonomous "hands off" modes will be available by **2020**. These features, along with electric vehicles and new models, form the core of PSA's broader "Push to Pass" growth strategy (including a return to the US).
In May 2017, PSA and nuTonomy become partners to test autonomous car in Singapore.

Tesla: In the public eye, EV manufacturer Tesla has become a leading banner-carrier for advanced driver assistance and self-driving technology. Tesla pushed its "Autopilot" software update to properly equipped Model S vehicles in October 2015, enabling auto steering, lane changing, and parking features. Tesla's deployment strategy and messaging were criticized following a series of crashes and its first Autopilot-driven fatality in summer 2016, although the NHTSA's official report was favorable towards Autopilot and did not find a safety defect.
Tesla promises to bring semi-autonomous and autonomous features to the mass market with its much-hyped Model 3, which has attracted over 400,000 pre-orders.
Since October 2016, all Tesla vehicles have been built with Autopilot Hardware 2, a sensor and computing package the company says will enable "full self-driving" capabilities once its software matures. The system has traded Mobileye's EyeQ3 for Nvidia's Drive PX 2 platform, and requires an activation fee to unlock the full autonomy promised.
In typical fashion, Elon Musk has promised an aggressive timeline for full self-driving capability, with the feature slated for release **by the end of 2017.**

Toyota: The company **has targeted 2021** as a goal for deploying "AI car features" to the road.
The institute showcased its latest autonomous research platform in March 2017.

Valeo: Like many other suppliers, Valeo has been working on its own ADAS and self-driving systems, with the company's innovation chief tapping autonomous driving as Valeo's main growth driver by **2020**. The auto supplier showed off its eCruise4U automated concept at CES 2017, equipped with connected camera and laser sensors as well as a reconfigurable cockpit.

Volkswagen: The Group's head of digitalization asserts that self-driving cars will be "commonplace" by **2025**.

The Google Self-Driving Car Project has been one of the most iconic and tenured autonomous vehicle programs.
Through 2016, Waymo's testing expanded beyond Mountain View and Austin to Kirkland, Washington in February (wet, rainy conditions), and Phoenix, Arizona in April (high temperature, dusty conditions). Google also found its first automotive partner in Fiat Chrysler Automobiles (FCA), which remains its only disclosed OEM partner as of May 2017. The new Alphabet company publicly revealed its custom-designed self-driving hardware in February 2017, planning to sell an integrated hardware and software package. In April 2017, Waymo opened signups for the first public tests of its customized Chrysler Pacifica minivans, quickly followed by the aforementioned Lyft partnership.

Thus, we note common deadlines for SAE Level 3 between 2018 and 2021. Afterward, Autonomous driving with level 4 will rather be between 2020 and 2025.

3.2 Technology road map

There are still many barriers limiting the development of autonomous vehicles which should have a direct impact on the Vehicle automation road map:

- Technical obstacles like for example Vehicle localization or Obstacle detection still need improvements to guarantee a safe and reliable automation
- Legislative, responsibilities and new economic models are also to be discussed either re-invented
- Last but not least Human Machine relation in terms of situation awareness, acceptance, and management of the takeover situations…must be re-defined.

The Automate project is elaborating some original technological solutions mainly addressing technical and obstacles and Human machine relations that should help to remove some of these obstacles.
The autonomous vehicles architecture includes 3 main steps: Sense, Plane, Act (*Figure 3*). These levels are supported by 5 main components (*Figure 4*): Sensors, processors, software algorithms, mapping, and actuators. Some of those components are rather mature or close to, on the other hands other components like embedded data processing and system management are still under construction.

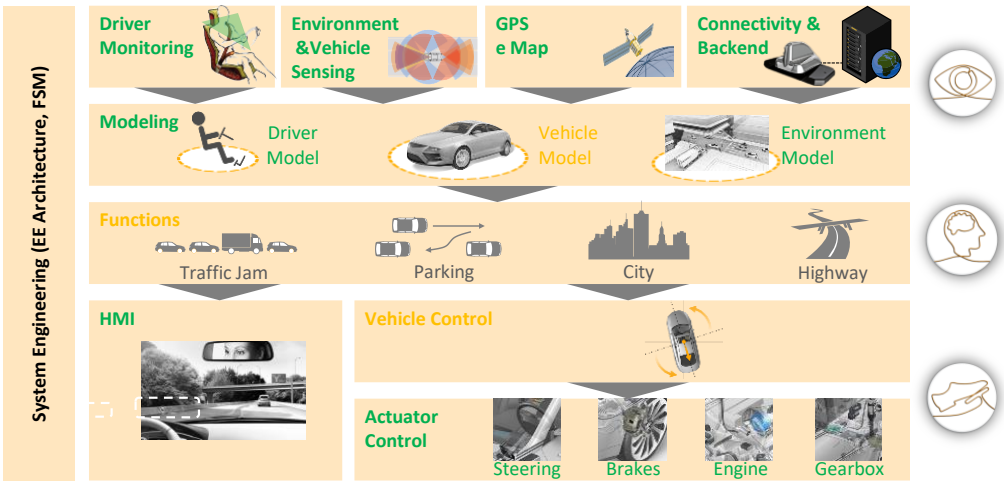

Figure 3: System engineering technology: Sense, Plan, Act

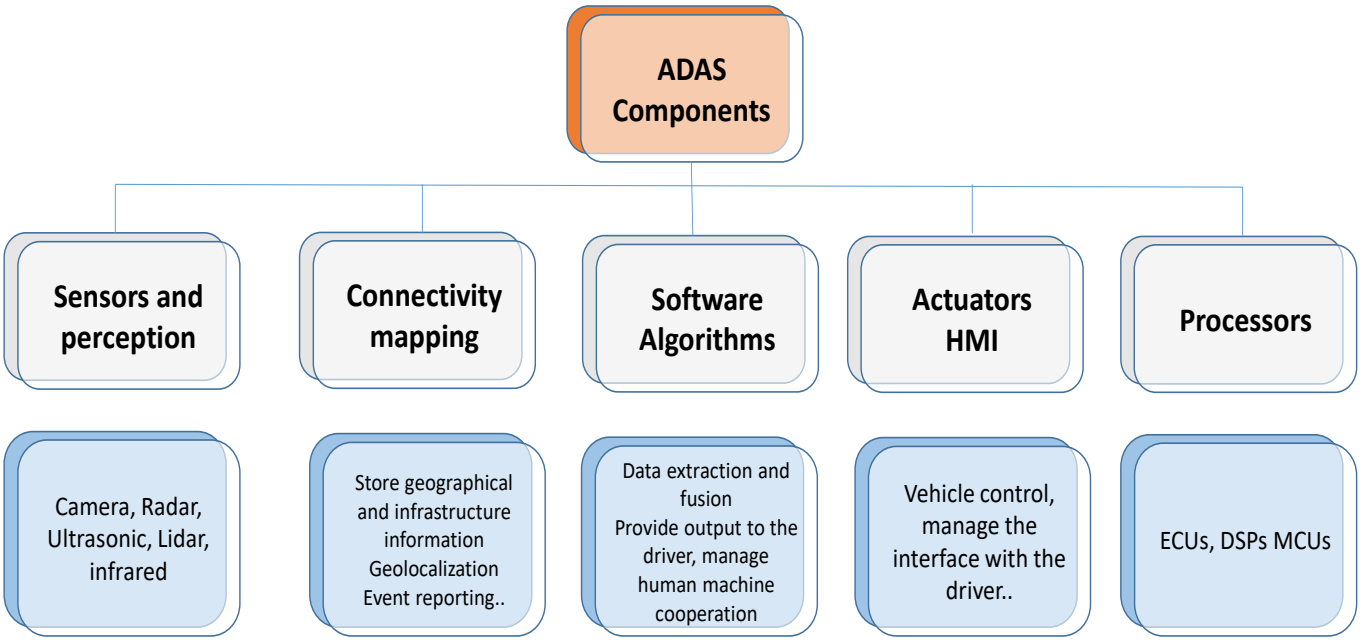

Figure 4: Segmentation of ADAS technology roadmap by components

- Actuators are mature technologies taking profits of the years of vehicle electrification and embedded electronics.
- Sensing technologies and perception: Since more than 15 years, thanks to the development of ADAS functions, an important focus has been brought to the development of embedded sensing technologies providing reliable information about the inner and outside vehicle environment. Sensor technologies are now reaching rather mature solutions (Camera, Radar, and Ultrasonic) and are following a continuous improvement process (improvement of resolution, FoV, dynamic

range). This penetration rate, even if it is still quite low, is continuously increasing, supporting the deployment of ADAS functions (see figure hereafter). Nevertheless some technologies like Thermal Cameras, LIDAR, and dead reckoning are still not to the point in terms of performances/reliability/costs and would need strong focuses within the next years.

- Connectivity, Mapping and data management penetration rate is currently mainly limited by harmonization problems has well as bandwidth and storage capacities. Furthermore, preservation of data security is a critical issue that refrain the penetration rate.
- Processors: The development of the processors (ECUs) has also an important impact onto the penetration rate. Despite the handsome development of processing power the request to run the embedded SW and the more and more sophisticated embedded algorithms is growing dramatically.

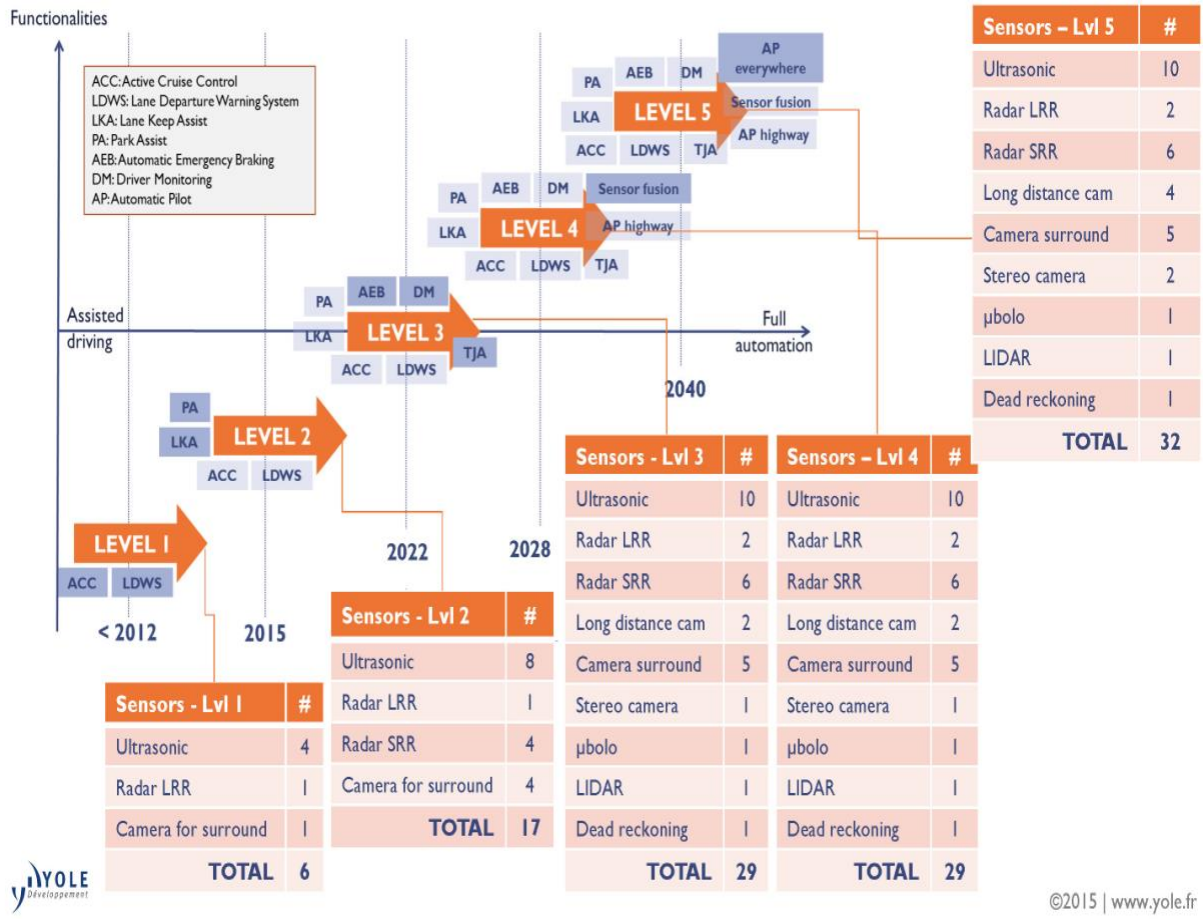

Figure 5: Sensor technology road map and associated autonomous functions (Source: Sensor & data management for Autonomous Vehicles report, Oct 2015, Yole department)

The Automate project makes use of those mature/existing components and focuses on breakthrough and innovative software solutions and algorithms to provide output to the drivers, to define how the system should intervene or behave.

Within Automate a technical approach including 6 enablers have been set that should all have a direct impact on Vehicle automation technology road map.

- E1) Data fusion for Driver and situation Recognition
- E2) Driver Modelling and learning
- E3) Vehicle and situation model

The main objective of these three first enablers is to develop and provide efficient and reliable solutions to monitor, understand, assess and anticipate the driver vehicle and traffic situation.

- E4) Adaptive Maneuver planning execution and learning allowing team mate car to plan execute driving maneuvers in a human expert way (learning and adapting performances to actual driving behavior)
- E5) On line risk assessment to assess and guarantee safety of all manual and automatically generated maneuver at any time
- E6) HMI and Interaction for flexible, gradual and smooth distribution of tasks between driver and automation to better handle critical situation

The technology advanced produced within Automate should progressively be implemented into automated vehicles (Figure 6):

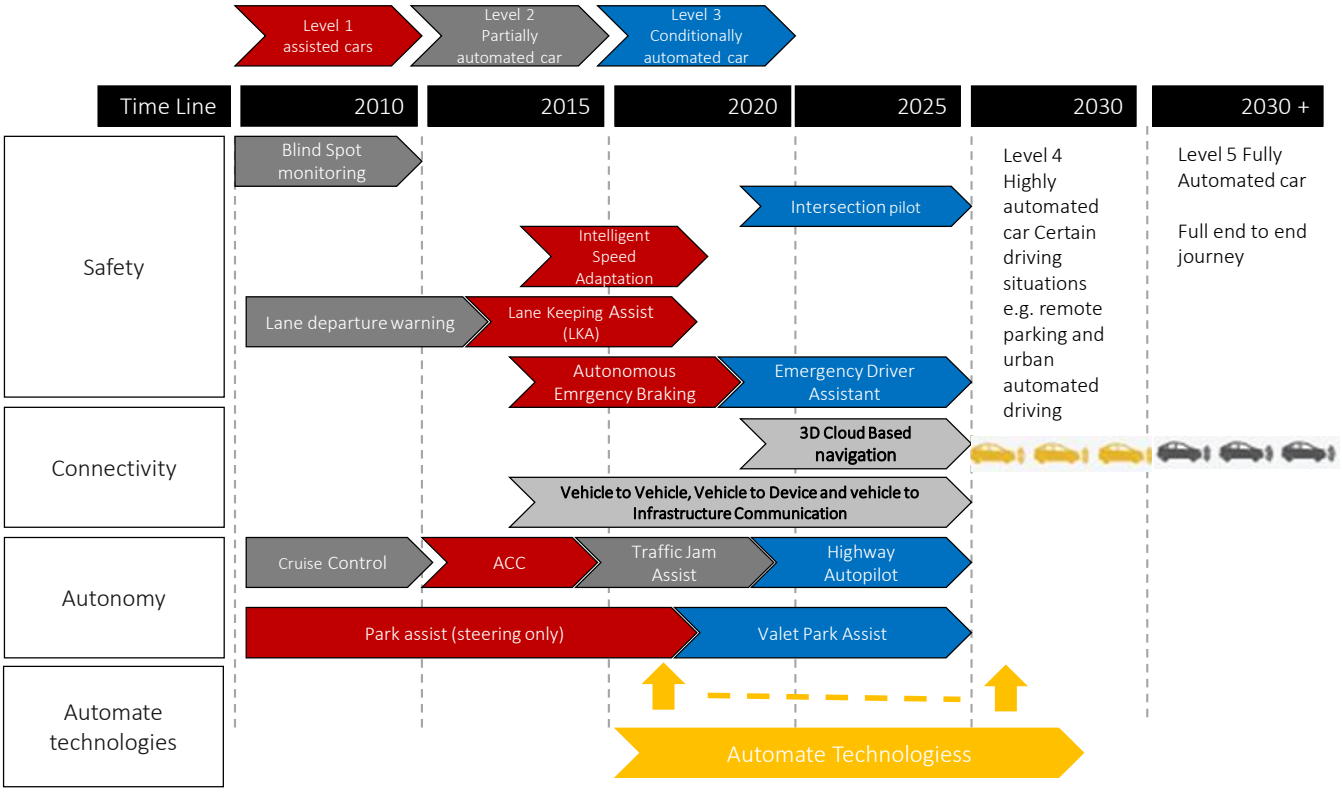

Figure 6: Impact of the Automate technologies on automated vehicle road map

In a short term, a simplified version of the Automate technologies able to handle very simple situations can be integrated in the releases of already existing/commercialized assistance functions (automation level 1 according to the SAE classification) improving their acceptability and performances. For example, advanced ACC and LKA ADAS should integrate simple models able to learn and automatically reproduce

driver's individual driving style with regard to TTC, lane positioning behaviors, accelerations, decelerations, etc. (considering that some drivers prefer to respect larger TTC than others or that some would prefer to driver closer to the right line than the left).
In a medium term, higher automation levels should be addressed when the system performs both lateral and longitudinal control, in specific situations, like for example traffic jam assist (automation levels 2 and 3). Team-Mate technologies should be applied to model the driver's driving behaviors in more complex situations (e.g. in takeover situation, obstacle avoidance, roundabout) and of course to learn safe and legal driver's maneuvers in order to improve the efficiency of the automation. Driver attention should also be considered to manage the task sharing between the driver and the system. Furthermore, the system could interact with the driver asking it for decisions (e.g. "Should I take over the vehicle ahead?") or information when it has to deal with unknown situation. Specific design for HMI will be introduced in order to support the bilateral communication between the driver and the system, i.e. informing the driver about the task distribution, the intended maneuvers or re-questing information from the driver.

3.3 New comers

For decades OEM had the full responsibility for producing cars supported by Tier X suppliers in a pyramidal organization where the OEMS occupied the summit; the situation is now dramatically changing with the development of autonomous and connected vehicles. New actors coming from outside or formerly poorly involved in the automotive application field like online players, telecom companies, devices manufacturers an high tech companies (nVidia..), SW suppliers (Google-Waymo…) are now involved in the development of the vehicle of the future. Most of them are attracted by tremendous innovation and financial potential of this new market. Other actors already involved the the automotive application field mostly has tier 2 or 3 are now competing as tier one (Intel-Mobileye).
Each of these new players bring their competences to build up these new generation of vehicles leading to a much more diverse and fragmented landscape of automotive business models(Figure 7 & Figure 8).In addition new OEMs actors like Tesla appeared on the market. Some of these new actors are also introducing new business models: Tesla upgrades its cars like Apple updates iPhones – over the air providing new functionalities to the end user, "The car will also not be sold over an upfront purchase price. We envision that a Google or Apple car will be financed by pay per use, fees, flat subscription prices, or licensing"[2].
New alliance are created involving both existing players in the automotive industry with new entrants to offer value-added services, for example:

- BMW is associated with Intel- Mobileye they are involved in the development of future automotive vehicles, but also with Apple on the connectivity for its future vehicles.
- Continental is working with Google and IBM for the development of self-driving cars

[2] ATKearney : How Auto makers can survive the self-driving era report

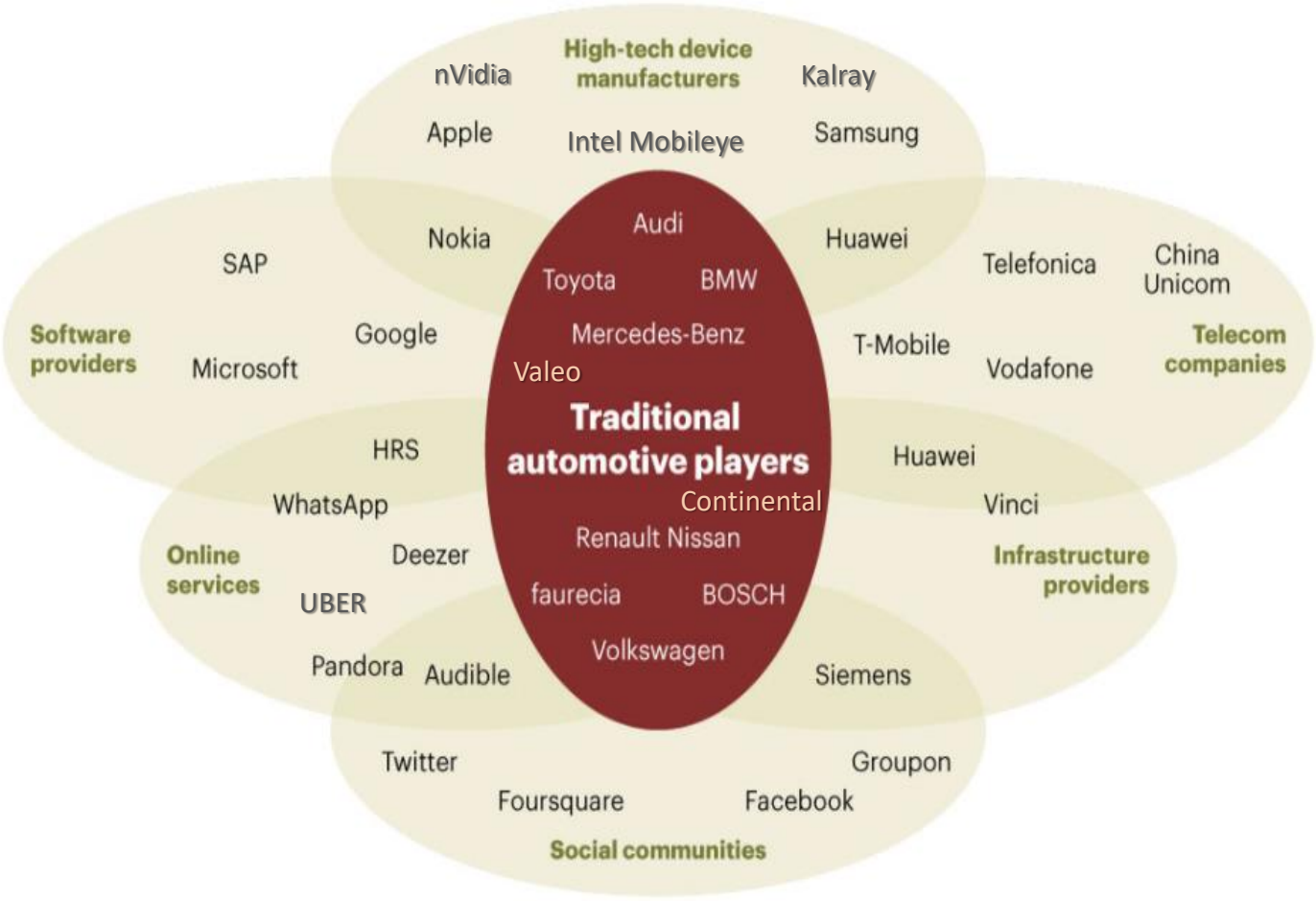

Figure 7: Non exhaustive view of the companies will join forces to create powerful ecosystems (from ATKearney : How Auto makers can survive the self-driving era report)

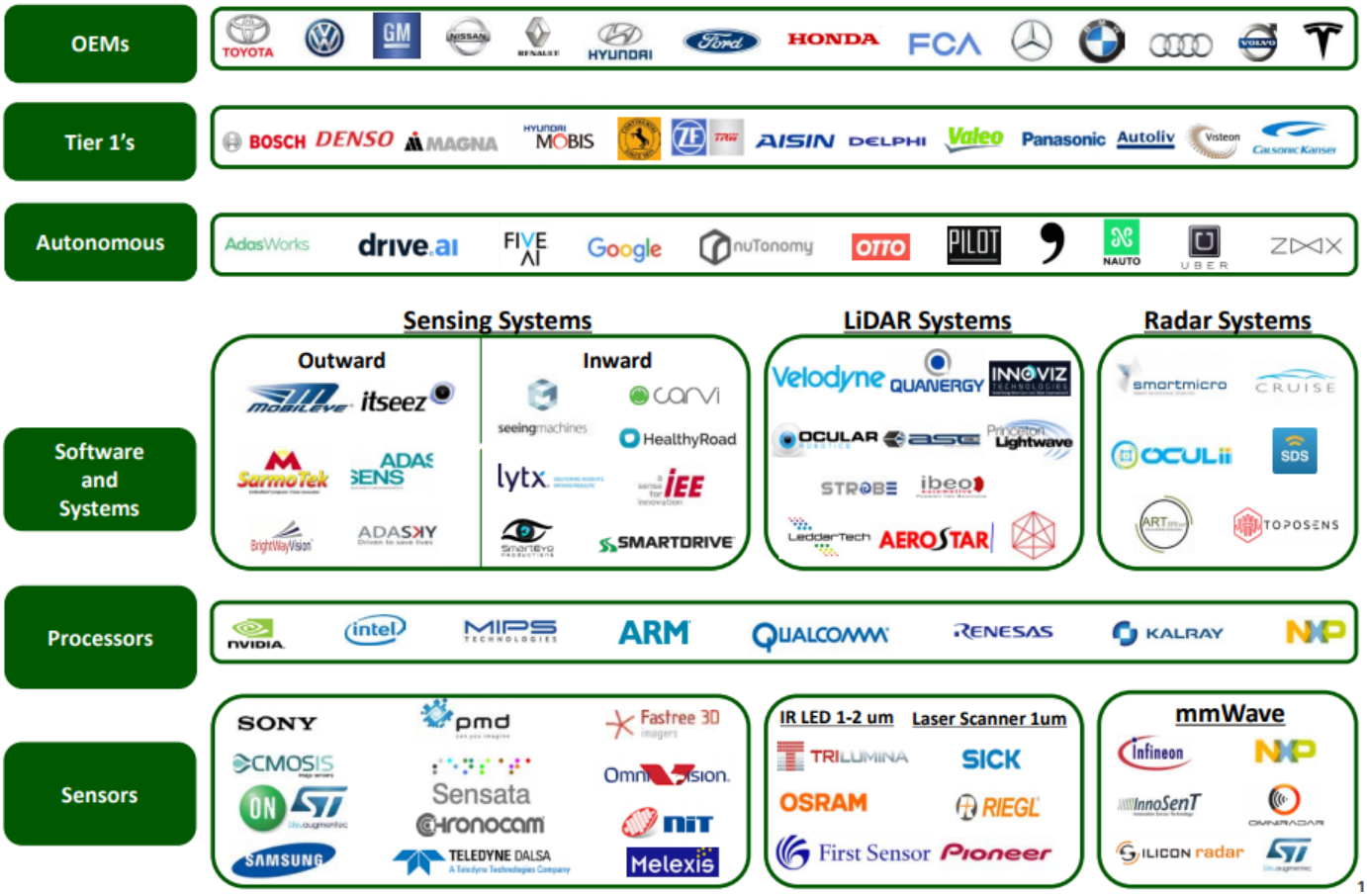

Figure 8: Overview of the main companies involved in the development of autonomous vehicles.

3.4 Policies

We saw in the previous part how is competitive the race for the Autonomous Driving between manufacturers. Dealing with its economic strategies, governments and certification centers adapt their regulations and certifications to be competitive.

3.4.1 US - NHTSA

"The world is facing an unprecedented emergence of automation technologies. […] The Federal Government wants to ensure it does not impede progress with unnecessary or unintended barriers to innovation. Safety remains the number one priority for the U.S. Department of Transportation (DOT) and is the specific focus of the National Highway Traffic Safety Administration (NHTSA)".
Extract from the "Automated driving systems 2.0 - A vision for safety".
According to the analysis of the journalist David Shepardson about this report of the NHTSA from September 2017, the USA will ease regulation about autonomous driving.
In particular, the Department of Transport should announce that OEMs would no longer have to apply for prior authorization to launch autonomous vehicles on the roads.

The Obama administration, for its part, asked the manufacturers to present the authorities with a 15 points control procedure for their autonomous driving systems. With additional regulations from the different States.
The new congressional officials are striving to develop new legislation to accelerate the commercialization of autonomous car and to prevent the different States from blocking their deployment at the regional level. The House of Representatives has already and unanimously passed a measure allowing manufacturers to launch 25 000 vehicles on road, the first year, without worrying about existing standards for automotive safety. This ceiling would be raised to 100 000 vehicles, in three years.
However, under this proposed law, OEMs will still have to provide an assessment of the safety procedures associated with their autonomous driving systems to the authorities. Nevertheless, they will not have to get the go at the federal level in order to put their vehicles in circulation. A group of senators presented a similar text to the upper chamber of Congress.

3.4.2 UE - Vienna Convention

About Vienna Convention (VC) and Geneva Convention (GC), the latest information seems to allow autonomous driving with monitoring.
The European group known as WP.1, in charge of the evolution of the conventions, accepted in September 2017 to consider that the actual VC, amended in 2016, allow the circulation of vehicle with autonomous driving SAE Level 3 and 4, with the conditions that were specified in March 2017 which are:
"When the vehicle is driven by vehicle systems that do not require the driver to perform the driving task, the driver can engage in activities other than driving as long as:

- Principle 1: these activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task,
- Principle 2: these activities are consistent with the prescribed use of the vehicle systems and their defined functions"

For more details refer to UNECE Link Paragraphs 17 and 18.
The WP1 still have to define the term "secondary tasks", and the OICA has been asked about it.
If there is no need to amend the VC for Level 3 and 4 with a driver, the WP.1 will give a position in March 2018 about level 4 and 5 without driver.

SAE level 1 & 2 require from the human driver to be in control. Therefore, articles 8 paragraph 5 is sufficient: "Every driver shall at all times be able to control his vehicle or to guide his animals."
With SAE level 3, when the system is activated, the human driver still have the control. So, article 8 paragraph 5 is still sufficient, and the obligation to minimize any other activity than driving is softened as the driver is allowed to use the onboard infotainment system. Anyway, the driver has to intervene upon request of the system.
For SAE level 4, when the system is activated, the human driver no longer has control. The obligation to minimize any other activity than driving is no longer valid, nor the prohibition to use a hand held phone. Article 8 paragraphs 5 and 6 are no longer valid especially that the human driver does not have to intervene upon request system. Paragraph 6 explain that the driver of a vehicle must avoid any activity other than driving.
Finally, the SAE level 5 induces no human driver. Because of that, article 8 paragraph 1 "Every moving vehicle or combination of vehicles shall have a driver" and article 13 paragraph 1, are no longer compatible with this kind of autonomous driving activity. Article 13 is about speed and distance between vehicles and paragraph 1 explains: "Every driver of a vehicle shall in all circumstances have his vehicle under control so

as to be able to exercise due and proper care and to be at all times in a position to perform all maneuvers required of him […]"

Last changes about VC - Remote Control Parking can be given as an example…

The next paragraph is a public analysis done by the WP1 working on the Vienna Convention (VC) about the RCP (Remote Control Parking), by the Netherlands, the Finland and the UK in May 2017, 19th. It gives a concrete example for a functionality that could be use with autonomous driving, and a possible way of development for the AutoMate activities.

Remote Control Parking (RCP) is a functionality that is available on the market, and can be used on private land, though until 2018 this functionality cannot be type approved. A driver can use a type approved RCP when they are located in close proximity to the vehicle[3]. RCP does not replace the driver; rather this functionality enables them to exercise proper control of a vehicle when they are not in it. This paper shows how RCP in vehicles which normally are operated by a human driver in the driving seat is guided under the Geneva and Vienna Conventions (GC and VC), and how the requirements of both can be met. The articles in the conventions that could be relevant for RCP are set out below.

- *Article 8 paragraph 1 (VC and GC) provides that every moving vehicle shall have a driver. This requirement is met when using RCP although the driver and driving position is outside the vehicle. The driver is still driving the vehicle, just using the remote control to do so.*

- *Article 8 paragraph 6 (VC) states: "A driver of a vehicle shall at all times minimize any activity other than driving. Domestic legislation should lay down rules on the use of phones by drivers of vehicles. In any case, legislation shall prohibit the use by a driver of a motor vehicle or moped of a hand-held phone while the vehicle is in motion."*

"If driver focus their attention on the parking task, they minimize any non-driving task. In this regard, they should have sufficient situational awareness, and conduct the remote control parking manoeuver in the way intended by the manufacturer. This may be done using a dedicated remote control device, provided by the manufacturer, or using an application on a smartphone.
As the dedicated remote control device can only be used for that purpose, the driver minimizes non-driving activities when using it to park their vehicle by remote control."

"The VC requirement not to use a hand-held phone aims to reduce the risk of the driver being distracted by phone calls or texting, or other phone activities that are not related to driving.
However, this does not prevent a smartphone application being used as the remote control for RCP. The application is used to drive/control the vehicle, provided that it excludes the possibility of the phone being used for any activities other than driving (ie no remote control parking while talking or texting)
Given the above considerations, article 8.6 does not block the use of RCP."
There is not an exact match for the GC but:

- *Article 7 GC requires a driver [and others] to 'conduct himself in such a way as not to endanger or obstruct traffic; he shall avoid all behavior that might cause damage to persons, or public or private*

[3] Proposal for Supplement 6 to the 01 series of amendments to Regulation No. 79 (Steering equipment), adopted in March 2017 session of WP.29 (ECE/TRANS/WP.29/2017/10)

property.' A driver can observe this requirement with a remote control device just as s/he can in the driving seat.

- *Article 10 requires the driver to drive prudently so a driver with a remote control could still be driving prudently.*

Since then, the WP.1 accepted (September 2017) that the RCP function, defined in ECE 79.02 do not cause a security problems.

3.4.3 National law Project, in Germany

All the recommendations of the Vienna Convention are included in national legislation. It will then be appropriate, at each stage of the amendments to this Convention, that these amendments be transcribed into national laws in the traffic laws.
An evolution of the German Road Traffic Law that allows the use of autonomous vehicles of level 3 and 4 under some well-defined conditions has been adopted by the second chamber (Bundesrat) in May 2017.
The next points are extracted from it.

- The delegation of the driving task is **only allowed in the limit of the type approved functions** of a vehicle. The driver must take over control as soon as the system demands it. It should not use the function if conditions are no longer met (example: weather conditions, use of a system planned for Motorway on a national highway, warning of a system failure, etc.).
- A function with driving delegation will only be allowed if it is approved by international regulation and if it can detect and signal the need for the driver to take over control.
- There shall **always be a driver** (a sleeping person is not a driver but a passenger)
- The **driver must resume the control** of the vehicle if the vehicle asks him to do so
- A **data recorder (Black box)** which is compliant to the vehicle design regulation is installed on the vehicle and **can be read by authorities**. The authorities are equipped with a specific read device. This "Black box" must record when the driver delegates responsibility for driving and when the vehicle requests a takeover.
- If an accident occurs in autonomous mode without violation of the Highway Code, the owner of the vehicle must compensate the victims even if he is innocent. The amount of compensation is limited to twice the legal amount that applies in the event that an owner causes damage without being guilty. (2 million € for property damage,10 million € for personal damage)
- All the rules for using an automatic parking system (level 4) are defined.
- Another interesting rule is the rule 18, about learning system (including on-online): they are allowed only if greater safety is achieved (opacity vs. justification of decision, responsibility attribution, etc.).

For what concerning the evaluation of Autonomous Driving Funtions (ADFs), there is one accident with causalities on German motorways every 12 million of travelled Kms (or every 120000 hours of highway driving). ADFs have to prove to do better: this means that, in order to have verification with statistical significance, 10 time of that distance is required. How to achieve that?

3.4.4 Euro N'CAP

The European New Car Assessment Programme (Euro NCAP) is a consumerist organization dealing with European car safety performance assessment, and based in Brussels (Belgium).

For the autonomous driving activity, the EuroNcap will not test the vehicles by a new method of safety. Merely because it is not possible, they already propose tests to compare the different levels of reaction in terms of safety vehicles. However, they will control that the autonomous driving does not lead to additional accidental situations.
The following paragraph comes from the "European Automobile Manufacturers Association" (ACEA) in November 2017. It is a discussion about AD Level definition:

- Long discussion about AD levels (L1 + L1 = L2?). Several different opinions.
- Thatcham ["*Thatcham* Research" in England, are experts in vehicle safety technology, vehicle security and crash repair] sees a vehicle which offers a continuous longitudinal and lateral control as relevant for an assessment (as there is a high risk that the customer takes the hands off the steering)
- Euro NCAP position/proposal: All systems, which are assumed as L2 by the manufacturer (e.g. commercially announced as an "Assist" system) will be assessed. Examples:
- Vehicle offering ACC + LKA: No assessment (L1 + L1)
- Vehicle offering ACC + lane centering, offered as "Level 2" or "Assist": Assessment (L2)
- The full system would be enabled during the tests.

For the AutoMate project, we note that it has to be considered as part of SAE Levels (L2; L3?) for Autonomous Driving; if we want to be tested by EuroNcap.

Next paragraphs summarizes preliminary discussions on Euro NCAP's roadmap for the period between 2020 and 2025. It comes from the document "First Thoughts about the Euro NCAP 20/25 Roadmap - In Pursuit of Vision Zero" in November 2016.
In this period, there are likely to be significant changes to the regulatory landscape and to the content of vehicle safety type approval. EuroNCAP must ensure that its consumer ratings complement those developments, while also rewarding higher performance, in a faster timescale than regulation.

The next quotations aim to elicit comments from the key stakeholders on the first exploratory ideas about the continuous development of the overall safety rating; about the role of EuroNCAP in promoting automation and about stimulating improvements in safety in vehicle categories other than passenger cars.

For our deliverable, we focused on the Automated Driving part of this document.
"For several years, EuroNCAP has recognized that active safety technologies can bring safety benefits, either by aiding safe driving (SAS, LSS) or by intervening to help avoid a crash if one is imminent (ESC, AEB). Technology is evolving quickly and more and more of the driving function is being handed to the vehicle. The potential safety benefits of this increased automation are clear. It is therefore in EuroNCAP's interests to raise awareness of the technologies that exist and to promote their introduction in such a way that the safety benefits are realised. At the same time, we need to check that these technologies do not **introduce new risks** with a potential negative impact on safety.
The Role of EuroNCAP
Public expectations of automated driving are high, although understanding may be low. In this situation, EuroNCAP can:

- Clarify availability and inform consumers on what is and what is not automated driving.
- Go beyond legislation to provide information about the relative performance of systems in critical situations.
- Ensure that safety remains a factor in consumers' purchasing decisions when it comes to automated driving technologies.

While at the same time, it promotes automated driving technologies and raise awareness of their safety benefits.

Automated Functionalities

The development of vehicle automation is likely to be rapid but evolutionary. No car yet offers complete automation in all situations and driving environments. However, cars are emerging which offer some degree of automation in certain defined scenarios. Given the step-wise development of technologies, it makes sense to assess automated driving on a function by function basis i.e. the scenarios in which automated driving is provided to be assessed separately. This would allow consumers to compare the results of one vehicle with those of another in the same driving situation.

The following is a list of use cases for which some degree of assistance or automation function is offered, or expected to be offered in the near future, and in which Euro NCAP may have an interest:

- Parking
- City driving
- Inter-Urban driving
- Traffic Jam
- Highway driving

In some use cases automation can offer greater safety benefits than in others. In the future, there may be good reason to combine the assessments of individual functionalities into a combined 'Automated Driving' rating. This would weigh the results of individual functionalities by the relative safety relevance.

Testing and Assessment

EuroNCAP aims to test the performance of a system and, to a large extent, assess the Human Machine Interface. EuroNCAP will mainly focus on those aspects related to safety; and will set targets for separate working groups to develop the technical aspects of assessment. […]

Gradation

It is proposed that the assessment of automated driving be kept separate from EuroNCAP's mainstream star rating scheme. A separate gradation scheme is proposed, with simple, descriptive levels of the degree and safety of the automation offered:

Grade	Expectation
Superior Automation	• Fully automated function (autonomous) • All road conditions • All weather conditions • No driver intervention
Advanced Automation	• Automated function • Most road conditions • Most weather conditions • Possible take-over requests, but car will be able to keep control
Basic Automation	• Automated function • Most road conditions • Most weather conditions • Take-over requests where driver has to take over control

Continued Assistance (Level 2 Min.)	• Semi-automated function (designed to provide continuous assistance to the driver) • Most road conditions • Most weather conditions • Driver is primarily in control

Provisional Timescale

EuroNCAP expects a phased-in approach that will focus first on Continued Assistance systems and emphasizes communication initially. This will likely to start ahead of the roadmap term, or as early as 2018.

3.5 Market share

The market share of the Autonomous Vehicles is the upcoming reality. But the number one feature of these smart cars is that they will be able to communicate with each other.
Connected cars will have to develop much smarter and more advanced technologies that could cover much larger areas and possible situations.

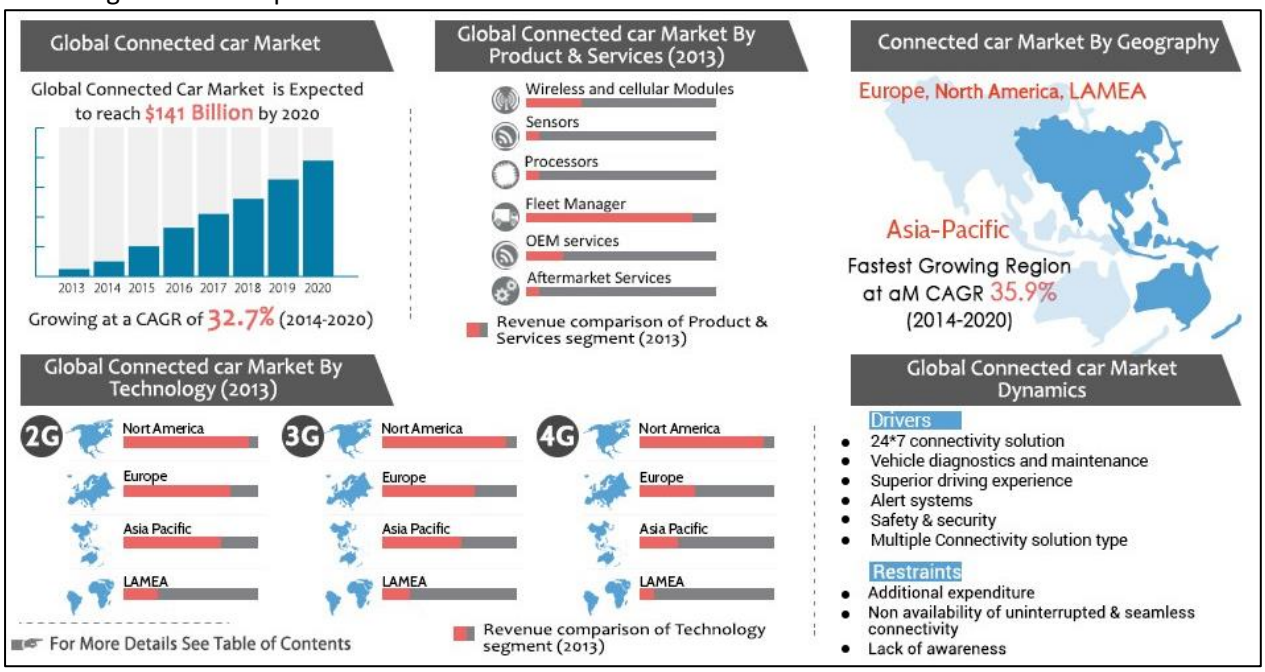

Figure 9: Global Connected Car Market. Size and Forecast (2013-2020):

A connected car offers more than a regular car. Its main benefits are being safe, secure, bringing more comfort to the driver, and it also has the latest technologies integrated into it.
According to HIS Markit, by 2020 there will be more than 150 million connected cars on the road with an Internet access. That can represent a Global Connected car Market of 141 billion of dollars.

The Machine 2 Machine feature is what makes it possible for cars to communicate with other cars around them. This calls for a lot of sensors and processors, so that the information is transmitted in real time, and is also as accurate as possible.
3G and 4G/LTE are the most used technologies for in-car connectivity, even if the technology is changing faster than ever. 3G is slowly starting to fade away. Almost everyone has given up 3G for 4G, even on their smartphones, and there is no doubt that we will soon talk about 5G.

Another track that will prevent the autonomous cars market is the global advanced driver assistance systems market. By this way, we may consider the Autonomous Driving Market or what it will soon be.

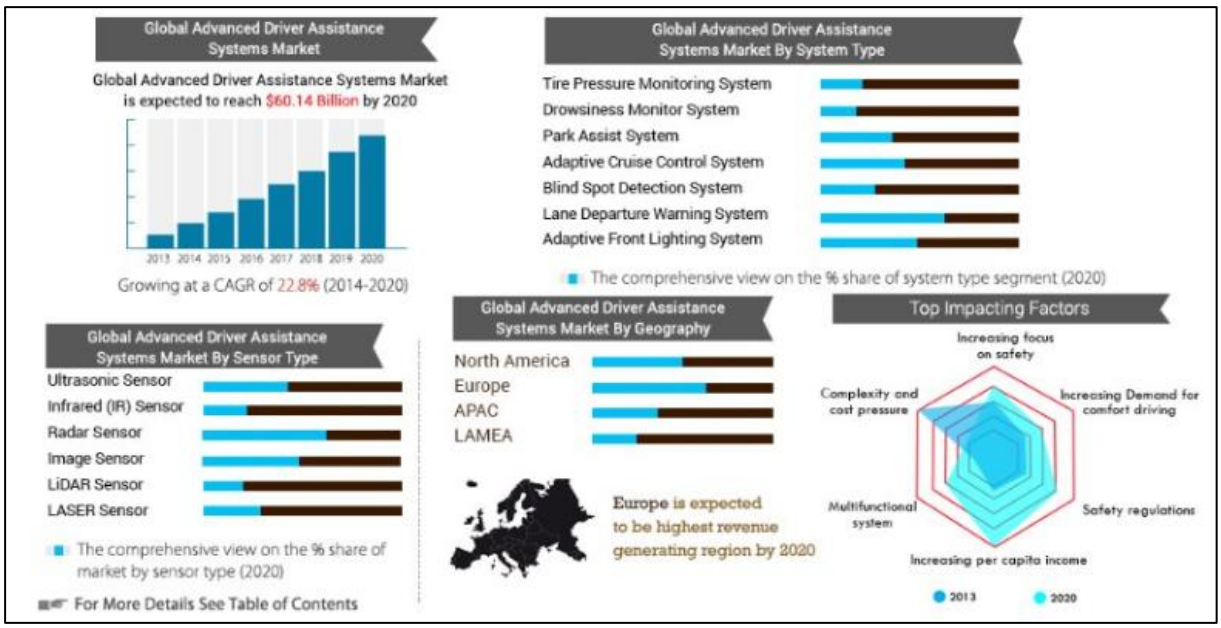

Figure 10: Global Advanced Driver Assistance Systems (ADAS) Market - 2015. Segmentation and Forecast, 2013 – 2020.

Advanced driver assistance systems (ADAS) facilitates safe driving and warns the driver if the system detects risks from the surrounding objects. Deployment of ADAS in vehicles to enhance comfort and ensure safety on road has emerged as one of the major trends. The system provides dynamic features such as adaptive cruise control, parking assistance, blind spot detection, lane departure warning, drowsiness monitoring, tire pressure monitoring and night vision. The developments in the automotive industry are not only limited to the enhancement in the design or engine but also cover the safety of a vehicle, passenger as well as pedestrian.

The growth of the market is driven by increasing focus of consumers on safety, the impending demand for comfort in driving along with a rise in government regulations for ensuring safety.
The European automotive industry is one of the largest and most innovative automotive markets in the world. With a massive transformation in the industry, there is rapid market penetration and mass adoption of ADAS amongst customers. There are regular upgrades in the ADAS technology, which facilitate competitiveness in the market.

Key players in the Advanced Driver Assistance System market may be enterprises like Valeo, Magna International Inc., Robert Bosch GmbH, Autoliv Inc., Continental AG, Denso Corporation, Audi AG, BMW AG, Ford Motors Co., General Motors (GM), etc. The ADAS market is segmented on the basis of component and geography. Component has been further bifurcated into systems and sensors.

The AutoMate project can be inserted in this market in constant evolution and in constant augmentation. It could be one of the bridge between the ADAS market, we just talk about, and the “Autonomous Driving” market that we will know from the 2021s, if we believe the road map described before.

4 Identification of Potential customers

It is obvious that Drivers would be the final (indirect) customers for AUTOMATE products. Nevertheless, the project results will strengthen the position and competitiveness of the industrial consortium partners (and beyond) as direct customers for AUTOMATE products in the European and worldwide market. Nevertheless, under certain conditions, OEMS and TierX, not partners from the Automate consortium, should become customers for AUTOMATE products.
Last and not least, many of the products developed within AUTOMATE should be commercialized/used in other application fields and also for research purpose by laboratories and industry. For this purpose, the AUTOMATE innovation ecosystem, leaded by VEDECOM has been set which role is to give the opportunity to organizations and industries not involved in the AUTOMATE project to get an access to its results.

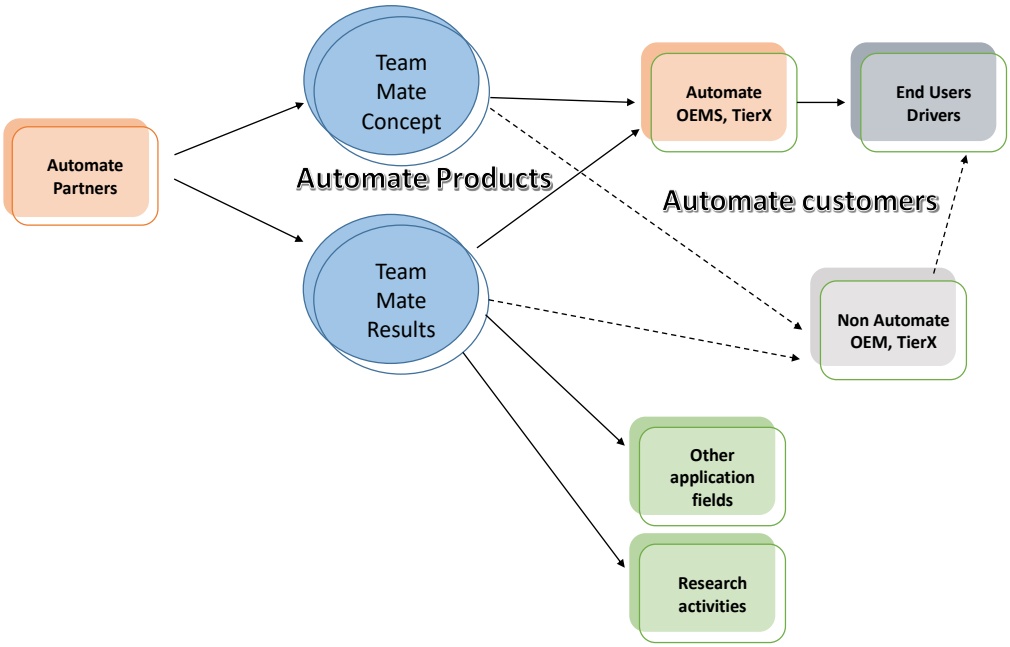

Figure 11: Automate customer ecosystem

4.1 Final customers

Many studies performed these last years are presenting some slightly different results. Recently a Gartner survey of 1519 people in US and Germany demonstrated that 55% of the answerers were not interested in driving an autonomous vehicle. Nevertheless, 71% would be interested by driving a partially autonomous vehicle. In another study held by university of Michigan, 45.8% of the drivers would like to keep the full control of their vehicle when driving while 38.7% where interested by already existing semi-autonomous functions (parking assist, autonomous driving on given roads,…) and only 15.5% of the drivers would accept to drive an autonomous vehicle. Another study performed by "l'Observatoire Cetelem" in 15 countries about the willingness to drive an autonomous vehicle on given areas show a great variability between developed and emerging countries (Cf.Figure 12)..
The major concerns of the drivers were mainly about technology failures and security of fully autonomous vehicles. "Fear of autonomous vehicles getting confused by unexpected situations, safety concerns around

equipment and system failures, and vehicle and system security are top concerns around using fully autonomous vehicles" (Mike Ramsey, research director at Gartner). Morality is a top societal concern. Questions about how a computer decides between two unavoidable, lethal options and liability if an autonomous vehicle is involved in an accident or criminal activity are currently unanswered.
"Educating consumers on what the technology can and cannot do is paramount to establishing trust and building acceptance. Overpromising may lead to unsafe and unsatisfied consumers,"

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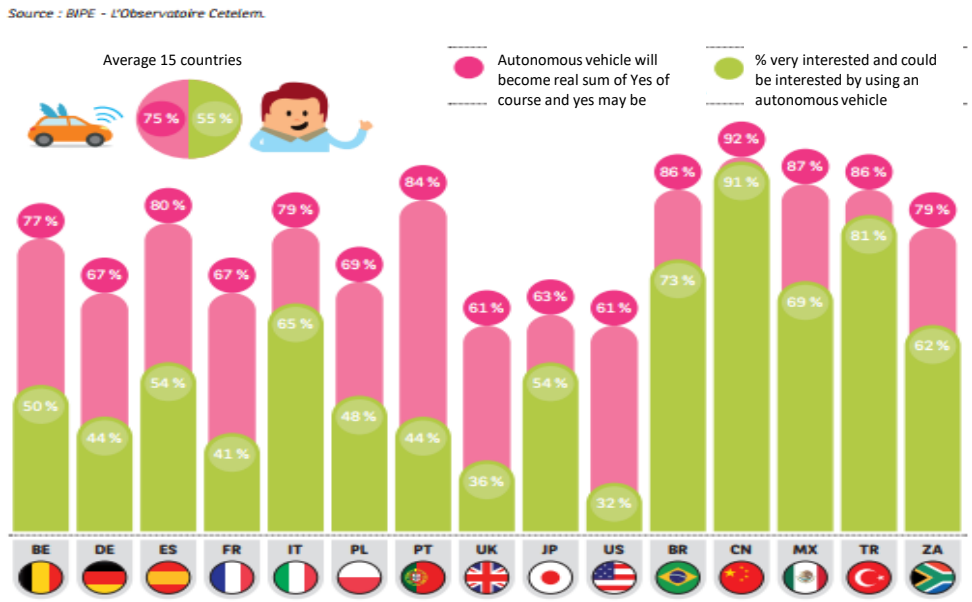

Figure 12: Willingness to drive autonomous vehicles in given areas (from "L'observatoire CETELEM")

4.2 AUTOMATE Industrial partners EoM, Tier1 and Tier 2

We observe different kind of participants for the autonomous cars market. New manufacturers like Tesla but mainly technical associations, Daimler and Bosch or BMW and Intel for example. Then, we also have users of the autonomous functionalities like Uber. This last category is eventually a data informative producer for technical associations.
AutoMate will be proposed/developed in the second category.
Considering the **current market position of the AUTOMATE Industrial Partners**, the consortium is in an excellent position to achieve a significant economic impact. PSA and CRF, representing the FIAT Group, together had 18.5% share of EU unit sales in 2014 and PSA was the second largest player in the EU market (close to 11,7% market share in 2014). They have also a relevant position in the global market. Car Manufacturers: **CRF** and **PSA** have already a consolidated (global) market share, distributors and dealers worldwide (sales channels), and both have already marketed partially autonomous vehicles, although with limited or no driver-automation interaction.

Apart from the OEM partners in the consortium, the Automotive Suppliers Continental Automotive is one of the world leaders in the field of ADAS technologies and functions, and it is also strongly involved in the

development of new concepts for vehicle automation. Continental has already marketed powerful and intelligent components, systems, and software for vehicles with autonomous features. Continental customer network include all major medium and small car manufacturers in the world.

RE:Lab has acquired in the last years a consolidated position in the HMI market for the automotive and transport sector, with key player customers that are planning to extend their market shares by introducing new concepts of automation in the next 3 years. RE:Lab plans to exploit the results in terms of HMI strategies for highly automated vehicles to OEMs and Tier 1 suppliers.

BroadBit, as Tier 2 supplier, has already a consolidated market for the development and validation of V2X communications technology licensed to Tier 1 automotive suppliers. BIT plans to market V2X related HMI technologies to Tier 1 suppliers and it aims to extend its market as consulting firm for the development and validation of V2X communications technology for Tier 1 companies that supply solution for the future market of automated vehicles.

Humatects will further develop its results into commercial products and will offer these to Tier 1 suppliers.

4.3 The AUTOMATE Innovation Ecosystem

In parallel to the direct exploitation of AUTOMATE results by the industrial partners of the consortium, it has been decided to create an AUTOMATE Ecosystem under the responsibility of the Automate partner VEDECOM. The aim of this eco-system is to give the possibility to organizations that have not been involved in AUTOMATE to implement new features or functions from the technologies developed in the project.

VEDECOM aims to disseminate widely the results amongst the community in order to be used as a foundation by partners and also by organization that have not been involved in the project. The objective is to provide AUTOMATE system so it will be largely used especially to improve the functionalities or develop new ones. VEDECOM organizes this communication under three different levels: between VEDECOM partners, at the National level and at the European level.

4.3.1 VEDECOM EcoSystem

VEDECOM is the French Institute for Public-Private Partnership Research and Training dedicated to individual, carbon-free and sustainable mobility. VEDECOM is a partnership-based foundation belonging to Versailles Saint-Quentin-en-Yvelines University. The Institute's 40 members include firms in the automotive and aviation sectors, mobility ecosystem infrastructure and service operators, academic research bodies and Ile-de-France local authorities, all working together in a pioneering manner.

VEDECOM's research activities are organised in three fields of research:

- Vehicle electrification,
- Self-driving and connectivity,
- Shared energy and mobility, infrastructures and services.

Each of these fields comprises a number of research projects covering different technological building bricks with the related demonstrators.

Hence, the first layer of the AUTOMATE Innovation Ecosystem is related with the VEDECOM Ecosystem which includes two disseminations opportunities:

- Self-Driving and connectivity steering committee:

Within VEDECOM, two projects are in charge of the activities developed in AUTOMATE. These projects deal with Autonomous Vehicle technology bricks and Human Factors aspects. They are both under this steering committee. The Committee is a working group that meets every two months to exchange with the VEDECOM partners about the roadmaps, the milestones and the achievements. It is a place to promote and exchange about the developments within associated projects, under a scientific point of view. It fosters a multi-disciplinary approach as the partners are from industries and academic.

- VEDECOM Tech:

VEDECOM Tech is a spin off from VEDECOM that is in charge of the commercial activities related with the research achieved within VEDECOM. It also provides us with another feedback from the industries and the markets on the trends and requests from the customers.

4.3.2 National Level

VEDECOM is deeply involved in the “Nouvelle France Industrielle” plan for Autonomous Vehicle. These workgroups aim to ease the introduction of Autonomous Vehicle by defining roadmaps, by identifying technological bottleneck and by proposing evolutions on the legal aspects. It works very closely with the French government. Every month, the steering committee of Autonomous Vehicle plan gathers both use case owner, technical workgroup leader and public authorities to present the overall works, under the supervision of car manufacturers. The Autonomous Vehicle plan is led by Renault (under the patronage of Carlos Ghosn). The workgroups are not restricted to passenger car and also deals with public transportations and goods transportations.

The workgroups can address almost all the industrial and academic partners in France.

4.3.3 European and international Level

Most of the dissemination at this level is directly managed through the dissemination activities of the project. However, two formal discussion forums must be highlighted as a target for the AUTOMATE Ecosystem:

- First one is the CARTRE project. It is a collaborative support action from H2020.
- Second one is the ERTRAC forum, it is the European technology platform which brings together road transport stakeholders to develop a common vision for road transport research in Europe.

Both work together to deliver a common vision for road automation, described both under use cases dimension and technical requirements dimension.

AUTOMATE can rely on several partners which has a presence in these forums to bring the voice and prove the innovative approaches that we develop.

5 Intelectual Property Rights (IPR) management

The successful exploitation of its results by each partner requires that rules be agreed on the IPR on knowledge arising from the project (the Knowledge), and that provisions be taken for the access rights to the IPR.
The Automate partners agreed, before project start, on rules defining the access rights to the IPR on the Knowledge and on the Pre-Existing Know-How, for the purpose of the achievement of the project on one side, and for further exploitation of those results on the other side.
This was made through the joint signature of a Consortium Agreement signed by all parties. The Consortium Agreement complements the Annex II of the EC contract, notably in describing further the rules for sharing the access rights to IPR, upon the principle to guarantee that each partner gets the information required both to achieve its share of the project, and to exploit its results after it.
This Consortium Agreement covers what is the pre-existing know-how that any partner may need from another one, and the conditions under which this pre-existing know-how is made available. An initial list has been provided by each partner at the beginning of the project and include as an annex to the CA. This description will be updated during the course of the project to ensure that the partners can exploit the results of their work. If needed specific agreements shall be made and signed between the different partners, to secure the individual or joint exploitation of results.

In detail IPR is managed according to the following rules:

Ownership of Results

Results are owned by the Party that generates them or on whose behalf the results were generated

Joint ownership

The co-owning Parties must, on a case by case basis, within a twelve (12) month period as from the date of generation of such Results, unless other period is agreed between the co-owning Parties, enter into a joint ownership agreement (in writing) regarding the allocation of ownership and terms of exercising, protecting, dividing related costs and exploiting such co-owned Results to ensure compliance with their obligations under the Grant Agreement.
The joint ownership agreement should cover in particular:

- specific conditions for granting licenses (if they are different from those already set out in the Grant Agreement);
- criteria or principles for Fair and Reasonable compensation to be provided to the other joint owners in case of granting licenses to Third Parties,
- how disputes will be settled (e.g. via a mediator, applicable law, group of independent experts etc.).

Unless otherwise agreed in the joint ownership agreement:

- Each of the co-owning Parties shall be entitled to use their jointly owned results for non-commercial and research activities freely and on a royalty-free basis. However, in the case where this use of jointly owned Results for non-commercial and research activities is realised outside the Project with a Third Party the concerned co-owning Party have to inform by writing the others co-

owning Parties before to collaborate with this Third Party, in order to permit to a co-owning Party to indicate whether these Legitimate Interests can be affected. Such other co-owning Parties shall not unreasonably withhold its approval to such use for research activities, and;

- Each of the co-owning Parties shall be entitled to otherwise Exploit (industrial and commercial activities) the jointly co-owned Results on a royalty-free basis, on conditions that:
  - this Exploitation is exclusively carried out for the exploiting Party's needs/activities; and,
  - the exploiting Party ensures that the rights of the co-owning Parties will not be affected;
- each of the co-owning Parties may grant non-exclusive licenses to its own Affiliated Entities and to Third Parties (without any right to sub-license), on the following cumulative conditions:
  - to inform the other co-owning Parties before to grant a non-exclusive license and at least thirty (30) calendar days advance notice. It allows to another co-owning Parties to oppose it whether its legitimate interests are affected (specially in terms of competition). Such other co-owning Parties shall not unreasonably withhold its approval to such licensing; and,
  - grant this licence to Fair and Reasonable conditions.

The co-owning Parties shall agree on all protection measures and the division of related cost sufficiently in advance in order to not affect the protection of such co-owned Results (eg in a joint ownership agreement).

Transfer of Results (own Results or co-owned Results)

- Each Party may transfer ownership of its own Results following the procedures of the Grant Agreement Article 30.
- It may identify specific Third Parties it intends to transfer the ownership of its own Results to in Attachment (3) to this Consortium Agreement. The other Parties hereby waive their right to prior notice and their right to object to a transfer to listed third parties according to the Grant Agreement Article 30.1.
- The transferring Party shall, however, at the time of the transfer, inform the other Parties of such transfer within a reasonable time which can not be less than fifteen (15) calendar days before the date of the transfer; and shall ensure that the rights of the other Parties will not be affected by such transfer.
- The Parties recognize that in the framework of a merger or an acquisition of an important part of its assets, it may be impossible under applicable EU and national laws on mergers and acquisitions for a Party to give the full forty-five (45) calendar days prior notice for the transfer as foreseen in the Grant Agreement. However, in that case, the transferring Party will do its best to inform the other Parties from this transfer in the context of this merger or acquisition as soon as possible.
- The obligations above apply only for as long as other Parties still have - or still may request - Access Rights to the Results.
- If any of the Parties wishes to assign any co-owned Results to a Third Party, it shall promptly notify the other co-owning Parties with at least forty-five (45) days' advance notice of the planned assignment and of the Third Party but shall not make such an assignment without the prior written consent of the other co-owning Parties, which shall not be unreasonably withheld. The terms and conditions of the assignment shall contain adequate provisions to ensure that such assignment will not prejudice the Rights of the other Parties to the assigned Results.
- The transferring Party shall ensure that the rights of the other co-owning Parties (in particular but not limited to Access rights) will not be affected by such transfer.

Information regarding applications for patent or other form of protection

A Party(ies) may in its/their own discretion, at its/their own expense, and only for its/their own Results, make applications for patent or similar form of protection in territories of its/their own choice and shall inform the other Parties of each such application in advance of publication of the application.
For co-owned Results the co-owning Parties shall however agree on all applications for patents or other adequate form of protection.

Dissemination

Dissemination of (co-)owned-Results

- During the Project and for a period of one (1) year after the end of the Project, the dissemination of Results by one or several Parties including but not limited to publications and presentations, shall be governed by the procedure of Article 29.1 of the Grant Agreement subject to the following provisions.
- Prior notice of any planned publication shall be given to the other Parties at least 45 calendar days before the publication. Any objection to the planned publication shall be made in accordance with the Grant Agreement in writing to the Coordinator and to the Party or Parties proposing the dissemination within thirty (30) calendar days after receipt of the notice. If no objection is made within the time limit stated above, the publication is permitted.
- An objection is justified if
  a) the protection of the objecting Party's Results or Background would be adversely affected, and/or
  b) the objecting Party's Legitimate Interests in relation to the Results or Background would be significantly harmed.

  The objection has to include a precise request for necessary modifications.
- If an objection has been raised the involved Parties shall discuss how to overcome the justified grounds for the objection on a timely basis (for example by amendment to the planned publication and/or by protecting information before publication) and the objecting Party shall not unreasonably continue the opposition if appropriate measures are taken following the discussion.
- The objecting Party can request a publication delay of not more than ninety (90) calendar days from the time it raises such an objection. After ninety (90) calendar days the publication is permitted, provided that Confidential Information of the objecting Party has been removed from the publication as indicated by the objecting Party.
- If the Results are co-owned Results, the co-owning Parties shall get the prior written authorization of the other co-owning Parties prior to any dissemination. Such authorization shall not be unreasonable withheld.

Dissemination of another Party's unpublished Results or Background

A Party shall not include in any dissemination activity another Party's Results or Background without obtaining the owning Party's prior written approval, unless they are already published.

Cooperation obligations

The Parties undertake to cooperate to allow the timely submission, examination, publication and defence of any dissertation or thesis for a degree that includes their Results or Background subject to the confidentiality and publication provisions agreed in this Consortium Agreement.

Use of names, logos or trademarks

Nothing in this Consortium Agreement shall be construed as conferring rights to use in advertising, publicity or otherwise the name of the Parties or any of their logos or trademarks without their prior written approval.

5.1 Available Pre Existing Knowhow according to CA annex

Owner	Pre Existing Knowhow	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for exploitation (Article 25.3 Grant Agreement)
DLR	none	none	none
PSA	none	none	none
CRF		Modules available	Basic performances achieved
BIT	none	none	none
CAF	none	none	none
ULM	none	none	none
OFF	Bayesian Autonomous Driver Mixture-of-Behavior (BAD MoB) models and BAD MoB Learning Suite. BAD MoB models are probabilistic driver models for the simulation, prediction and recognition of human driving behavior. The BAD MoB Learning Suite is a collection of software tools and algorithms for the definition, utilization, and (machine-)learning of BAD MoB models-	None.	The software tools integrate source-code that is licenced under the MIT licence and the BSD licence. The usage of BAD MoB models and corresponding software tools resp. source code is restricted to the duration of the AutoMate project.
HMT	Driver Model to infer driver's risk awareness. The driver model gets observations of physiological data as input and derives	None.	The software tools integrate source-code that is licenced under the MIT licence and the BSD licence. The usage of the driver model is restricted to the

	inferences on the risk awareness of the driver		duration of the AutoMate project.

Table 2: Available Pre Existing Knowhow

5.2 IPR on project results

Owner	Type of IPR	Reference n°	Short description
PSA	none		
BIT	none		
CAF	none		
ULM	none		
OFF	Software	E2.1, E3.1	
HMT	Software	E4.2, E6.6	

Table 3: IPR on project results

6 Exploitation strategy

Exploitation in AUTOMATE will facilitate the industrial use of the project results as well as prepare their commercialization in relevant markets. According to the DOW AUTOMATE should produce the following exploitable results:

- TeamMate Car demonstrators: The OEMs can use the Teammate Car demonstrators as reference prototypes to design and build their future highly automated vehicles based on the Teammate approach with some or all associated technologies inside.
- TeamMate technologies: The demonstrators will integrate a set of technical Enablers as described in Section 1.3.1. These technologies can also be exploited separately. We foresee to market these in form of software licenses and engineering services to adopt the software to the needs of specific customers:
    - software for sophisticated driver-automation interaction
    - software (based on driver models) to infer driver states and intentions,
    - software (based on situation and vehicle models) to infer the environmental and vehicle state,
    - software for safe maneuver planning and execution,
    - software for learning human-like maneuver execution,
    - software platform for sensor fusion and communication.
- New knowledge: The consortium partners will gain valuable knowledge and insight on how to design and build automated cars that are trusted and accepted by drivers. This will give them a competitive advantage on the Automotive market and in the automation human factors research arena. The essence of this know-how will be made available to the public in form of a conceptual framework for driver automation team-work. Based on the experiments performed in WP2 new knowledge on driver behavior and cognition in highly dynamic traffic situations will be gained which will be published at conferences and in journals.
- Innovation platform: The TeamMate system architecture will include an SDK for supporting the extension and modification of the TeamMate technologies and an open API for allowing access to the data gathered by the TeamMate technologies. The SDK and API will constitute a technological platform for building further innovations for the TeamMate approach in the future. The platform will be maintained and used in the frame of the AUTOMATE Innovation Ecosystem.

In section 6.1 the individual exploitation strategies will be first described.
The consortium plans to achieve project results at TRL 5/6. In 6.2 we are providing a **short-to-mid-term exploitation roadmap** to turn these results into commercial products at TRL 9.

6.1 Individual exploitation strategy

Within the exploitation strategy individual roles and responsibilities have been defined for each partner according to their organization type:

Car Manufacturers	
CRF	**CRF** (as also PSA, the other car-manufacturer in the consortium**)** has already a consolidated (global) market share, distributors and dealers worldwide (sales channels), and both have already marketed partially autonomous vehicles, although with limited or no driver-automation interaction. For example, FCA autonomous emergency braking system (also called City Brake Control) is now available also on the 500L and its variants. The new 500L also includes the electronic stability control system, the anti-lock braking system and integrates the ASR/MSR anti-slip functions with those of the electronic rollover mitigation and active electronic steering. In particular, CRF is conducting internal workshops to inform and convince internal decision makers (technical directors, managers) of the project's added value to prepare internal exploitation. This is interesting because the project can receive further feedback on its applicability, impact and necessary improvements. Therefore, the results from AUTOMATE project will give to CRF the opportunity to improve the performance and acceptance of driver models (including the driver's monitoring) for the development of ADAS and ADV strategies and components. The aim of CRF is to include the TeamMate technologies into its products (e.g. SW modules) to extend their functionalities. The results from AUTOMATE projects can be integrated progressively into products, also considering the interaction with other partners.
PSA	**Groupe PSA** has already a consolidated market share, distributors and dealers worldwide; and both, with CRF, have already marketed partially autonomous vehicles, although with limited or no driver-automation interaction. E.g. PSA introduced active emergency braking system in 2014 in the Peugeot 308, which also includes dynamic cruise control, blind spot monitor and city park assistance systems. Both OEMs prepare exploitation of the TeamMate approach internally to their company. PSA persons actively participating to AUTOMATE are regularly informing their technical director to explain and demonstrate the rational and added value of the TeamMate approach and technologies. PSA will organize internal workshops to introduce the AutoMate innovation in order to develop its own products and to acquire new market shares in the connected and automated vehicles market.
Tier 1	
CAF	Continental is one of the world leaders in the field of ADAS technologies and functions and is involved in the development of new concepts for vehicle automation. Continental has already commercialized powerful and intelligent components, systems, and software for vehicles with autonomous features: ACC, EBA, lane keeping functions. Continental is also strongly involved in the development of components and functions for driver monitoring. Continental customers are all the OEMs in the world. Results from AUTOMATE project will give to Continental the opportunity to improve the performance and acceptance of these products and then to propose to its customers global concepts for driver centered assistance design, taking profit of its competence both

	in the development of ADAS technologies and Driver monitoring components. The aim of Continental is to include the TeamMate technologies into its products to extend their functionalities and its market by supplying (directly to OEMs) more sophisticated solutions for the future connected and automated vehicles. The results from AUTOMATE projects should be integrated progressively into continental product. First applications could directly impact the next generation of ADAS to be produced by 2020.
Tier 2	
BIT	BroadBit has special knowledge on V2X communication technology, which will be an inevitable part of future ITS systems. BroadBit participated the standardization of the GeoNetworking protocol in ETSI. The protocol is the basis of short range communication used by ITS. BroadBit follows closely new ETSI ITS standards. Furthermore, BroadBit provides know-how and customized solutions for industrial partners related to V2X communication technology and planning. Therefore, on the one hand, the experience gained from the AutoMate project will be used during the standardization procedures of future ETSI ITS protocols. On the other hand, BroadBit has the opportunity to develop solutions for demonstrating the benefit of V2X technology. This will be utilized to improve BroadBit's influence on V2X market and build new business partnerships. The developments are planned to be commercialized.
REL	Thanks to the close cooperation with surrounding economical clusters (more than 300 companies, most of them in the area of automotive, mechatronic and logistic in one of the richest economic area in Italy) REL has already acquired a consolidated position in the hmi market for the automotive and transport sector, with key player customers that are planning to extend their market shares by introducing new concepts of automation in the next 3 years. Therefore, the results of AutoMate will be a catalyst to boost the innovation in the automotive sector through the adoption of novel HMI concepts to exploit the overall potential of the automation. The value proposition of REL depends on its flexibility and ability to rapidly prototyping HMI concepts: REL develops prototype solutions, not products. This also affects its market position. In fact, REL does not compete with the key International players (e.g. in the Global Automotive HMI Market: Delphi Automotive plc, Johnson Controls Inc., Magneti Marelli SpA and Valeo SA), but it is complementary to them (and it often works in collaboration with them) because it prototypes the solutions they will then deliver as a final product to the OEM. Therefore, for an innovation-oriented company as REL, the contamination and open-minded approach of the EU project is key to continuously increase its competitiveness. We plan to use the experience acquired in the project to consolidate our position as "innovation enabler" to be recognized as a key R&D partner to design HMI strategies that exploits the potential of an innovative concept/technology/product ("meta innovation").
HMT	**HMT** is active in the Aeronautics and Space domain and has gained a consolidated experience in the development of innovative solutions and technologies for machine learning and for inferring human states and for using these to enhance the adaptiveness of automation systems. In AutoMate HMT will transfer its competences gained in the Aeronautics and Space domain to Automotive automation and will develop algorithms for human-like driving and adaptive HMI solutions. HMT will gain a competitive advantage by being able to show

	demonstrated technologies for inferring human states and intention and for using these to enhance the adaptiveness and teamwork capabilities of automation systems. This will open up doors to new customers (OEMs and Tier 1 suppliers) in the Automotive market. HMT plans to market the machine Learning algorithm to Automotive suppliers. HMT will present evaluation results to Automotive suppliers and will try to find suppliers that are willing to invest in further development after the project in order to mature the technology to further TRLs and to integrate the technology into driver automation systems.
Research organizations	
VED	*VEDECOM aims at becoming a prime institute in the field of Autonomous Vehicle, by developing excellence in research. We have already demonstrated our capacity to build an autonomous vehicle, which has been demonstrated in several places (last one during the ITS Europe conference at Strasbourg). With only four years existence, VEDECOM has achieved a good standard in publications and disseminations.* *The AUTOMATE project will provide to VEDECOM the opportunity to enhance several research topics that were not previously faced or which were foreseen to be managed later. VEDECOM could include step by step the TeamMate architecture and the technologies associated in the VEDECOM demonstrator. The first integrated application will be realized within the frame of the project and we should build development upon it after the project.*
OFF	**OFF**, as research institute for information technology pushes the scientific boundaries of driver models and techniques for driver state inference to further develop them for usage in the industry. OFF expects that the expertise and reputation gained from AUTOMATE unlocks further (contract) research funding as well as licencing of patents. OFF is actively participating the scientist communities about driver modelling and HMI development. Gained results are also to be published as papers on international conferences and international journals. Also OFF is hosting relevant conferences, like e.g. the international ACM AutoUI conference this year. OFF has also a strong connection to the local university and Intermediate results are used in lectures for students. Further commercial exploitation is done via the spin-off company Humatects.
DLR	DLR will support exploitation by giving the Europe-an Automotive industry and academic organisations a direct access to the outcomes of Automate. Since DLR works with a cross-domain systemic approach, they will be able to multiply these results even into further domains (e.g. Aeronautics) where they also can be used for activities in research and development to sup-port a wide range of European science and industry institutions, e.g. OEMs or tier-one suppliers.
ULM	Ulm will contribute to exploitation and dissemination by publishing technical papers and thus giving the technical community access to knowledge developed in Automate. Also further employees at Ulm working on other projects than Automate will participate from gained knowledge of Automate. Furthermore, Ulm as a university institution has strong connection to students and academic community and will offer results at lectures and seminars.

Table 4: Individual exploitation strategy

6.2 Exploitation Road map

A progressive approach is considered concerning the introduction of the TeamMate technology matching the introduction of progressive automation levels to the market (cf. Business Plan in Section 2.2.4): in a very short term only some TeamMate technologies will be included in the market (e.g. by upgrading existing automation functions already on the market), while in mid-term more advances features will be integrated into the highly automated cars (see section 2).

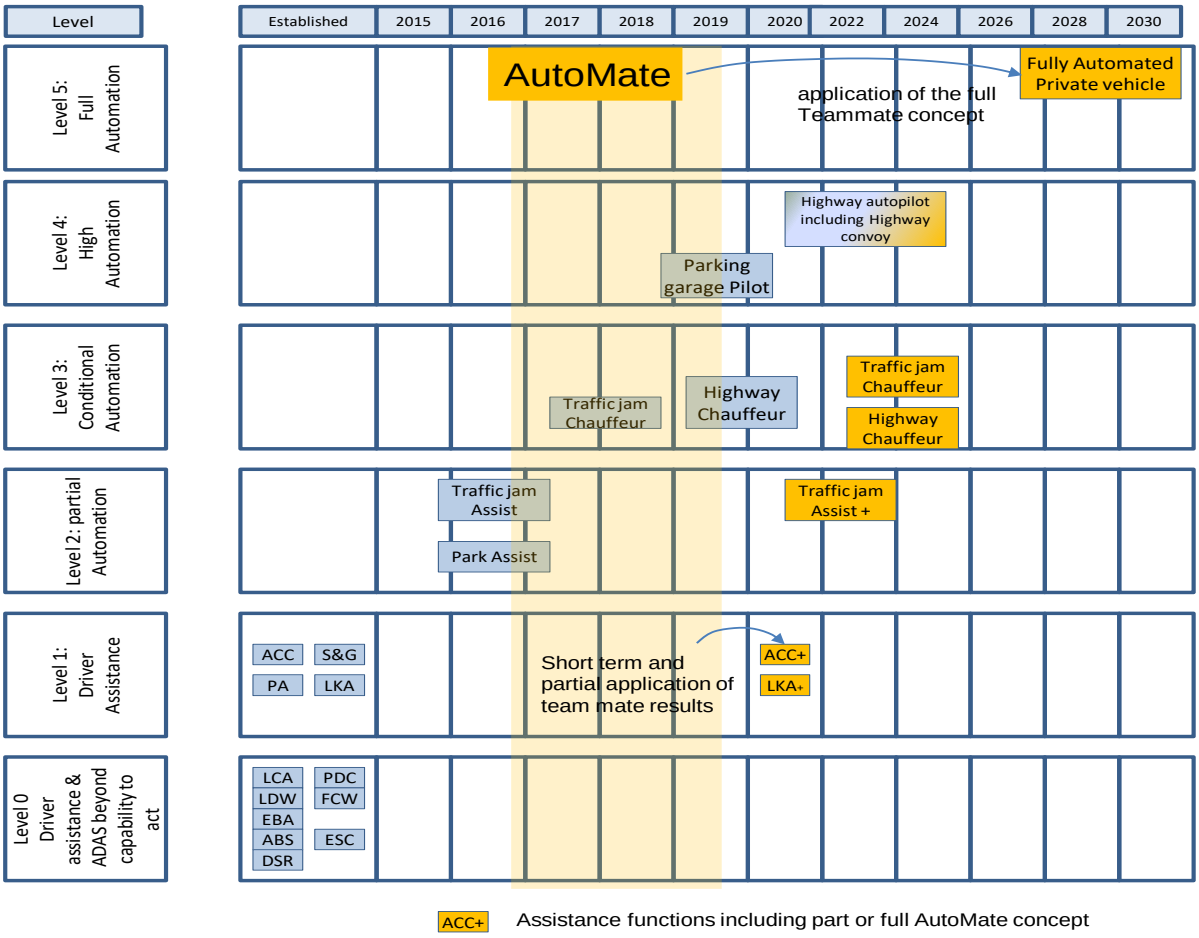

Figure 13: The Automated Driving deployment path for passenger cars

7 Business Plan

TeamMate products developed within the frame of the Automate project can be proposed for different level of automation, following a progressive introduction of these technologies.
TeamMate Business plan considers short, medium and long term applications of AUTOMATE products. The short term applications handles very simple situations that can be integrated in the releases of already existing/commercialized assistance functions (automation level 0/1 according to the SAE classification). The medium term applications addresses higher automation levels when the system performs both lateral and longitudinal control, in specific situations, like for example traffic jam assist (automation levels 2 and 3). The long term applications considers TeamMate approach and associated technologies to be fully exploited up to the highest level of automation where the driver is still involved (up to level 4). This encompasses the introduction of more sophisticated adaptive models of the driver driving behaviors covering all potential road scenarios.
The AUTOMATE Business plan considers:

- The Analysis of the various assistance functions that could be impacted by the AUTOMATE products
- The Automated functions road map (see figure below) presenting a first view on the assistance functions where automate products could be implemented
- The Market size and evolution considering the various levels of automation and assistance functions
- The market share considering the market positions of Automate Industrial partners
- The barriers for the introduction of .Team Mate products
- The targeted customers and commercial strategy relying on existing industrial partners networks
- The Competitors
- The potential new market targeted by the AUTOMATE Innovation ecosystem committee

Considering the **current market position of the AUTOMATE Industrial Partners**, the consortium is in an excellent position to achieve a significant economic impact. As shown in Figure 10, PSA and CRF, representing the FIAT Group, together had 18.5% share of EU unit sales in 2014 and PSA was the second largest player in the EU market (close to 11,7% market share in 2014). They have also a relevant position in the global market, with a total of 8% share between them Figure 11.
Apart from the OEM partners in the consortium, the Automotive Suppliers CAF will contribute to the overall economic impact of AUTOMATE. In fact, Continental Corporation (of which CAF is a part) shares 20% of the auto-motive electronics market according to a Semicast study (Figure 12). This study focuses exclusively on under-the-hood electronics including body, chassis, powertrain, safety and security related ECUs and applications. It does not take into account the fast growing segment of infotainment, embedded telematics and audio where Continental Corporation has got a strong position, too.
Considering the deployment path described in Section 2.2.4, PSA and Fiat Group can expect to sell first vehicles equipped with simple Team-Mate technologies in short-term after the project by the end of 2020. Taking into account the global market share in 2013 this will translate to a total of 800.000 cars with TeamMate features worldwide at minimum by the end of 2020 (8% of 10 million = 800.000). We want to note that this is a very conservative estimation taking into account only the sales of PSA and FIAT, while our dissemination and exploitation activities will target all Europe-an OEMs.

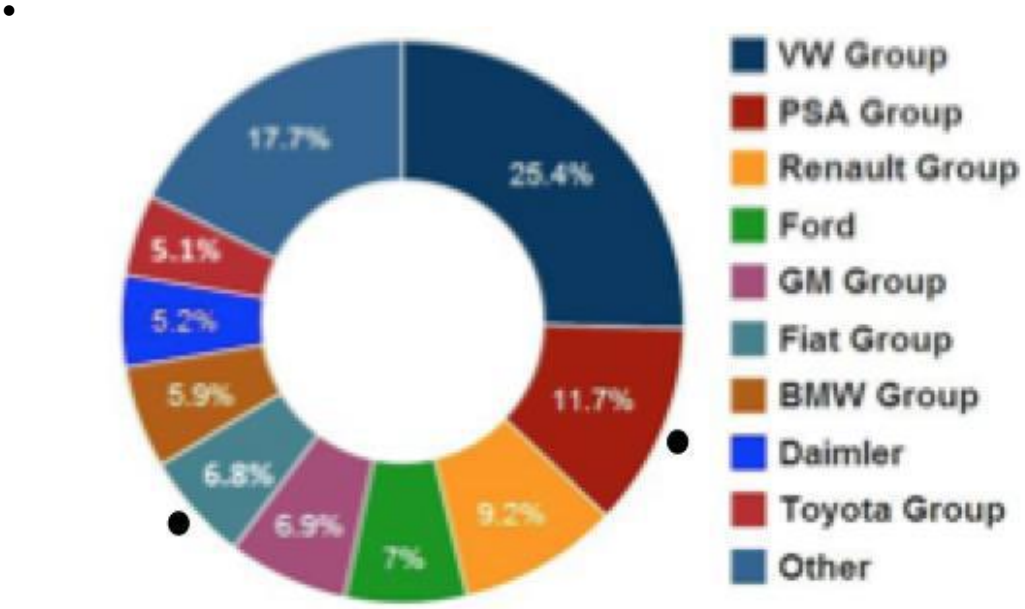

Figure 14: European Market Share by major Manufac-turer, January 2014 (http://www.acea.be/)

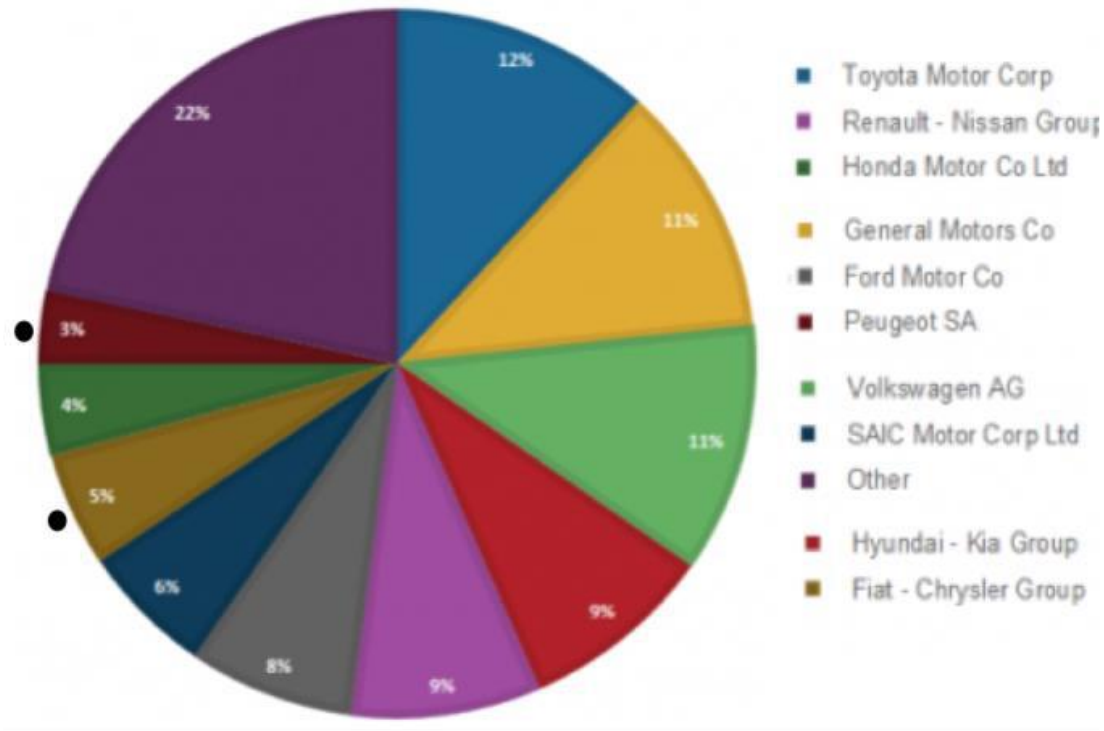

Figure 15:Global Market Share by major Manufac-turer, 2013 (Bloomberg 2013)

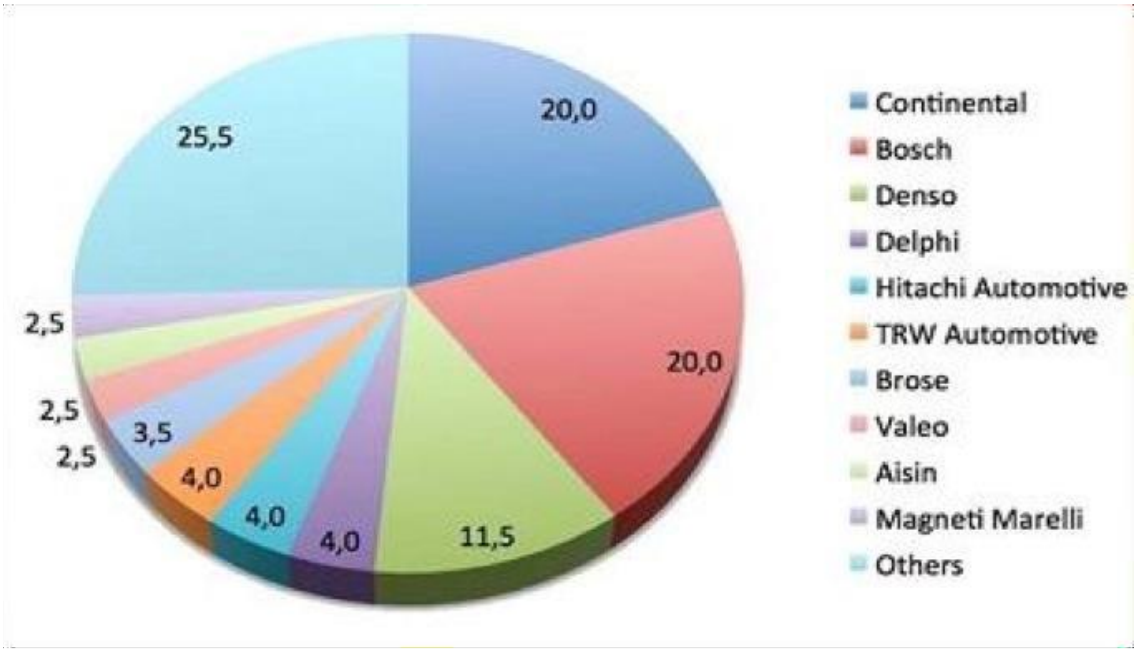

Figure 16: Global market for electronic systems in 2014

According to a recent studies, IHS Automotive forecasts that the price for self-driving technology will add an average cost of 6.000 € to a car's sticker price in 2020, to turn the average price of an automated car (such as the 500L or the Peugeot 308) up to 25.000 €. By considering these numbers, and the global sales of cars with TeamMate features to reach 800.000 units by 2020, an accumulate revenue of 20 billion € (25.000€ * 800.000 units) can be achieved by the end of 2020. An additional turnover is also due to the components that will be installed on the Automate vehicle. If we consider the 6.000 € additional cost as mainly due to the electronic components (new sensors, ECUs, actuators, communication infrastructure, etc.), the overall revenue for the global electronic systems suppliers of Automate cars can be estimated to be 4.8 € billion. Considering Continental Corporation's market share of 20%, it can reach a revenue up to 1.4 billion € by 2020.

The AUTOMATE project will enable the companies to fully exploit and to even exceed this potential, because the Teammate technologies will allow to build advanced automated driving functions that are trusted and ac-cepted and purchased by the end-users. The AUTOMATE innovations will leverage a broad market acceptance that will drive sales at a significant growth rate.

As becomes evident by comparing Figure 10 and Figure 11, the main markets of PSA and Fiat Group until now have been within EU (18.5% share of the EU market compared to the 8% of the global market). AUTOMATE will contribute to reinforce the competitiveness of the European industry by establishing a European solution for building trusted and accepted cooperation between human drivers and automated systems, which will boost sales volumes for European highly automated cars on Far East and US markets, too.

Finally, scientific partners and SMEs expect that the expertise and reputation gained from their involvement in AUTOMATE will unlock further (contract) research consultancy funding as well as licencing of patents of 500.000 € up to 1 million € per year per organization in the short term.