D7.8 **Final Exploitation Plan & Report**

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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.

These 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 final version of project exploitation plan. It will address the following topics

- The Main project results and innovation potentials (see section 2). This section provides the final list and description of the partners results achieved during 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 4), 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 5) Presents a summary of project IP rules and an overview of the IP status
- The exploitation strategy (see section 6), introduces the global consortium exploitation strategy and individual exploitation strategy
- The business Plan (see section 7) gives a final overview about the Automate project business plan following the CANVAS methodology

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).

Table 1 provides an overview of those results and innovation potentials while their detailed description 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
E2.3	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	OFF - HMT
E5.1	Online risk assessment	A	OFF HMT
E6.1	Interaction modality	A	ULM
E6.2	TeamMate Multimodal HMI (Combines previous E6.2, E6.3, E6.4 and E6.5)	A	REL
E6.6	Augmented Reality	A	HMT
E6.7	HUD	A	REL
Other	Simulator's functionalities improvement		ULM
Other	Simulator's functionalities improvement	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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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)	
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**
Preliminary description	Deliverable 2.2	CO
Detailed description	Deliverable 2.6	PU

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 an HMI as a 3D, 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 prototype phase, basic functions are available for testing.

CURRENT STAGE OF DEVELOPMENT

Please tick one category only 4

Scientific and/or Technical knowledge (Basic research)	
Guidelines, methodologies, technical drawings	
Software code	
Database, Data Source	
Experimental development stage (laboratory prototype)	
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**
Preliminary description	Deliverable 2.2, Deliverable 2.3, Deliverable 2.4	PU
Detailed description	Deliverable 2.6	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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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 4

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
Description of Validation study	Deliverable 2.6	PU

2.4 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

4

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

2.5 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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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
Description of Validation study	Deliverable 2.6	PU

2.6 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

4

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

2.7 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**

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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)	x
Guidelines, methodologies, technical drawings	
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 3.5	PU
Validation	Deliverable 3.7	PU

2.8 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 calculates trajectories to guide a vehicle safe and comfortable through the environment. The code is written in C++, integrated in the Ulm vehicle and used for evaluation studies.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	

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**
Preliminary description	Deliverable 3.3, 3.5	PU

2.9 Description of the result ''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
Validation	Deliverable 3.7, 6.3	PU

2.10 Description of the result "Online Risk Assessment"

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

WP	**3**

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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
Validation	Deliverable 3.7	PU

2.11 Description of the result "Interaction Modality"

No.	**Self-descriptive title of the result**
E6.1	Interaction Modality

WP	**4**

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SUMMARY

This module provides guidelines to design the interaction modality for highly automated vehicles. Based on the empirical results of the different interaction modalities in the driving simulator and existing literature, ten guidelines which define the modality, needed feedback and restriction have been derived. These are recommended to be taken into account while designing the interaction with highly automated vehicles. These guidelines can be used outside the project. Currently, they are in the publication process of a conference and therefore will be publicly available soon.

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)	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 6.2	PU
Validation	Deliverable 3.7	PU

2.12 Description of the result "TeamMate Multimodal HMI"

No.	**Self-descriptive title of the result**
E6.2	TeamMate Multimodal HMI

WP	**4**

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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
Description of 2nd version	Deliverable 4.6	PU

2.13 Description of the result "Augmented Reality"

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

WP	**6**

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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

.

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

2.14 Description of the result “Simulators functionalities improvement” -ULM

No.	**Self-descriptive title of the result**
	Simulators functionalities improvement

WP	**5**

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Specific Result URL	https://www.uni-ulm.de/in/psy-hf/team/juergen-pichen/

SUMMARY

During the AUTOMATE project, both the ULM driving simulator and also the Ulm vehicle have been extended with specific functions.
In the ULM simulator, SILAB driving simulation engine has been extended with automated driving features and augmented reality features. A basic HMI has been implemented to allow the transition from automated driving to manual driving. In addition, the steering wheel interaction modality with a force feedback has been integrated in the driving simulator to support the cooperation between drivers and highly automated vehicles. For the integration of and the communication between all enablers the simulator was upgraded with hardware that allows to run the simulation with all features simultaneously. The operators' room has been equipped with an additional interface to control the TeamMate functionalities during an experiment. The TeamMate enablers have been implemented in the simulator and could be used in collaborative research between the consortium partners.
In the Ulm vehicle, trajectory planning has been implemented to guide the vehicle safe and human like through on road traffic. The planner uses a driver model to make sure the corresponding motions are social compliant. Furthermore, the planner is capable of performing lane changes by using a decision layer based on the same driver model as used for planning.

The achieved research results can be used by industrial partners transferring the knowledge to innovative products worldwide. Besides, the close cooperation with the industrial partners in AUTOMATE has greatly helped the exchange of research interests and strengthened the networking, which provides the possibility of project acquisition and collaboration in the future.

CURRENT STAGE OF DEVELOPMENT

Scientific and/or Technical knowledge (Basic research)	X
Guidelines, methodologies, technical drawings	
Software code	X
Database, Data Source	X
Experimental development stage (laboratory prototype)	X
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**
Preliminary description	Deliverable 5.3	PU

2.15 Description of the result "Simulators functionalities improvement" - REL

No.	**Self-descriptive title of the result**
	Simulators functionalities improvement - REL

WP	**5**

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URL	
Specific Result URL	

SUMMARY

During the AUTOMATE project, REL simulator has been upgraded to SCANeR 1.7 version in order to integrate customizable automated driving functionalities and new interaction elements, such as a force-feedback steering wheel.

Moreover, during the project the simulator has been updated with some of the modules developed in AutoMate, such as the Driver Monitoring System (DMS) for drowsiness and distraction detection – developed by Continental, the Driver Intention Recognition – developed by Humatects, and the TeamMate multimodal HMI – developed by REL, including a haptic seat cover able to use the data collected by the other modules through the simulator's network (e.g. to vibrate when the DMS detects that the driver is distracted). The guidelines on interaction modality have been integrated in order to allow a safe and comfortable transition of control between the agents in highly automated driving.

In the project's framework, a software module to easily integrate the external components (hardware and software) in the driving simulator, has been developed. The results achieved in the project can be used by REL in conjunction with industrial partners, to facilitate the integration and testing of different modules and interaction system at driving simulator, in iterative R&D studies. The results of this project will foster the role of RE:Lab as key partner in research and innovation activities, thanks to the experience gained in driving simulator studies conducted in relation to highly automated driving features.

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)	X
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**
Description of the Baseline implementation	D5.2	PU
Description of the TeamMate implementation	D5.3	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.

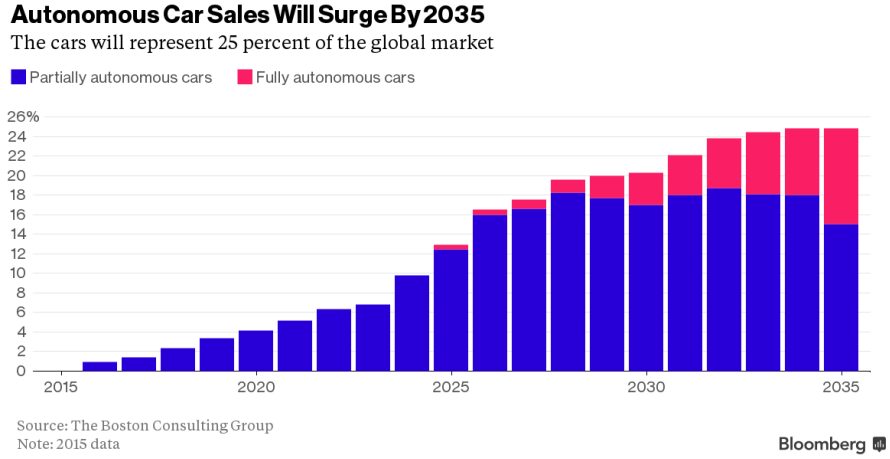

Figure 1: The Boston Consulting Group

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.

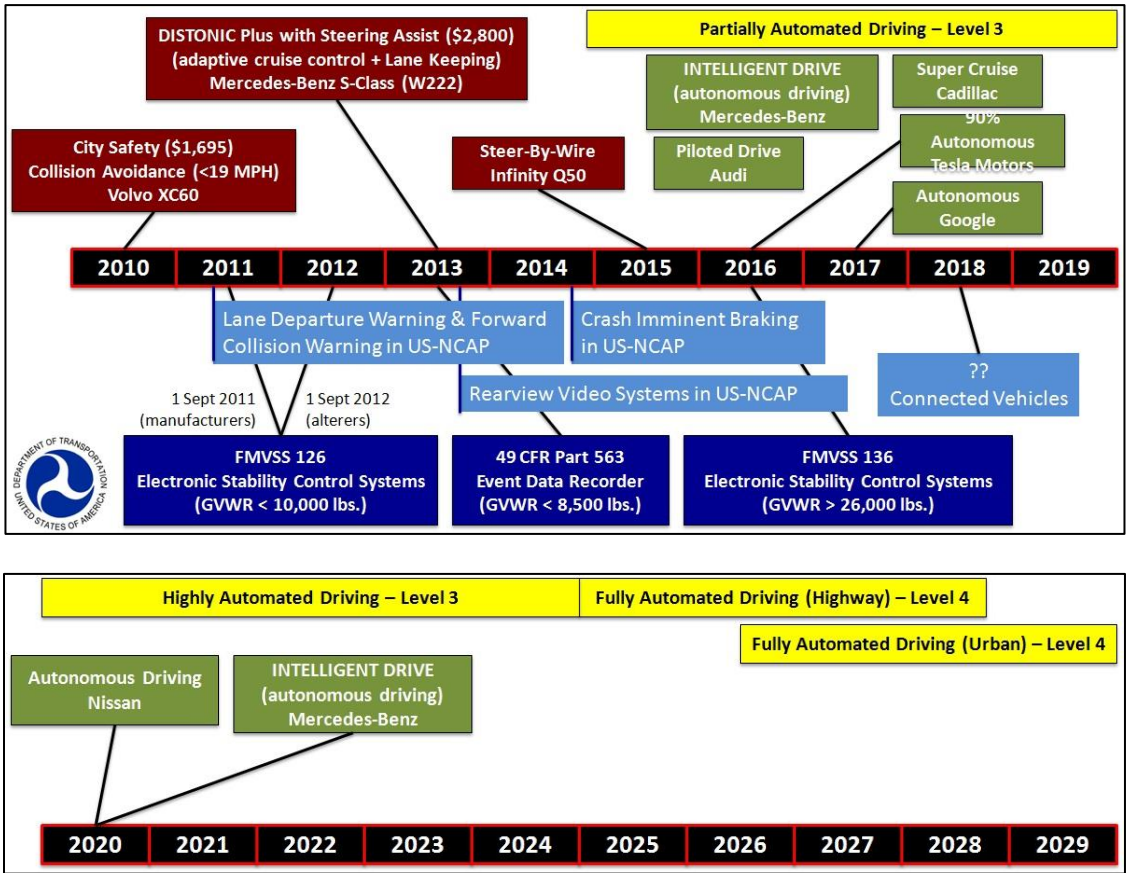

Figure 2: RoadMap given by the SAE

Nowadays, some high level automation is already being tested in some areas in Europe in low speed and/or in dedicated infrastructure for automation. The road map of automated driving system, given by ERTRAC (European Road Transport Research Advisory Council) in 2017, shows a progressive step-wise increase of automation level during the upcoming decade.

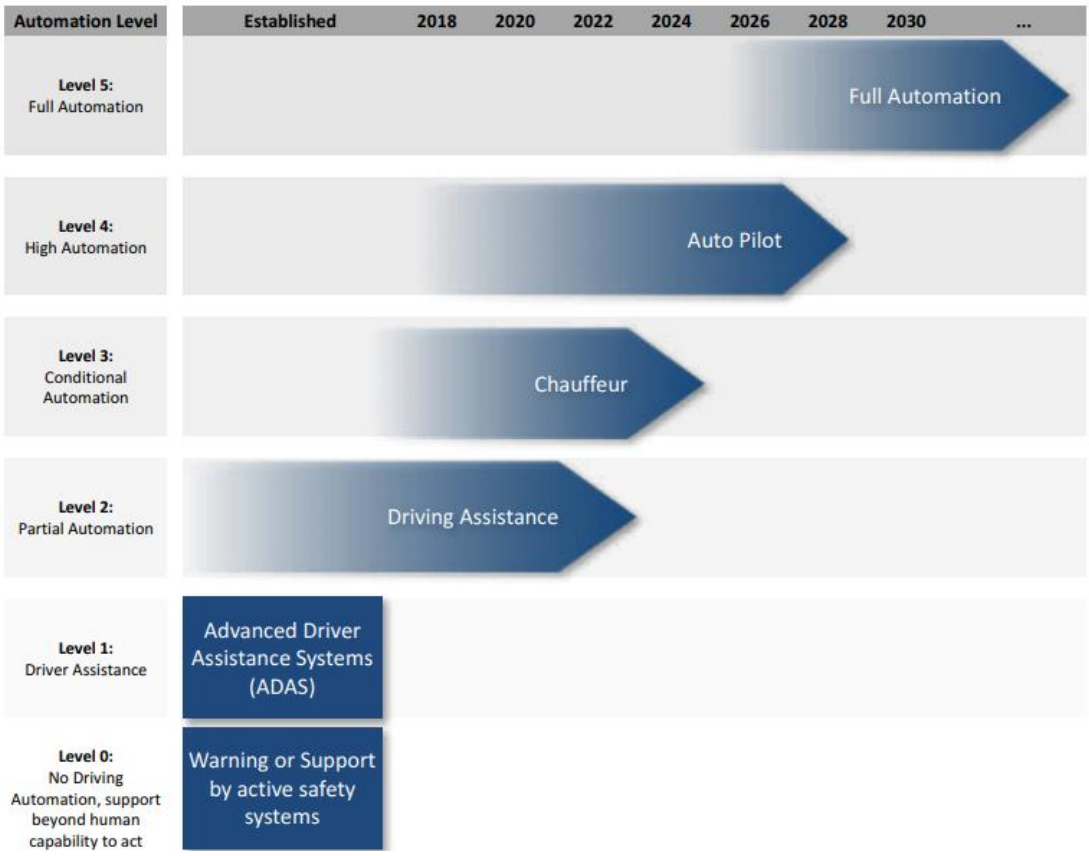

Figure 3: The vehicle automation development paths

According to the report of ERTRAC, the high level automated driving cars (Level 3) has been established since 2018, with features like Highway Chauffer and Traffic Jam Chauffer which need the driver ready to take over the driving task when there is a request from the system.
The level 4 and level 5 of automation driving cars in urban road and highway, which do not need the driver to take over during the driving task, will come later, after 2020 and 2030 respectively.

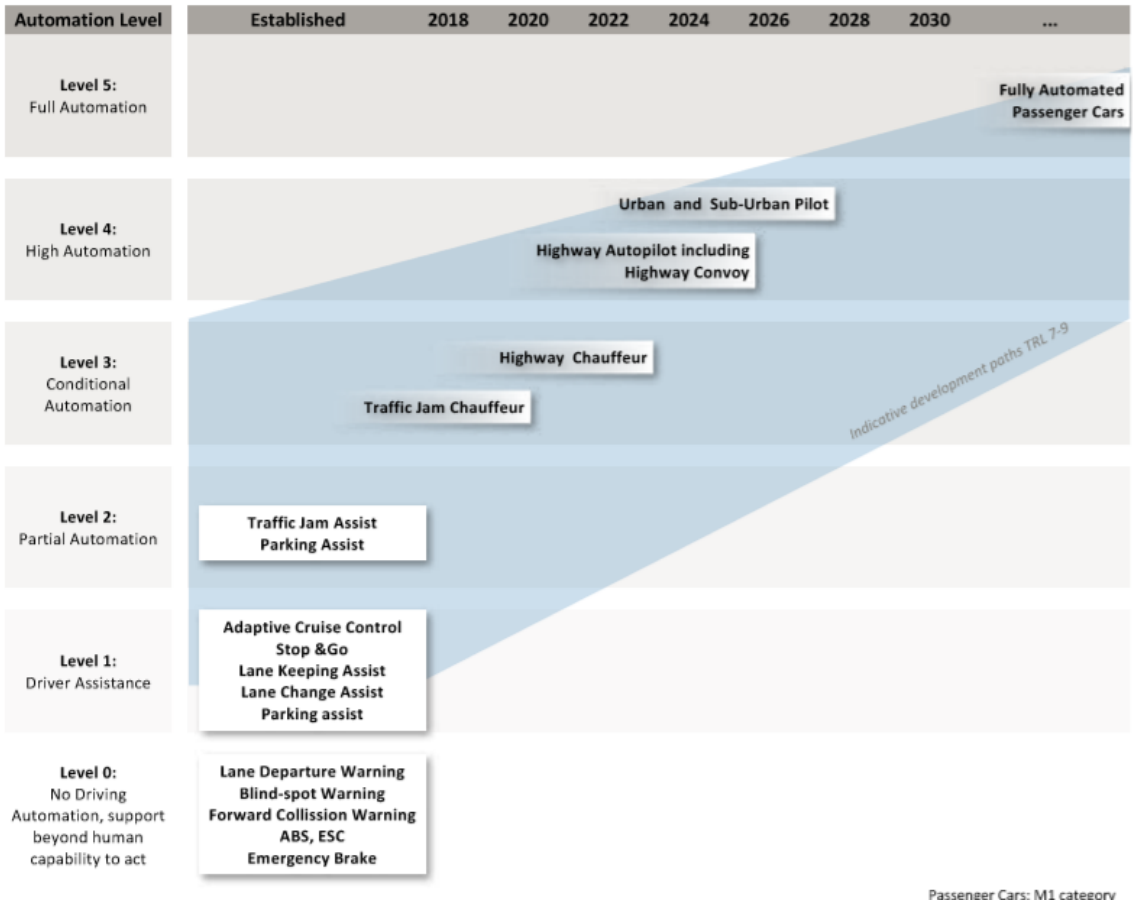

Figure 4: The automated driving development path for passengers cars

Regarding the automated driving for freight vehicles, it mainly focuses on the highway driving. Some features of level 3 and 4 has been established before 2018. Still according ERTRAC, most of high level automation (level 4 and 5) will come after 2022 or later.

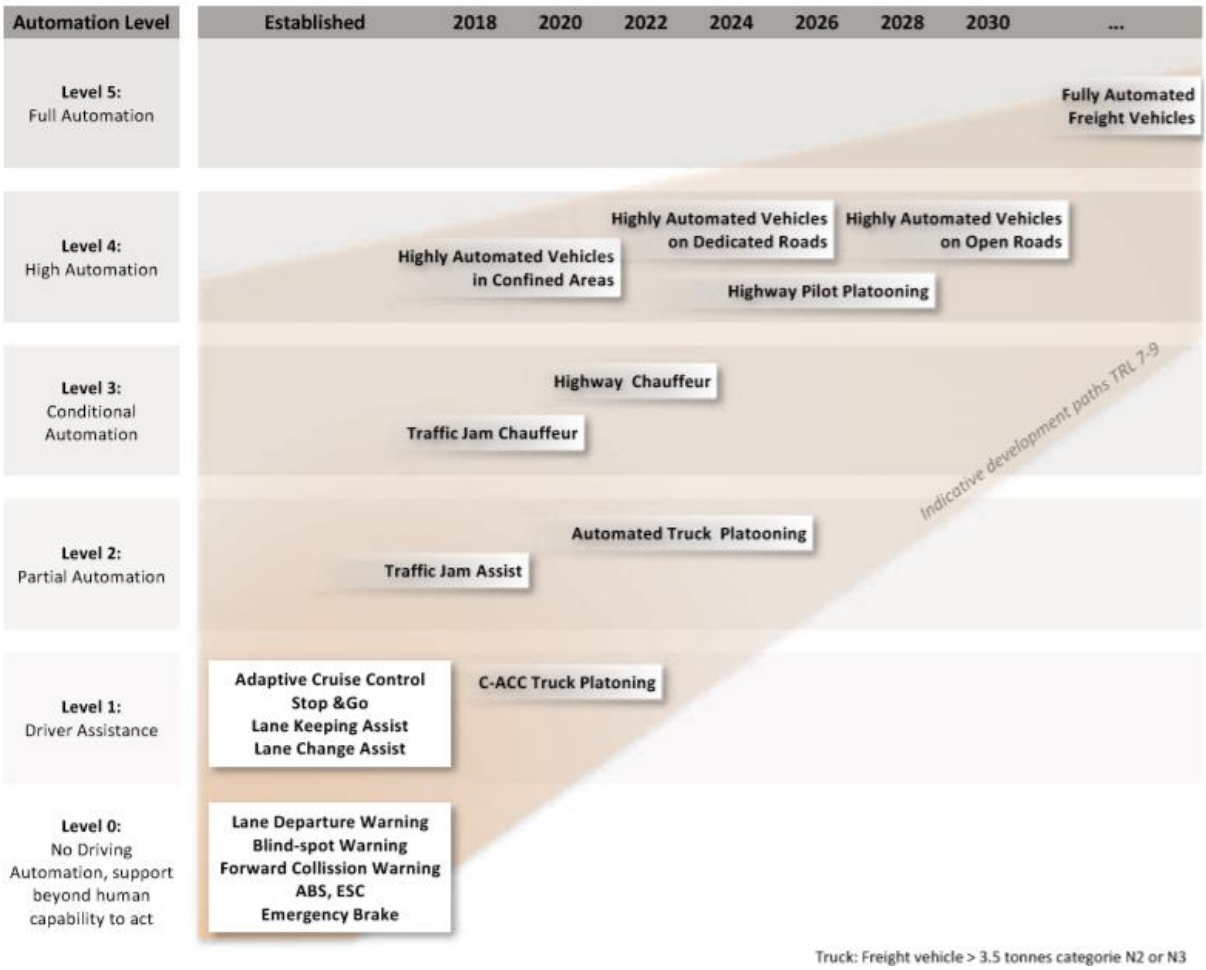

Figure 5: The automated driving development path for freight vehicles

The automated driving for urban mobility vehicles is mainly focuses on the transport of urban road to improve the traffic flow in the city. The automated bus/PRT/shuttles on dedicated roads has been established since 2018. On mixed traffic it will come after 2024. The fully automated urban mobility should be established after 2030.

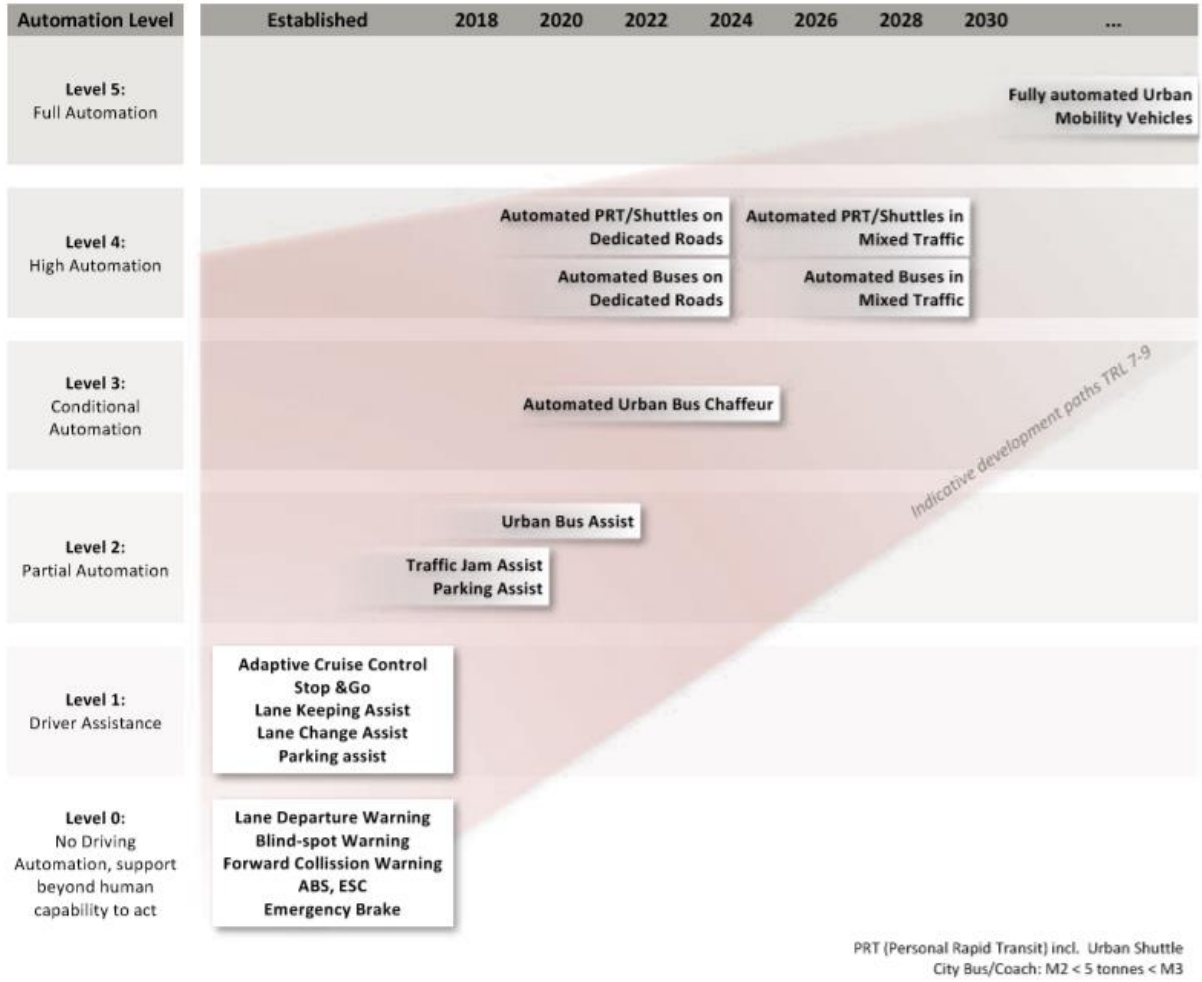

Figure 6: The automated driving deployment path for urban mobility vehicles

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. The plans of this project were later scaled back to just focus on self-driving technologies. Then it will be shared with OEMs partners such as Volkswagen who will provide the hardware.
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. The company hired Doug Field, a former chief engineer for Tesla, to oversee its project alongside Bob Mansfield, who used to be senior vice president of hardware engineering. The first prototype of the autonomous vehicle of Apple will be available in 2023-2025, according to the prediction of professional analyst.

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, especially as Traffic Jam Chauffeur, in its next-generation A8 flagship, although the vehicle's SAE Level 3 (conditional) automation will have limited availability pending regulatory approvals. This automated driving system can take over steering, braking, and acceleration in some parts of highway roads. Besides, it does not require the attention of the driver to the car's surroundings.

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. Volvo will begin shipping to Uber 24 000 XC90 sport utility vehicles for self-driving activities in 2019, in spite of delays due to the testing program following a fatal accident in march 2018.
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. Volvo Level 2 for automated vehicles will be on the market by the early 2020s.

And more recently, a new partner named NVIDIA also joined Zenuity.

The main focus of NVIDIA is to provide autonomous platform of In-Vehicle AI Computer to the OEMs. The big announcement from CES 2019 in Las Vegas was the unveiling of DRIVE AutoPilot, which the company calls "the world's first commercially available Level 2+ automated driving system".

Baidu: In June 2016, Baidu CEO Robin Li disclosed a five-year goal for the mass production of driverless vehicles. Its open platform for autonomous driving (including hardware and software), named as Apollo, has been advancing to contribute to the high level automated vehicle. Recently, Baidu and Volvo said that they plan a mass production for the Chinese market, although there is no timeline for this corporation.

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 (Aptiv) 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, Daimler and Bosch have joined forces to develop Level 4 (high automation) and 5 (full automation) vehicles, with Daimler having two years of exclusivity on the co-developed system before it can be offered to competing automakers. The aim of the urban mobility in California is to improve the fluidity of traffic in cites, enhance road safety, and provide an important building block for the way traffic will work in the future. The prototypes will be based on the Mercedes-Benz S-Class sedan and they will travel autonomously with a safety driver behind the wheel.

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." Cooperating with chip supplier NVDIA in 2018, its Artificial Intelligence self-driving vehicle systems will be based on NVDIA's computing platform, with planned market introduction in 2021 for Level 3 automation features.

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 invested 1 billion dollars and announced that it would take a majority stake in AI startup Argo. Argo AI has received a testing permit in the early 2019 from the California Department of Motor Vehicles to test on public roads, as part of a ramp-up toward Ford's commercial service that's supposed to begin in 2021. Recently, Volkswagen plans to invest approximately 1.7 billion in Argo AI as part of a growing partnership between the two automakers.

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. For 2019, GM expects to spend roughly 1 billion dollar on Cruise and plans to double in size by the end of 2019 to push its self-driving taxi service up and running. Following the investments from SoftBank and Honda, Cruise is now valuated at 14.6 billion dollars.

Chinese telecommunication giant Huawei has shifted resources toward the development of autonomous vehicles Huawei is continuing to debut next-generation communications and AI solutions that will be of interest to companies around the world. Huawei's latest such offering is the Mobile Automation Engine (MAE), a solution designed to accelerate autonomous driving using cellular networks.
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). Huawei expects that AI will grow in capability during the late 4G and early-to-mid 5G eras, with fully driverless cars becoming available in 10 years or so, likely in the 2030s. The high speed (~ 10 Gbit/s) and no latency 5G network will enforce the connection of autonomous vehicles to communicate with other vehicles, with infrastructures and with everything (V2X).

Jaguar Land Rover and Waymo announced a long-term strategic partnership in early 2018, the two company will develop the world's first premium self-driving electric vehicle for Waymo's driverless transport service. They will work together to design and engineer self-driving Jaguar I-PACE vehicles equipped with Waymo's self-driving system.

Nissan/Renault: At April's New York Auto Show, former 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." Renault has unveiled EZ-Ultimo concept Self-driving car with full electric and a level 4 autonomous driving technology in Paris Motor Show 2018. 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. Its efforts are mainly focused on a software- and hardware- based open platform called Drvline, designed to make Samsung a 'go-to partner' for manufacturers that want to develop autonomous cars.

Groupe PSA: In April 2016, French Groupe PSA (including Peugeot, Citroën, DS and Opel-Vauxhall) 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. In April 2019, Groupe PSA vehicles, equipped with Level 3 autonomous driving functions, have been operating on open road in France, as part of the European L3Pilot project.

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. In January 2019, Toyota Research Institution (TRI) introduced the TRI-P4 automated driving test vehicle at CES Las Vegas. The P4 is based on the all-new fifth-generation Lexus LS flagship sedan and will be used in TRI's two-track Guardian and chauffeur automated driving system development.

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. Valeo also showed its Driv4U Remote concept which is used to remotely control autonomous vehicles strictly when needed for safety reasons, and Valeo Voyage XR which is able to simulate the virtual presence of a person – based in a fixed location – on board the autonomous vehicle during the journey at CES 2019.

Volkswagen: The Group's head of digitalization asserts that self-driving cars will be "commonplace" by **2025**. In 2019, Volkswagen begins to test automated driving Level 4 at real driving conditions in major German cities. For now, a fleet of five e-Golf, equipped with laser scanners, cameras, ultrasonic sensors and radars, drives on a three-kilometer section of the digital test bed for automated and connected driving in Hamburg. The partnership of Volkswagen Group and Aurora in 2018 has provided best-in-class expertise and experience bringing self-driving cars to the roads quickly, broadly and safely, Aurora is supporting the Volkswagen group to make their version of the future 'Mobility for all, and the push of a button' becoming reality.

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 hybrid 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 7*). These levels are supported by 5 main components (*Figure 8*): 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.

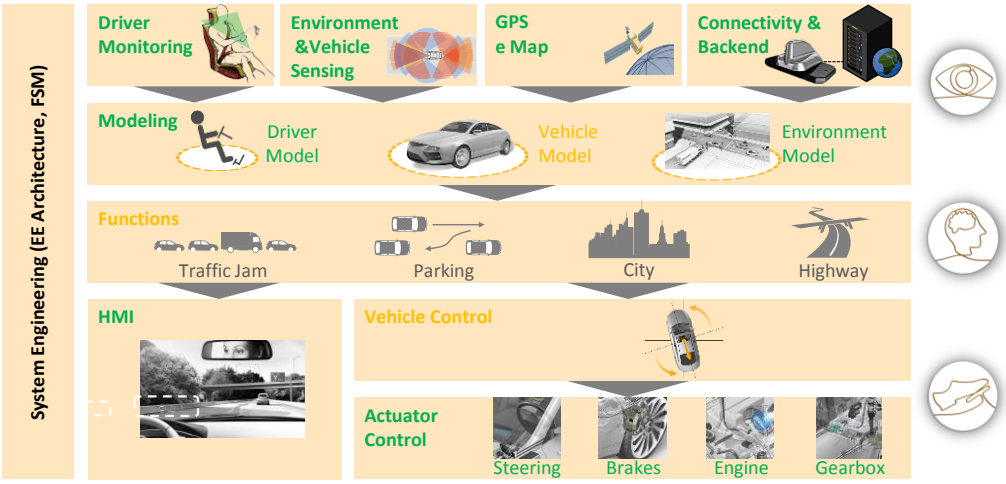

Figure 7: System engineering technology: Sense, Plan, Act

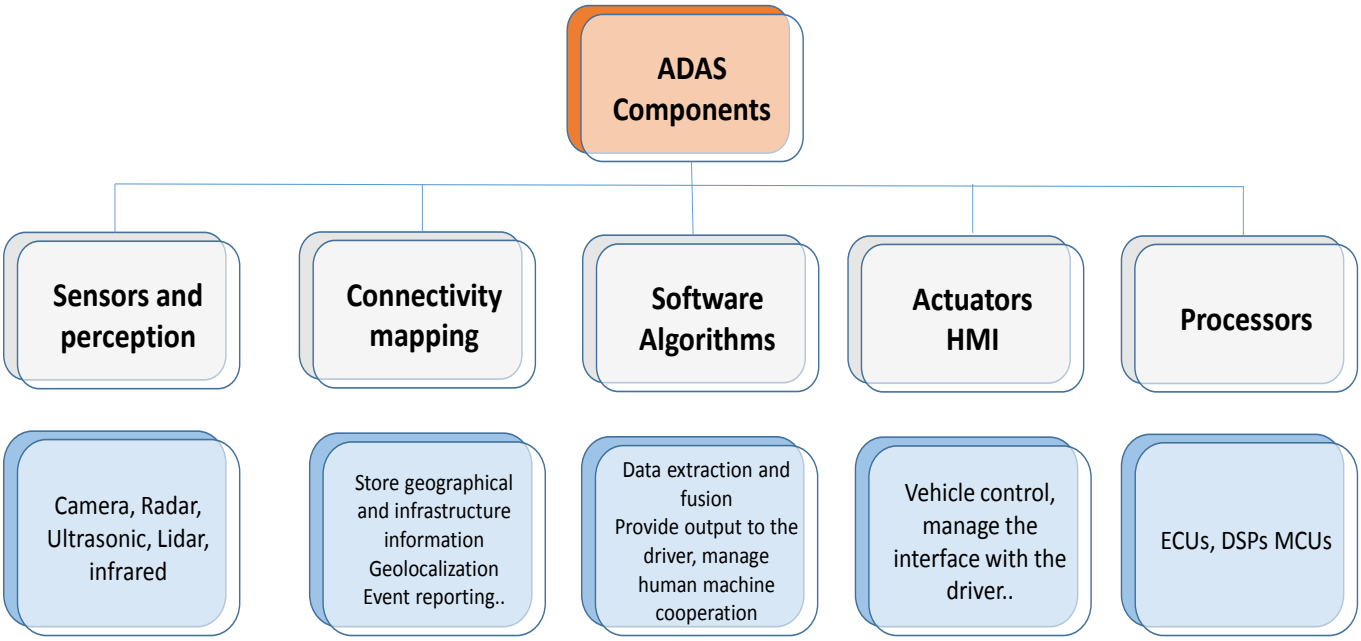

Figure 8: Segmentation of ADAS technology roadmap by components

- 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.

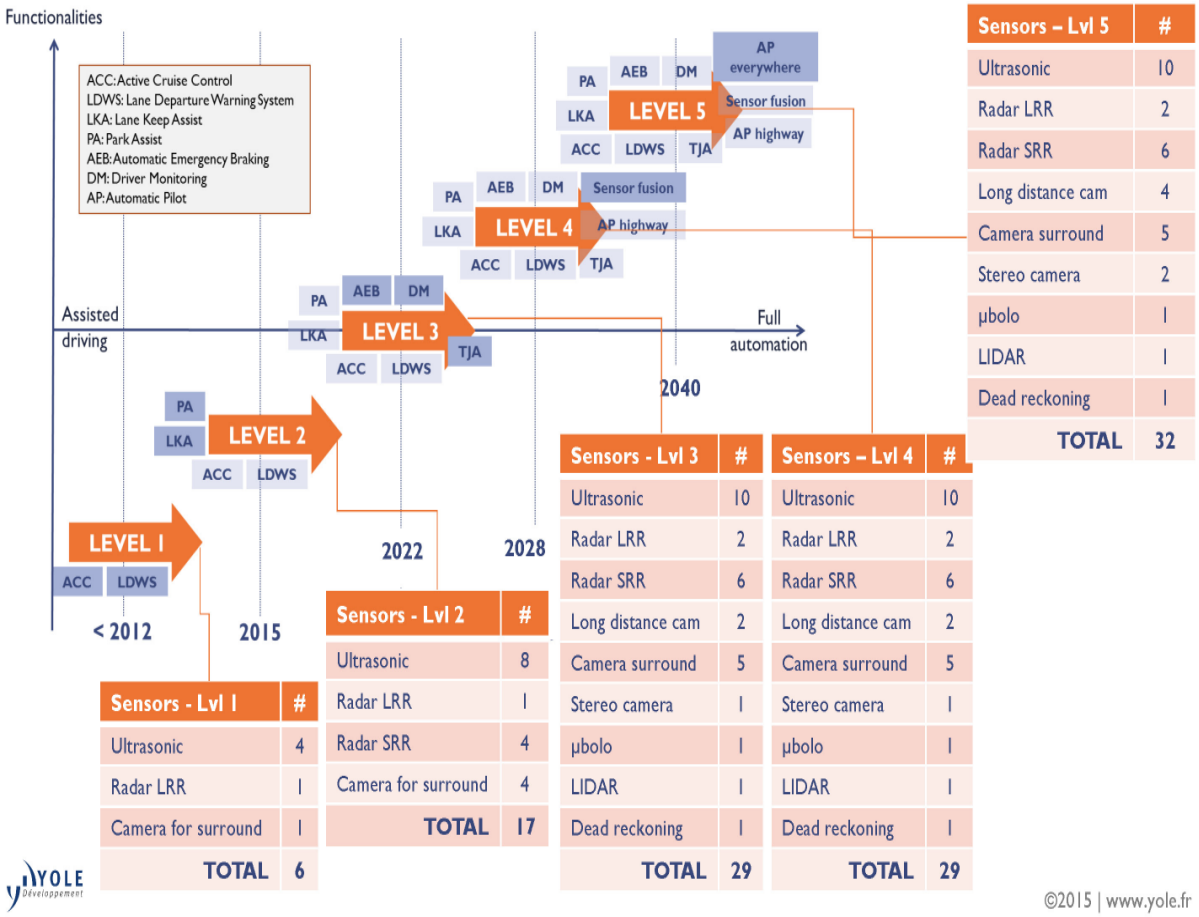

Figure 9: Sensor technology road map and associated autonomous functions (Source: Sensor & data management for Autonomous Vehicles report, Oct 2015, Yole department)

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 10):

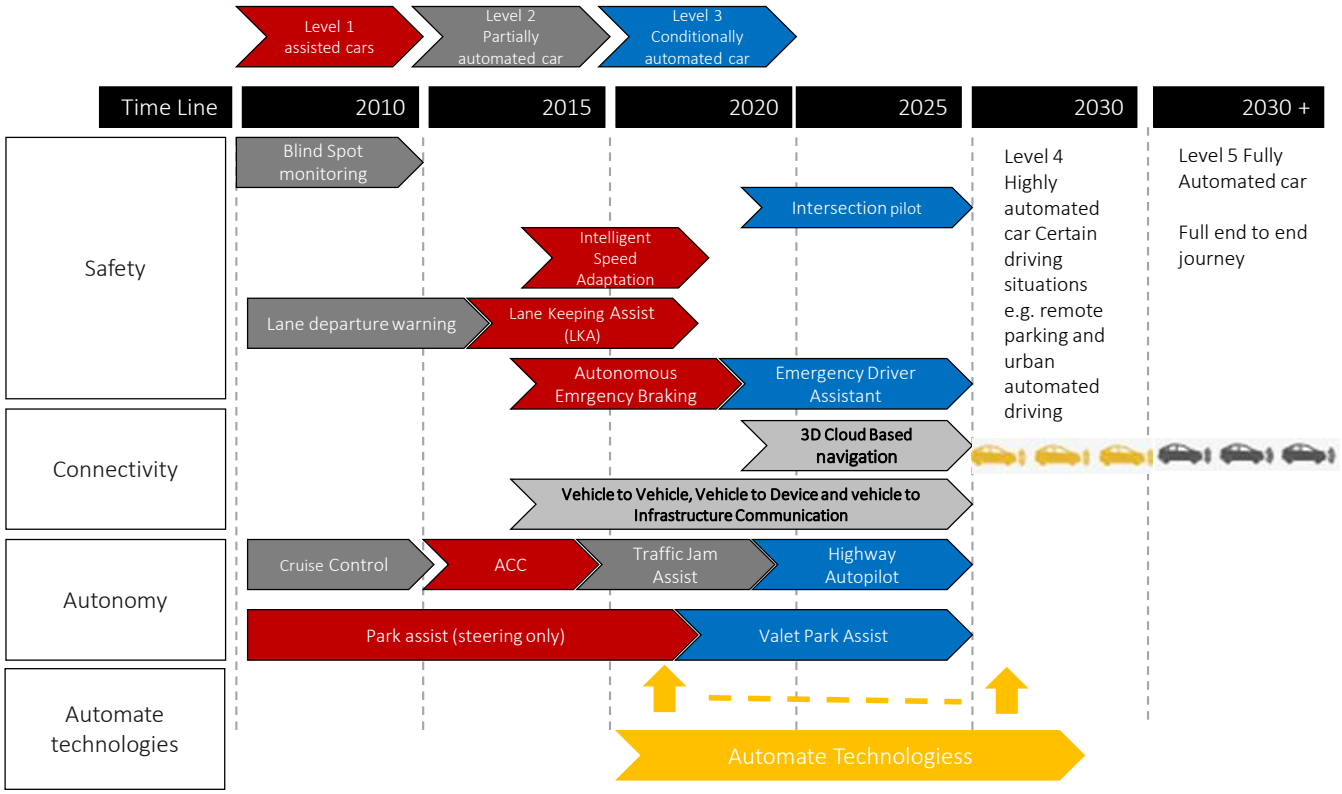

Figure 10: Impact of the Automate technologies on automated vehicle road map

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 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. 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.
- Daimler and Bosch have joined forces to develop Level 4 and Level 5 autonomous vehicles.
- Argo is supporting Ford to test its autonomous vehicles on public road.
- GM invests Cruise to push its self-driving taxi service up and running.
- Jaguar Land rover works with Waymo to develop the world’s first premium self-driving electric vehicle for Waymo’s driverless transport service.
- Volkswagen and Aurora works together to bringing self-driving cars to the road.
- Waymo also opened signups for the first public tests of its customized Chrysler Pacifica hybrid minivans (FCA), quickly followed by Lyft partnership

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

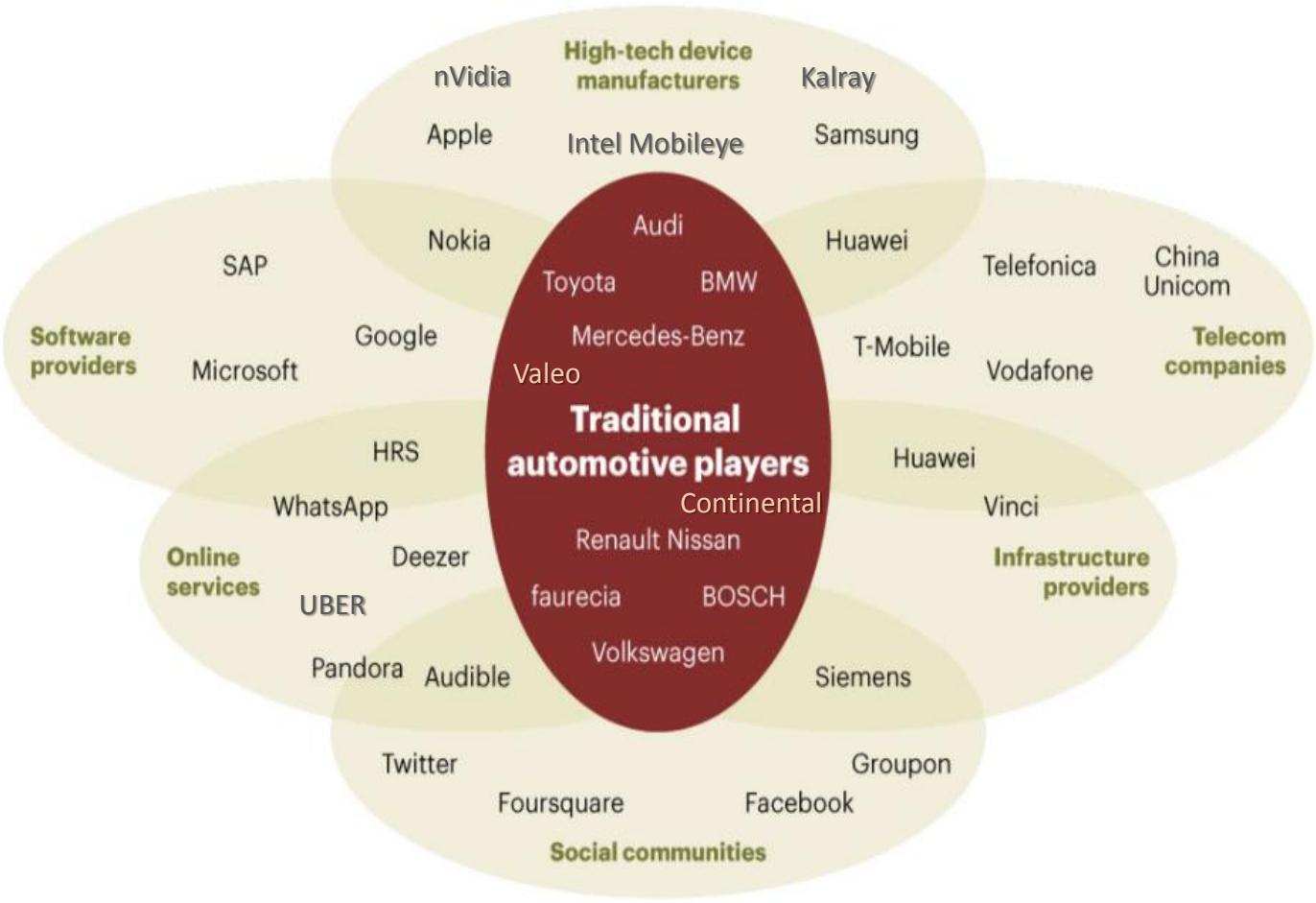

Figure 11: Non exhaustive view of the companies will join forces to create powerful ecosystems (from ATKearney : How Auto makers can survive the self-driving era report)

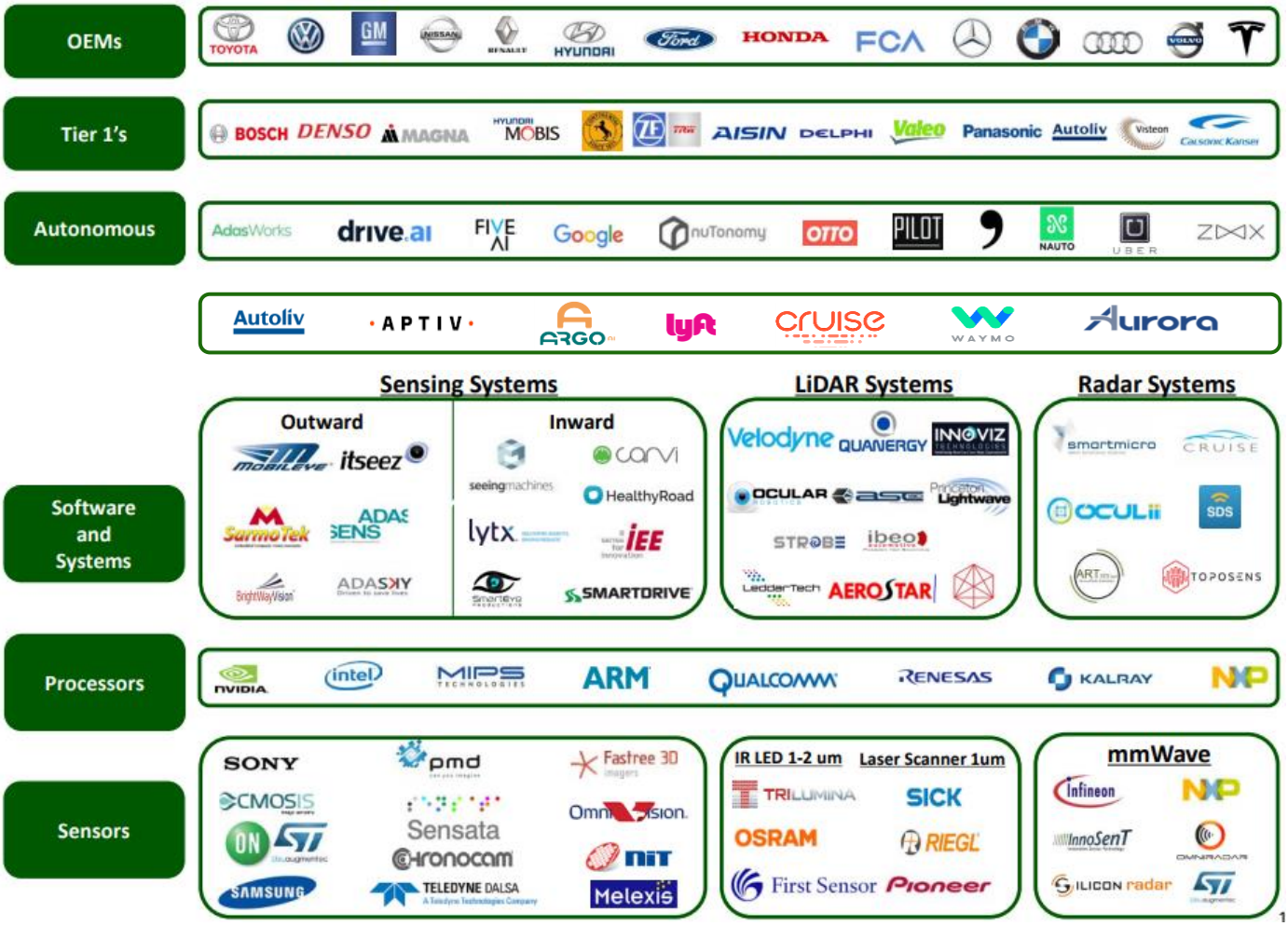

Figure 12: Overview of the main companies involved in the development of autonomous vehicles.

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."

[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)

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 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 Functions (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.

3.4.5 Future Certification of Automated/Autonomous Driving Systems

Recently, regarding the augmentation of the complexity of automated driving systems and the increasement of the soft-ware based AD functions in self-driving cars, the experts of OICA (The Organisation Internationale des Constructeurs d'Automobiles) work together to propose a new certification. It will allow to demonstrate the level of safety and reliability for safe market introduction of automated/autonomous vehicles. In an informal document (named "Future certification of automated/autonomous driving systems") worked in WP.29 GRVA in early 2019, several general challenges/premises for a suitable approach to regulate Automated Driving are consider:

- *It is important to consider that WP.29 GRVA is aiming at regulating new technologies of which the majority is not available on the market yet*
  - *Lack of experience should not be neglected and tackled with reasonable strategies (e.g. generic safety approaches/requirements) in order to guarantee the highest possible level of safety.*
- *Technology for Automated/Autonomous Driving Systems will continue to evolve rapidly over the next years*
  - *need flexible structures that can be applied to the different kinds of L3-L5 systems instead of limiting the variation/innovation of different kinds of systems by design restrictive requirements*
  - *Regulating "function by function" would require frequent updates/ upgrades of regulations and would therefore not be practical. Furthermore, it could easily become highly design restrictive*

The new concept for certification depends on three pillars: "audit and assessment" ; "physical certification tests" and "real world test drive".

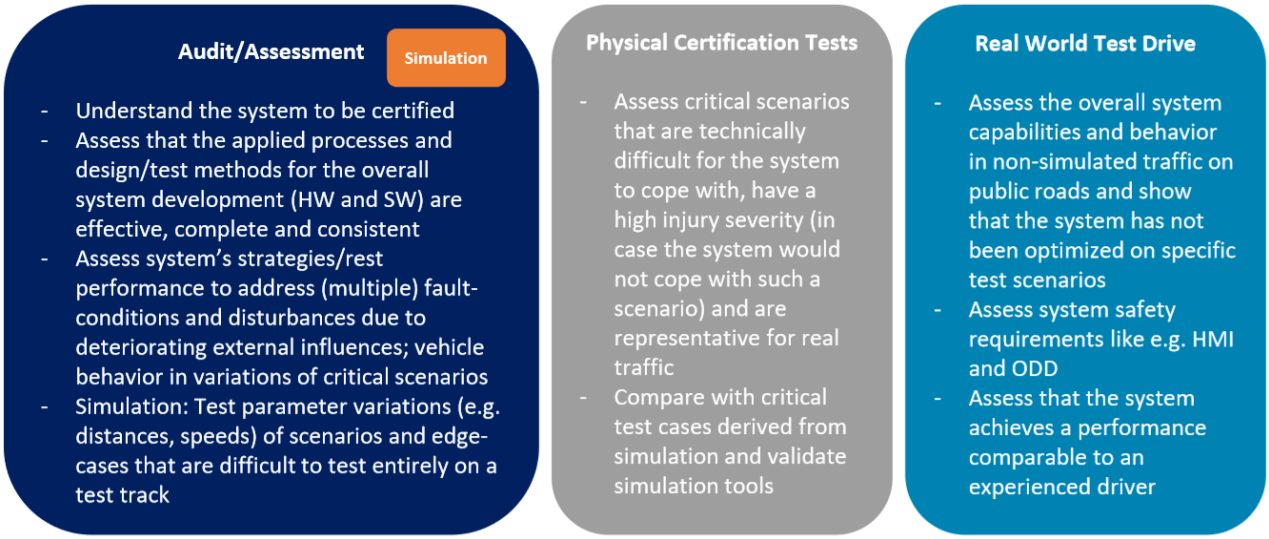

Figure 13: Concept for certification - the three pillars and their individual purpose

The approach of OICA can generate an equivalent/higher safety-level compared to the "classical" approach:

- *The new approach recognizes established process and functional safety oriented audits for certification of complex electronic vehicle control systems as a foundation.*
- *The new approach requires manufacturers to give evidence that their system has been designed and tested in a way that complies with established safety principles, different traffic rules, and ensures safe performance both under fault-conditions and arbitrary external influences.*
- *Furthermore, the new approach evaluates specific complex situations on a test track.*
- *To complement the assessment, the new approach includes a real-world-drive test in real world traffic (non-simulated).*

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.

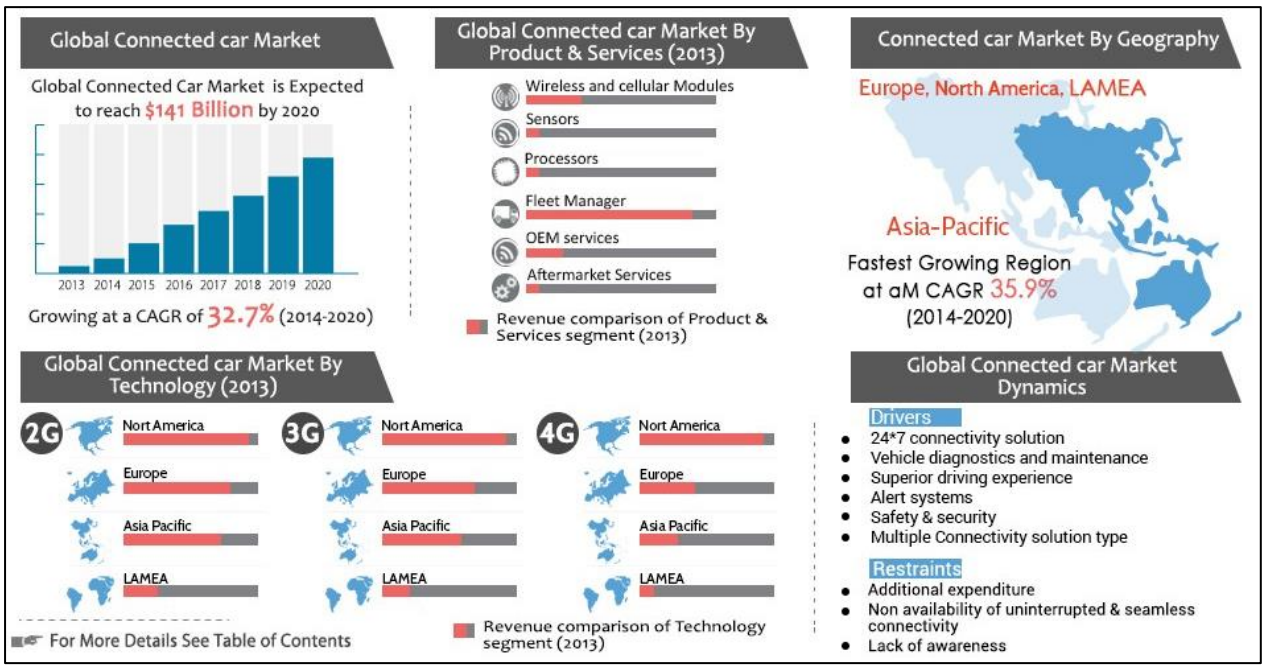

Figure 14: Global Connected Car Market. Size and Forecast (2013-2020):

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. The 5G communication, with deployment scheduled from as early as 2020 in vehicles communications or V2X communications with C-V2X (Cellular vehicle-to-everything), promises a high-speed upload/download data rates and a very low latencies by an enhanced communication range and reliability in dedicated ITS 5.9 GHz spectrum. This new technology will enable vehicles to interact in real time with encountered environment (vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian) to ensure the road safety, optimize the traffic efficiency and energy consummation. According to the report of BCG, from 2018 to 2035, the market of connected cars will increase dramatically, in 2020, V2X vehicle will hold a market with almost 100 billion dollars.

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.

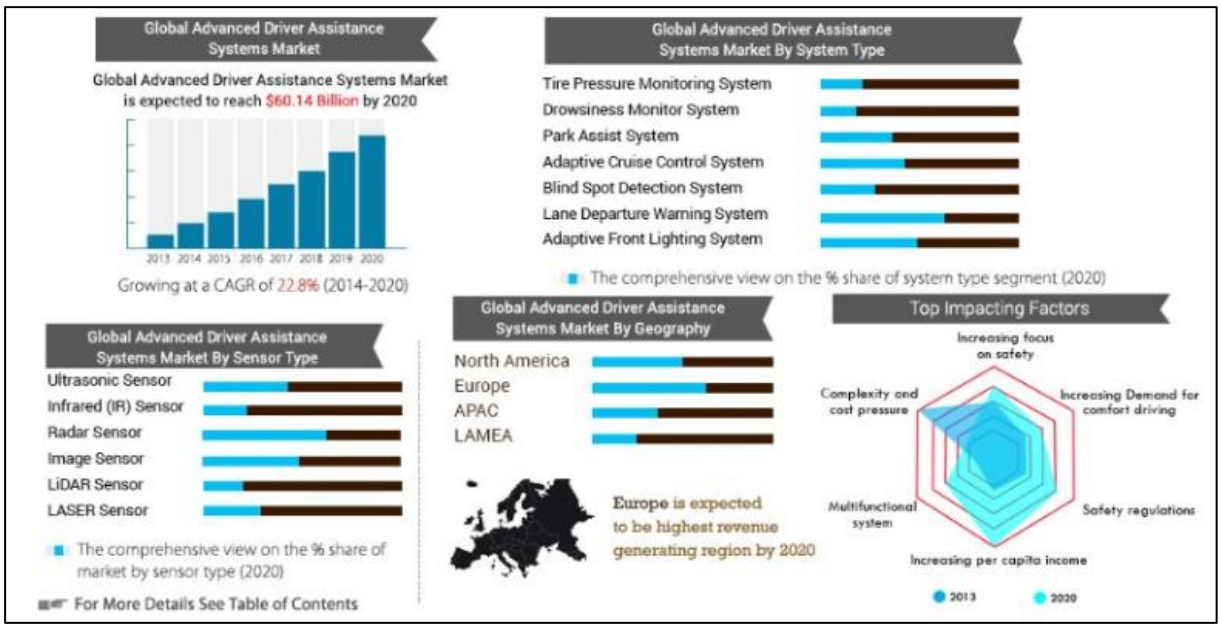

Figure 15: Global Advanced Driver Assistance Systems (ADAS) Market - 2015. Segmentation and Forecast, 2013 – 2020.

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.

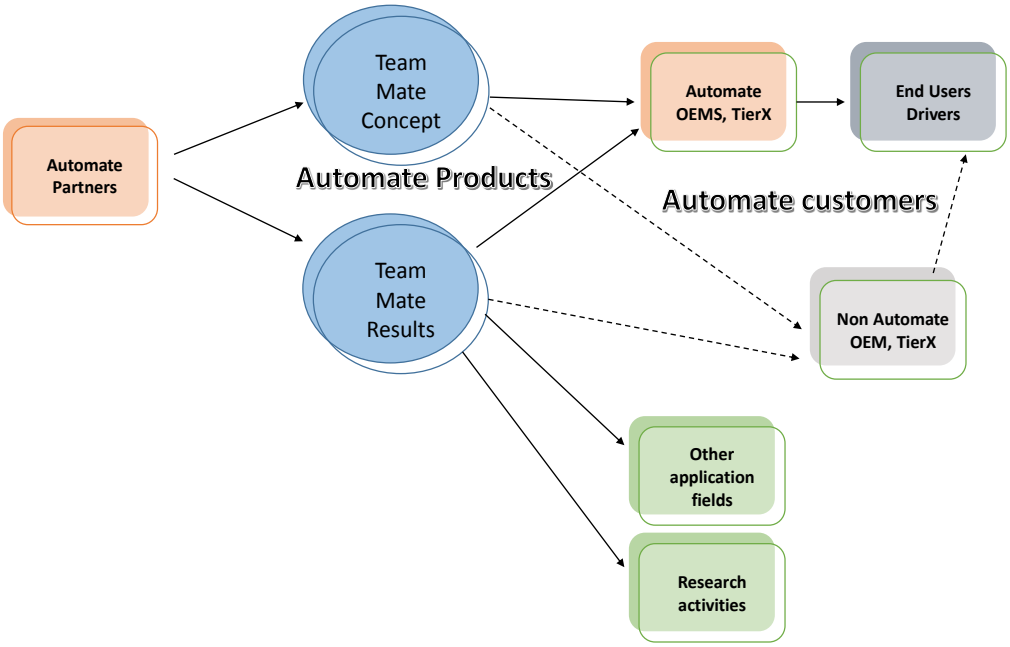

Figure 16: Automate customer ecosystem

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 17)..
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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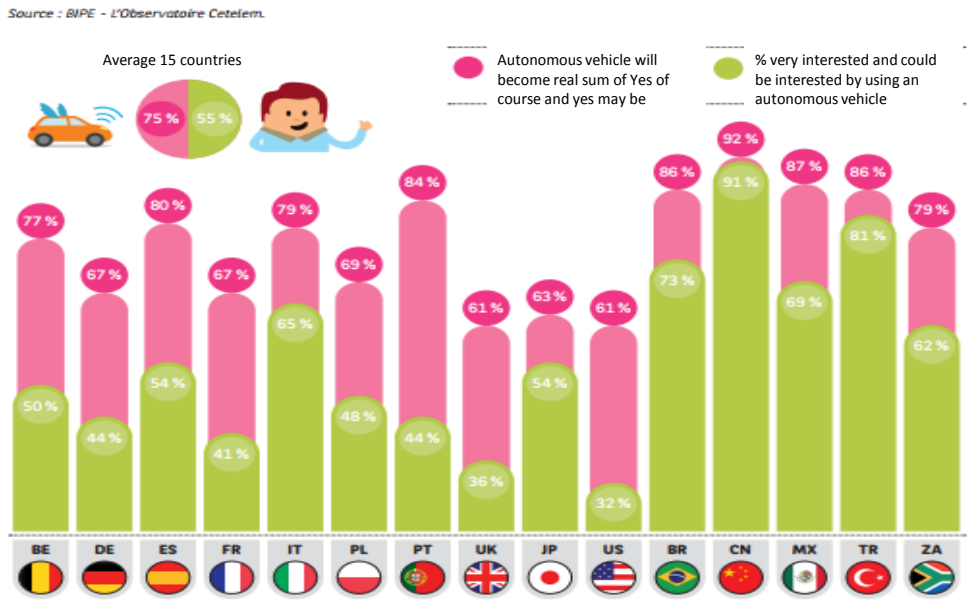

Figure 17: Willingness to drive autonomous vehicles in given areas (from "L'observatoire CETELEM")

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. BroadBit plans to market V2X related test 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 Intellectual 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:

5.1 Ownership of Results

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

5.1.1 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).

5.2 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.

5.3 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.

5.4 Dissemination

5.4.1 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.

5.4.2 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.

5.5 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	none	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	None.	The software tools integrate source-code that is licenced under the MIT licence and the BSD licence.

	physiological data as input and derives inferences on the risk awareness of the driver		The usage of the driver model is restricted to the duration of the AutoMate project.

Table 2: Available Pre Existing Knowhow

5.6 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, 500X and Jeep Renegade (including all their variants). These vehicles also include other ADAS functionalities (such as Adaptive Cruise Control (ACC) and Blind Spot Detection (BSD)), as well as 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'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. Partially thanks to AutoMate project, BroadBit participates in the work of ETSI POTI STF that is responsible to create the "Intelligent Transport Systems (ITS); Facilities Layer function; Part 2: Facility Position and Time management (PoTi)" standard. At the end of the AutoMate project, the standardization process is still ongoing. The expected release date of the standard is end of 2019. Besides that, 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 is 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 (e.g. AutoAkzept, SituWare) 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 2017. 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).

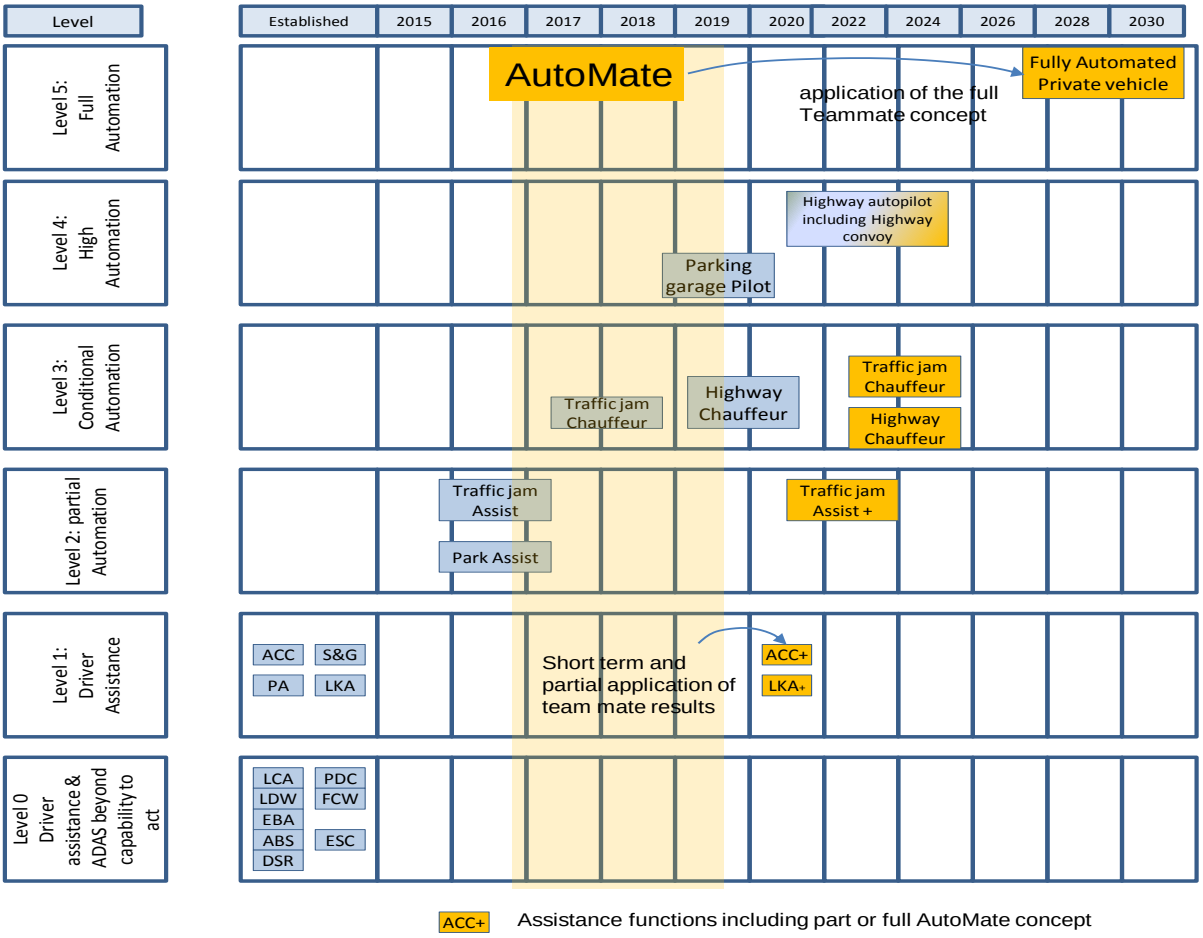

Figure 18: The Automated Driving deployment path for passenger cars

7 Business Plan

7.1 General overview

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.

-

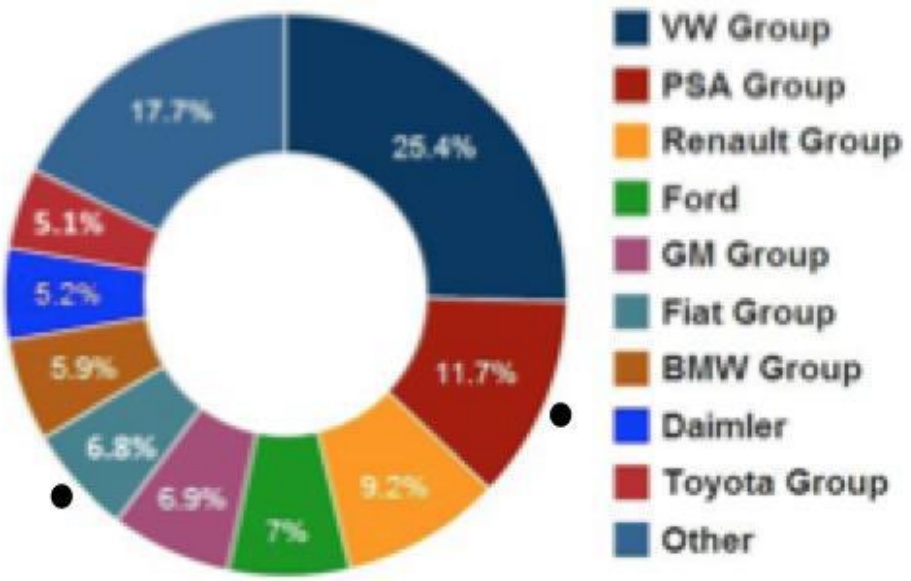

Figure 19: European Market Share by major Manufacturer, January 2014 (http://www.acea.be/)

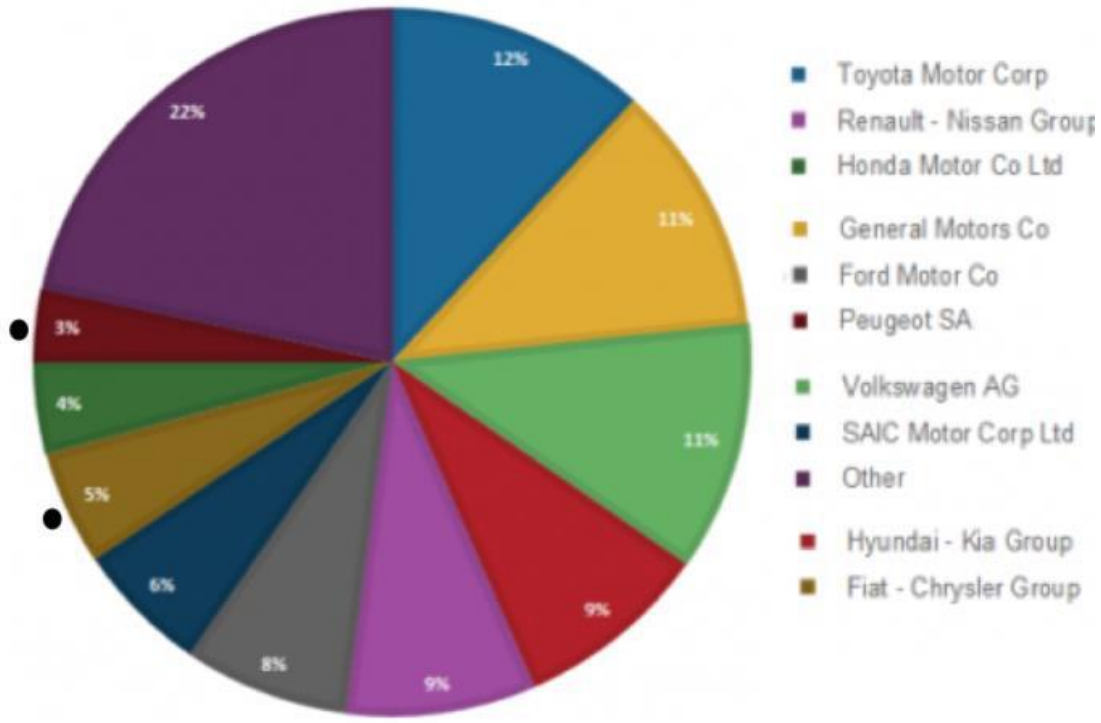

Figure 20:Global Market Share by major Manufac-turer, 2013 (Bloomberg 2013)

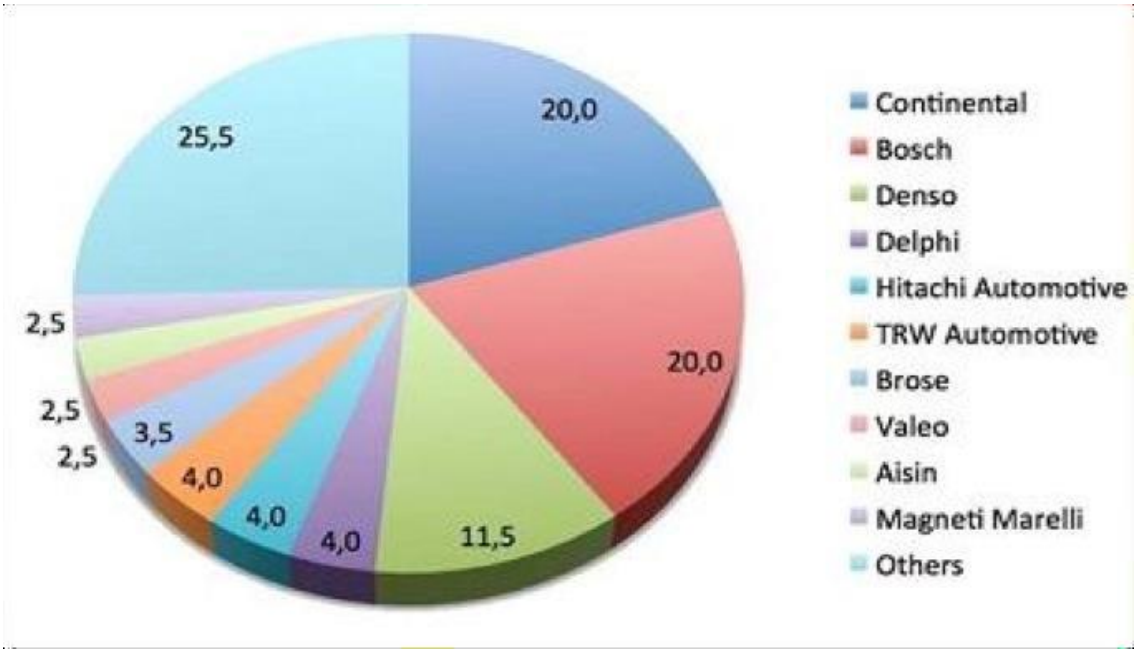

Figure 21: Global market for electronic systems in 2014

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 accepted 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.

7.2 Individual business models and SWOT

This chapter presents the partners Strength, Weakness, Opportunities and Threats (SWOT) to exploit the Automate results and the partners business models based on the Alexander Osterwalder Business Model CANVAS (BMC); This BMC contains 9 model building components described in the table below:

<table>
<tr>
<td rowspan="2">Key partners
Who are your key partners/suppliers?
What are the motivations for the partnerships?</td>
<td>Key Activities
What key activities does your value proposition require?
What activities are important the most in distribution channels, customer relationships, revenue stream…?</td>
<td rowspan="2">Value Position
What core value do you deliver to the customer?
Which customer needs are you satisfying?</td>
<td>Customer relationship
What relationship that the target customer expects you to establish?
How can you integrate that into your business in terms of cost and format?</td>
<td rowspan="2">Customer segment
Which classes are you creating values for?
Who is your most important customer?</td>
</tr>
<tr>
<td>Key Ressources
What key resources does your value proposition require?
What resources are important the most in distribution channels, customer relationships, revenue stream…?</td>
<td>Distribution channel
Through which channels that your customers want to be reached?
Which channels work best? How much do they cost? How can they be integrated into your and your customers’ routines?</td>
</tr>
<tr>
<td colspan="3">Cost structure
What are the most cost in your business?
Which key resources/ activities are most expensive?</td>
<td colspan="2">Revenue Stream
For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?
How much does every revenue stream contribute to the overall revenues?</td>
</tr>
</table>

Business Model Canvas: Osterwalder, Pigneur & al. 2010

7.2.1 OFFIS

<table>
<tr>
<td rowspan="2">Key partners
Who are your key partners/suppliers?
What are the motivations for the partnerships?

Automotive industry Supplier and manufacturers to provide guidance and objectives, and provide access to ressources like data, especially real driving data

Research partners to provide technological proof of concepts, provide access to ressources like real driving data and cars, and for expertise exchange</td>
<td>Key Activities
What key activities does your value proposition require?
What activities are important the most in distribution channels, customer relationships, revenue stream…?

Research concerning state of the art and developent of corresponding techniques and tools.

Conduct driving simulator studies and data aqusition.

Support integration of software of research partners.</td>
<td rowspan="2">Value Position
What core value do you deliver to the customer?
Which customer needs are you satisfying?

As a research institute, OFF uses its technological background from national and EU projects to develop methods, techniques and tools for probabilistic user models, situation modelling and risk assessment.

OFF provides research competencies, evaluation studies and simulator data acqusition.

OFF helps to transfer the knowledge to our partners and especially to spin-offs like HMT, which drive the commercialization of project the outcomes.

OFF is part of the competency network</td>
<td>Customer relationship
What relationship that the target customer expects you to establish?
How can you integrate that into your business in terms of cost and format?

Long-term and mutual beneficial relationship also resulting in follow up projects (e.g. AutoAkzept, SituWare)

fulfilling requirements and expectations

easy communication</td>
<td rowspan="2">Customer segment
Which classes are you creating values for?
Who is your most important customer?

Transportation industry, suppliers and manufacturers mainly in the automotive domain, OFFIS Spin-Offs (e.g. Humatects), research partners with interest in automated driving and driver modelling.</td>
</tr>
<tr>
<td>Key Resources
What key resources does your value proposition require?
What resources are important the most in distribution channels, customer relationships, revenue stream…?</td>
<td>Distribution channel
Through which channels that your customers want to be reached?
Which channels work best? How much do they cost? How can they be integrated into your and your customers’ routines?</td>
</tr>
</table>

	Knowledge and expertise in automotive domain, probabilistic modelling, machine learning, software integration. Fixed base driving simulator hardware and corresponding software Simulator driving data	SafeTRANS which bundles the research competencies of OFFIS Transportation, the Research Centre for Safety Critical Systems at the Carl of Ossietzky University Oldenburg, as well as DLR Institute for Transportation and Flight Systems in Braunschweig, and offers close cooperation with leading industrial companies of the transportation domain (e.g. Airbus, Bosch, Carmeq, Daimler, Siemens Transportation, VW, and many more)	collaboration with partners on national and EU project activities. Publication of research work at national and international conferences and exhibitions.	

Cost structure
What are the most cost in your business?
Which key resources/ activities are most expensive?
Personnel costs

Licence fees for simulation software (e.g. SiLab) and 3rd party development and integration frameworks (e.g. RTMaps)

Hardware procurement, operation and maintenance (e.g. fixed base driving simulator)

Revenue Stream
For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?

Software licences in the form of profit sharing from spin-offs

Research, development, and integration activities paid by the coresponding funding authority of (third-party) funded research projects

STRENGTHS	WEAKNESSES

Specific knowledge and expertise (driver, situation, risk) Strong cooperation with OFFIS spin-off companies Excellent scientific track record State of the art development relevant for highly automated driving Relevant lab hardware (simulator) e.g. for validation and data acquisition High R&D potential profit from cross-domain institute structure and close bond to the Carl von Ossietzky University of Oldenburg cash flow due to national and third-party funding allows investment further projects	Complex testing and verification Development mainly prototypes Data acquisition not optimal concerning amount and realism of data (No real highly automated vehicle)
OPPOTUNITIES	THREATS
Increasing market demand for our development category and new solution raises funding availability Cooperation with other partners opens availability of real car Data sharing policy makes real data easier available Parts of the development could be transferred to other domains	Better established institutions in automated driving receive more funding Data Protection laws may decrease availability of real data Conservative parties prohibiting and slowing down introduction of new technologies and their licensing

7.2.2 PSA

Key partners	Key Activities	Value Position	Customer relationship	Customer segment
Who are your key partners/suppliers? What are the motivations for the partnerships? Other OEMs, which reinforce the synergy of R&D to innovate new technology and reduce the innovation costs. Tier one suppliers to provide core technologies and components, which could be utilized in product. Institute of Science and technology or Start-up company with core technology of autonomous driving (AD function, HD maps, perception algorithm, behavior monitoring etc.)	What key activities does your value proposition require? What activities are important the most in distribution channels, customer relationships, revenue stream…? R&D development and test activities (development and integration of HW/SW/System, Validation/Verification/test /Quality) Industrialization/Production /Manufacturing process and optimization of production efficiency Distribution channel Business, Commercial activities **Key Resources** What key resources does your value proposition require? What resources are important the most in distribution channels, customer relationships, revenue stream…? Management resources to synchronize and coordinate	What core value do you deliver to the customer? Which customer needs are you satisfying? The driver monitoring system is a core aspect of the autonomous vehicle to ensure the interface between human and vehicle, furthermore to guarantee the safety of the driver during the driving task encountered with different driving environments. Groupe PSA works with this key issue in order to provide a reliable and robust monitoring system, with respects of the recent standard of industry or regulation of the states, to ensure the high monitoring efficiency and accuracy, in order to satisfy the requirement of the high-level safety and comfort from our different customers all around the world.	What relationship that the target customer expects you to establish? How can you integrate that into your business in terms of cost and format? To get the right customer requirements To satisfy customer requirements and to get the truth from customer In line with the recent standard of the development and production process of products to ensure the high quality of products To deal with the feedback of customers appropriately. **Distribution channel** Through which channels that your customers want to be reached? Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines?	Which classes are you creating values for? Who is your most important customer? The middle and high car segments in the market. The stakeholder and the customer (Drivers, pilots, transporters, companies or governments) of automobile ; also with automated driving functions.

	the advancement of whole project (R&D, logistic, test, industrialization, business, commercial, etc.) R&D and test human resources (HW/SW/System engineers or researchers, Validation/Verification/test engineers, Quality engineers) and material resource, (HW/SW/components) Industrialization/ Production/Manufacturing engineers or employees) Business analyzer and developers Commercial and retail managers		Group PSA's international distribution channels with key partners. Education of the new functionalities of our products to our customer (drivers, pilots, transporters, companies or governments). In the public multiple media channels or advertisements channels. Salon of automobile. Dealerships of the retail of cars.	

Cost structure What are the most cost in your business? Which key resources/ activities are most expensive? R&D development costs include the human costs (employee salaries) material costs (HW/SW/Components), validation/verification/test/quality costs and production costs. Raw material costs to ensure the manufacturing phase and the distribution costs. Commercial costs and after sale costs.	**Revenue Stream** For what value are your customers willing to pay? What and how do they recently pay? How would they prefer to pay? How much does every revenue stream contribute to the overall revenues? The new technologies which can ensure a more safety driving for customs Pay for the HW monitoring components installed in the car

STRENGTHS	WEAKNESSES
Strong brand portfolio; Loyal customer base; High safety and quality level of product; High R&D capability; Strong experience in development and tests of automated vehicle; Competitive product price; High patent procession; Stable relationship with suppliers and partners; “Free to Move” brand for sharing vehicle experiences.	Majority of sales in Europe. Necessary adaptation to new ecological regulations. Need the optimization of all the organisation for the adaptation on new market rules; Need on specific suppliers; Few experiences for new transportation business (like Taxi or shuttle bus).
OPPOTUNITIES	**THREATS**
Emerging autonomous driving market; New ways of transportations; Advancing new technology for automated vehicle; New values of product could be transferred to customers; Regulation and homologation benefit the development of autonomous driving market; New customer needs which can significantly improve the profit margins.	Competition from new players in autonomous driving market; Competition from other classic OEMs; New regulations; Low market occupancy augmentation rate; Market shrink around the world. High safety demand of autonomous driving; Potential gaps with core technologies for autonomous driving.

7.2.3 Continental

Key partners	Key Activities	Value Position	Customer relationship	Customer segment
Who are your key partners/suppliers? What are the motivations for the partnerships? - key HW components supplier (sensor, processor, optics,) - Company developing state of the art technologies (behavior modelling, face tracking..) - Research institute in driver behavior - Company/institute offering test facilities in simulation or real driving conditions Service delivery companies: provide additional/complementary competences, absorb peak workload, provide flexibility	What key activities does your value proposition require? What activities are important the most in distribution channels, customer relationships, revenue stream…? - HW development - SW development and integration - extensive testing to ensure high product quality - manufacturing process to support high volumes and low cost - R&D development to ensure state of the art products.	What core value do you deliver to the customer? Which customer needs are you satisfying? - Driver monitoring is a key issue for the deployment of partially automated vehicles. Driver is part of the overall systems which includes, the infrastructure, the road the surrounding traffic, the vehicle itself. All these subsystems need to be monitored in real time in order to garantee a good efficiency reliability and safety. Continental technology provides the customer with a high quality, great efficiency, low cost automotive technology releasing customer threats by providing a non intrusive product, fully autonomous technology validated in all driving situation and operatiing on a wide diversity of driver profiles, skin color, morphology, glasses, appearance, etc... Furthermore the product developed by continental whould help the customer for the deployment of their AUtonomous vehicle strategy. It will provide arguments to reach EuroNcap recommendations and driver's safety -	What relationship that the target customer expects you to establish? How can you integrate that into your business in terms of cost and format? - trust in fulfilling customer requirements. - respect of timeline - high quality process - reliable manufacturing process - invest in quality process - keep tooling up to date	Which classes are you creating values for? Who is your most important customer? - all cars starting with high car segments supporting innovation costs - car/truck manufacturers - transportation in general in which operators (drivers, pilot) already play an important role and have to cooperate with automated systems - mass market
	Key Ressources What key resources does your value proposition require? What resources are important the most in distribution channels, customer relationships, revenue stream…? - Production employees - Technical Human capital in R&D (HW/SW/Algo), Quality, tests and validation engineers -Manufacturing equipment -HW raw components -SW Licences		**Distribution channel** Through which channels that your customers want to be reached? Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines? - Automotive/truck manufacturers are Continental traditional customers, communication and distribution channels are already well established through dedicated KAM, sale staff; and permanent contact at decision maker level,	

	-Business developer -Commercial manager		Continental, is regularly consulted by OEMs through RFQ (Request for Quotation) and RFI (Request for Information) on specific topics. For niche Markets the main relation is trhough business developers which role is to identify potential market and customers	

Cost structure
What are the most cost in your business?
Which key resources/ activities are most expensive?

- R&D development cost and as a consequence the associated ressources to perform this R&D developments, Engineers/employees salaries, tests and validation tools and support.
Manufacturing costs
Then during the production phase, the most important costs is the Bill Of Material (raw materials) which can represent more than 80% of the final product cost (out of R&D costs)
-Component return because of failure

Revenue Stream
For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?
How much does every revenue stream contribute to the overall revenues?

- new function which makes car safer
- primary revenues stream comes from sale of HW components (Driver Monitoring product)
- customer financial contribution to R&D costs

STRENGTHS	WEAKNESSES
Tier 1 supplier Strong brand portfolio Product Quality Strong fee cash flow allowing to invest in new project/product High R&D potential	Investment in Research and Development is below the new players Organization structure needs to adapt to new Autonomous driving business Some key technologies are owned by third party companies Automotive industry lacks attractiveness to young engineers compared to connected multi media ones.
OPPOTUNITIES	**THREATS**
Mandatory need for drowsiness technology Regulations New customers (OEMs) New environment policies	New players Technology not specific to automotive industry Shortage of skilled resources

7.2.4 RELAB

Key partners	Key Activities	Value Proposition	Customer relationship	Customer segment
- Automotive and transport OEMS, in particular those located in the same geographical region (Emilia-Romagna, Italy), representing the main customers category - Tier1 suppliers are an important partner category, since REL works in close cooperation with them at concept, implementation and integration level, both as REL's customers and suppliers - Italian research institutes and universities are among the REL major partners, operating in close cooperation in several R&D projects	- HMI (look and feel, interaction modalities and flows) concept and concept design - Prototyping and wireframing of Graphical User Interface - Software development **Key Resources** Human Resources, mostly at technical level: - Graphical and interaction designers - Technical designers - Ergonomists - SW and HW developers	RELAB is able to cover all the production chain of the Human-Machine Interface domain, from the concept to the integration, thanks to the coexistence of different professionals (graphic designer, interaction designers, ergonomists and Human Factors specialists, software and hardware developers). 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 because it prototypes the solutions they will then deliver as a final product to the OEM.	- Trust in fulfilling customer requirements and timelines - High quality process - Flexibility in the iterative design and implementation process - Highly procedurized process, able to meet the customers' expectations, called "HMI engineering" **Distribution channel** REL has established a long-term collaboration with its customers, based on collaborative and consultancies work activities. Moreover, for some specific activities, REL is regularly consulted with traditional commercial channels (RfQ, contest, Proof of Concept). Also generic communication channels (e.g. website, fairs etc.) has have proven to be able to generate satisfactory returns.	REL primary customers are the automotive OEM located in Emilia-Romagna. In particular, the most significant market share is represented by Top Class and Luxury brands, such as Maserati and Ferrari. These companies, even if are not planning to ride the wave of fully autonomous vehicles, are progressively investigating the impact of the introduction of ADF (in particular in terms of interaction with the users and intention of adoption). The results of the project are increasing REL awareness on the topic, allowing the dissemination with existing customers and extending the network to ecustomers in other market segments (e.g. less "branded" companies).

Cost structure

- Mainly personnel resources costs, since the work is mostly based on the effort of highly specialized workforce
- Costs of the equipment (e.g. software for graphical design, HMI development, driving simulator HW and SW components) to perform the design, implementation and test of interaction systems

Revenue Stream

- Customer financial contribution to R&D activities
- Activity of consultancy, prototyping, co-development of human-machine interaction systems

STRENGTHS	WEAKNESSES
Consolidated market and relevant growth index Strong partnership with an industrial cluster of the same geographic area made of 100+ companies (OEMs, Tier1, Tier2) and academic bodies Ability to cover all the supply chain in the design and development of Human Machin interaction systems.	• As SME, reduced capability of covering several projects at the same, time compared to a Large Enterprise • Reduced capability in transforming services in products, e.g. to transform hardware prototypes in large scale consuming products
OPPOTUNITIES	**THREATS**
• The market of HMI for highly automated vehicles is quite new and is requiring specific competencies, flexibility and abilities to explore new frontiers • The digitalisation of in-vehicle instrumentation determined a market explosion • The introduction of new technologies is becoming more and more crucial for automotive OEMs	• Globalization of the market, in terms of new competitor companies coming from countries without a tradition in the domain • Constant variation and evolution of the market, that may arise continuous need for updates and constant threats in the market share

7.2.5 CRF

Key partners

Who are your key partners/suppliers?
What are the motivations for the partnerships?

- Activity of internal research for FCA group.
- Other OEMs to create / reinforce synergies in R&D activities (reduction of costs and risks).
- Consolidated partnership with Tier1 suppliers, research institutes, etc. (gained in EU projects) for core-technologies and components.
- Start-up, SME and universities with core-technology in ADFs (i.e. perception algorithms, HD-maps, etc.).

Key Activities

What key activities does your value proposition require?
What activities are important the most in distribution channels, customer relationships, revenue stream…?

- Development of sharing control strategies for ADFs
- Validation and verification of key-components of ADFs
- Evaluation of the whole system, both in technical terms and under end-users point of view

Key Resources

What key resources does your value proposition require?
What resources are important the most in distribution channels, customer relationships, revenue stream…?

- Human resources for: i) managing the R&D activity; SW developers and engineers; ergonomist and technical designers.
- HW and SW tools (such as MATLAB, VECTOR …).
- Simulation tools (i.e. CAR-MAKER and ADST).

Value Position

What core value do you deliver to the customer?
Which customer needs are you satisfying?
The role of CRF, as research centre of a car-manufacturer, is to design and develop the overall system and the integration into the vehicle (at prototype level).
Results from the project are then exploited and further used for the in-house development of new generation vehicles and new generation of ADAS and highly autonomous driving systems.
In particular, CRF is focusing on the following main aspects:

1. Analysis of behaviour of the driver using the DMS, as developed in the project.
2. Trajectory planning for automated mode, including the dynamics of the other objects on the road and the control algorithms for the vehicle
3. Sharing and cooperative strategies, to manage the interaction between human-agent and machine-agent.

Customer relationship

What relationship that the target customer expects you to establish?
How can you integrate that into your business in terms of cost and format?

Capacity to fulfil the customer requirements and actual expectations.
High quality process of development.
Trust in dealing with the feedbacks of customers, appropriately.

Distribution channel

Through which channels that your customers want to be reached?
Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines?
Centro Ricerche Fiat (CRF) has the mission to develop and transfer innovative products, processes and methodologies to improve the competitiveness of the products of FCA, also through the cooperation with a pan-European and increasingly global network from Industry and academia.
In this context, CRF conducts collaborative research initiatives at the national and international levels in partnership with all the key public and private stakeholders concerned with sustainable mobility, targeting

Customer segment

Which classes are you creating values for?
Who is your most important customer?
CRF primary customer is internal one: FCA (with all related brands), including the automated driving functions.
The target models are middle and high car segments in the market.

	The mission of CRF is to make easier the technological transfer towards the other brunches of FCA Group, in order to fasten and improve the innovation process.	specifically the industrial exploitation of research. The CRF business objectives consist in developing research and innovation along the environmental sustainability, social sustainability, focusing on the safety of transportation systems through the development of active, passive, preventive and cooperative solutions while addressing the mobility of all users.	

Cost structure

What are the most cost in your business?
Which key resources/ activities are most expensive?

R&D development costs include the human costs (employee salaries), material costs (HW/SW/Components), validation/verification/test/quality costs and production costs.

Raw material costs to ensure the preparation and implementation of prototype vehicle(s).

Revenue Stream

For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?
How much does every revenue stream contribute to the overall revenues?
The new technologies / functions which makes car safer.
Pay for the SW/HW monitoring components installed on the car.

STRENGTHS	WEAKNESSES
• Specialized and extended expertise for the state of the art products. • Support to FCA Group for consolidated market share and development. • Ability to cover all the supply chain in the design, development and evaluation of Autonomous Driving Functions (ADFs).	• Very complex implementation of prototype(s). • No capability to provide products (and thus to transform also services in products). • Difficulties and high costs for testing ADFs in all possible scenarios (or most relevant of them).
OPPORTUNITIES	**THREATS**
• Market for ADFs is quite new and thus it needs innovative solutions, as well as availability of research and industrial funding to develop applications exploring new frontiers.	• Globalization of the market, with new competitors, without a traditional automotive approach. • Only a few potential interested customers (e.g. acceptance of ADFs from end-users).

• Big-data, in-vehicle digitalization and the availability of powerful computational board determined a market explosion. • The introduction of these new technologies is becoming more and more relevant for traditional OEMs (especially considering the new actors), which are required to have specific competencies, flexibilities and abilities. • Gain knowledge in collaboration with partners.	• Constant variation and evolution of the market, with different legislations and regulations across EU countries, both in terms of ADFs development and in terms of their validation/evaluation. • Missing extensive data for most critical (unpredictable) and risky situations.

7.2.6 VEDECOM

Key partners	**Key Activities**	**Value Position**	**Customer relationship**	**Customer segment**
Who are your key partners/suppliers? What are the motivations for the partnerships? - OEMs, Tier 1 suppliers, Tier 2 suppliers, innovative small and medium enterprises, French and European research institutes and universities working on mobility, human factors and	What key activities does your value proposition require? What activities are important the most in distribution channels, customer relationships, revenue stream…? Development of perception and monitoring systems, fleet and cars monitoring, studies on human factors (inside and outside the vehicle),	What core value do you deliver to the customer? Which customer needs are you satisfying? A good understanding and interaction between the customer (driver) and the integrated architecture or sub-architecture,	What relationship that the target customer expects you to establish? How can you integrate that into your business in terms of cost and format? Trusting and accepting the system and being a part of the system when needed,	Which classes are you creating values for? Who is your most important customer? All vehicle classes are addressed and can be potential products the system is evolution and can address vehicle classes not yet addressed in the project (trains, trucks …),

automated/autonomous driving (personal cars, shared cars and shuttles)	**Key Resources** What key resources does your value proposition require? What resources are important the most in distribution channels, customer relationships, revenue stream…? Human resources to develop and integrate the hardware and the software and define the required methodologies to test and validate the system technically and with users,		**Distribution channel** Through which channels that your customers want to be reached? Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines? Buisness or research conferences and symposiums.	According to the definition of the project the most important costumer are car users, we can adapt or extract a sub architecture (low cost) in order to make it feasible to every car using an extra 3G/4G, HMI and a camera and focus on the perceptive part/communication.

Cost structure What are the most cost in your business? Which key resources/ activities are most expensive? The car building from scratch is the most costy task, in addition of the costs dealing with gateway adaptation for the software integration verification and validation,	**Revenue Stream** For what value are your customers willing to pay? What and how do they recently pay? How would they prefer to pay? Costumers will by gradually use such kind of systems in order to ensure their and other road users safety.

STRENGTHS	WEAKNESSES
Integration of all TeamMate components in one single car	Developpment of the desired gateways to integrate all the enablers.

Utilization of a middle ware compliant with the defined API Car adapted to almost all the scenarios	Adaptation to defined use-cases and the prototype has been costumed to integrate all the enablers as they are developed Laborious and time-consuming to extend to other scenario possibilities The prototype integrates different systems that are voluminous due to
OPPORTUNITIES	THREATS
Interesting set of data from expert and naïve population that can be used in further research Rich and constructive feedback collected from different testing campaigns'. Experience gained in the fusion of all systems will allow to have guidelines that will be shared and extended to other applications Plug and play strategies for new sensors and algorithms	Limitations of the system have not been considered exhaustively because of infinite possibilities (many enablers with many parameters each)

7.2.7 DLR

Key partners Who are your key partners/suppliers? What are the motivations for the partnerships? - OEMs, Tier 1 suppliers, Tier 2 suppliers, innovative small and medium	**Key Activities** What key activities does your value proposition require? What activities are important the most in distribution channels, customer relationships, revenue stream…?	**Value Position** What core value do you deliver to the customer? Which customer needs are you satisfying? A better understanding, description and prediction of the environment and the driver are key to the development of both	**Customer relationship** What relationship that the target customer expects you to establish? How can you integrate that into your business in terms of cost and format? Trusting and mutual beneficial relationship	**Customer segment** Which classes are you creating values for? Who is your most important customer? Added value is desired for all vehicle classes; potential customers can be found in various car segments; most

enterprises, European research institutes and universities working on driver behavior and vehicle automation	Development and evaluation of software ; development of tool support and automation of the labeling process	driver assistance and vehicle automation; current sub-symbolic approaches need to be enhanced by symbolic measures	with customers; conforming customer expectations	important customers come currently from public institutions
	Key Resources What key resources does your value proposition require? What resources are important the most in distribution channels, customer relationships, revenue stream…? Personnel and time to further develop the required software and methodologies; data for testing and validation		**Distribution channel** Through which channels that your customers want to be reached? Which channels work best? How much do they cost? How can they be integrated into your and your customers' routines? Distribution channels can be established through already existing channels and those to be newly acquired, e.g. via conferences and dedicated industry meetings	

Cost structure
What are the most cost in your business?
Which key resources/ activities are most expensive?

The highest cost are incurred in the process of software verification and validation and the integration of the software and the required hardware in the target environment

Revenue Stream
For what value are your customers willing to pay?
What and how do they recently pay? How would they prefer to pay?

Customers will pay for new and improved functionality to enhance comfort and safety

STRENGTHS	WEAKNESSES
Research organization with active involvement in national and international projects within Intelligent Transportation Systems (ITS) domain, and multidisciplinary scientific areas High standard research and development, leading to quality outcomes Multidisciplinary expertise focusing on present and future challenges within ITS and urban autonomous driving	The strong research oriented focus of the project modules, lead to a prototype driven development Adaption and scaling the module for new environment is challenging and laborious
OPPORTUNITIES	**THREATS**
Extensive collaboration with OEMs, and Tier-I towards prototyping and testing new systems in ITS Merge expertise from different disciplinarians to find innovative solutions for the challenges within ITS and urban autonomous driving Technologies focusing on explainable environment and situation models	Ambiguity in knowledge modelling Prototypical implementation of system Dependence on unreliable and unexplainable external inputs

7.2.8 Humatects

Key partners	Key Activities	Value Proposition	Customer relationship	Customer segment
HMT key partners are from two main groups: industry partners and research partners. Automotive industries including suppliers and manufactures are essential partners to inform HMT with the end-user requirements and to provide advices on goals and objectives setting. Industry partners, moreover, provide access to resources such as data required for evaluation and testing of the	- Research concerning state of the art - Acquisition and development of new technologies - Develop and demonstrate proof of concepts to potential customers - Advance the technology by attending in collaborative projects between multiple companies - Actively attend in the conferences and press and present the products and services	HMT develops state of the art technology for driver modeling and HMI concepts, with a special focus on Autonomous driving. HMT supports the Automotive suppliers in integrating the probabilistic framework and HMI prototypes into the autonomous functions in vehicles. HMT provides the "proof of concepts" to potential customers and then offers expertise, services and software catalogues to help (as a subcontractor) in the implementation of probabilistic	HMT aims for a long-lasting customer relationship, by providing comprehensive support to the customers and iterative improvements of the product to adapt to the customers' demands. HMT is open for discussions, criticism and suggestions. HMT respect the customer desires and gives the priority to the needs of the customers and therefore establishes a trustful customer relationship.	The main target group of HMT are the suppliers of automotive industry, especially the suppliers providing the autonomous driving functions to the automotive market. HMT considers national (e.g., Bosh) and international automotive suppliers (e.g., eSOL) in this segment. HMT also provides the technology and expertise to the R&D department of the Automotive manufactures.

products and to the development environments. Volkswagen, Bosch, eSOL are examples for the industrial partners.
The requirements learned from industry partners needs to be studied in research projects. Collaborative projects with research partners, provide the opportunity to develop innovative solutions and test the solutions in experimental scenarios, e.g., using simulators. The tested solutions could later lead into highly valuable products and will be delivered to industry. Example of research partners are OFFIS, ReLAB and Vedecom

- Update the Website frequently with the news and demonstrative pictures and videos
- marketing through distributions channels,
- Fit the product to the market and customers' requirements

Key Resources

- Human resources such as talented Software developers, industrial designer, project managers and marketing experts are the key resources for HMT.
- The key staff knowledges involved in research and development include expertise in automotive domain, probabilistic modelling, machine learning, human behavior and sensor data, automotive IDEs, as well as, graphical and HMI design.
- Data for the scenarios and use cases of autonomous driving, which is necessary to test and verify the probabilistic modellings and HMI concepts

autonomous driving functions in the vehicles.
HMT supports the Automotive suppliers to implement AR HMI concept for application-specific scenarios such as overtaking maneuvers.

HMT replies quickly to the customers' questions.

Distribution channel

- Active participation in the autonomous driving exhibitions and present the product and services offered by HMT.
- Present the important advancements and results in the conferences and publishing in journals
- through Website, tweeter and facebook and reporting the news on the internet and providing the videos of the example use cases of the technologies offered by HMT
- HMT knows a network of people from different companies through the previous collabrative projects and attendance to the conferences and fairs. HMT presents and offers individually adapted technologies to the Automotive industry though this network channel

The regional and national manufactures are the primary customers in this segment, e.g., Volkswagen, Audi, Daimler and BMW.

Cost structure	Revenue Stream
-Personnel cost for the development of new and the advancement of existing product proof of concepts - License fees for IDEs like SILAB, RTMaps and - fees to set up experiments and collect data to develop a new technology and to examine the developed solution in experimental scenarios - Costs for networking, and presentation to potential customers, or in conferences, such as travel costs and conference fees	The software products are distributed with license fees, which are the main source of income and further supplies for the advancement of the current product and development of new technologies. The service fee is the resource for the effort of staff providing the support to the customers.

STRENGTHS	WEAKNESSES
Specialized and extended expertise Regional/national recognition State of the art product High quality support service for the product Affordable development	Very complex product and mainly prototype Not supporting the end-user product (and therefore be subcontracted by an industrial partner with direct access to the end-users and therefore relatively smaller business market) Expensive to test all possible scenarios
OPPORTUNITIES	**THREATS**
Developing extended products and gain knowledge in collaboration with partners Market need for new solutions and availability of research and industrial funding to develop innovative solutions Increasing market demand (customer interest) to our product category Possibility to sell to big companies	Only a few potential customers Unbalanced resources (e.g., via research funding compared to industrial customers) Conservative parties prohibiting usage of new technologies and slow licence approval Lack of extensive data to immunize against unpredictable danger situations Whole Product is dependent on other partners and needs to be customized for customers' requirements

7.2.9 BroadBit

BroadBit provides test solutions and testing expertise to assist V2X development and field trials. Our experts contributed to the success of several previous ETSI-organized V2X interoperability test events.
Within AutoMate, we completed a V2X communication visualization tool, which helps autonomous vehicle developers to understand and retrace interactions among vehicles. The more complex scenarios are being tested, the more important such support tool is. BroadBit plans to offer this tool for prospective autonomous vehicle manufacturers and their suppliers. BroadBit plans to actively participate in future autonomous vehicle field test events, and this tool shall be used by our experts during the field-testing work.

Key partners	**Key Activities**	**Value Position**	**Customer relationship**	**Customer segment**
Who are your key partners/suppliers? V2X communication equipment providers, OEMs (car manufacturers), Tier 1 suppliers, road operators, transportation related companies and institutes What are the motivations for the partnerships?	What key activities does your value proposition require? Custom software development What activities are important the most in distribution channels, customer relationships, revenue stream…? Demonstrations and possible ways to show the capabilities and benefits of V2X communication	What core value do you deliver to the customer? Experience with field testing support of V2X communication Which customer needs are you satisfying? Understanding the transaction on V2X interfaces during real-life scenarios	What relationship that the target customer expects you to establish? Contract for test support and test events How can you integrate that into your business in terms of cost and format? It fits well to our present business contracts and relationships.	Which classes are you creating values for? OEMs (car manufacturers), Tier 1 suppliers, road operators, transportation related companies and institutes Who is your most important customer? OEMs

customers need field trial support solutions	**Key Resources** What key resources does your value proposition require? Human resource: software developers and communication experts		**Distribution channel** Through which channels that your customers want to be reached? Via web, conferences, test and demo events	

Cost structure What are the most cost in your business? Human resources, special devices and development kits Which key resources/ activities are most expensive? Software development	**Revenue Stream** For what value are your customers willing to pay? Special knowledge on V2X interface and field test support experience What and how do they recently pay? How would they prefer to pay? Test sessions and developments are individually charged How much does every revenue stream contribute to the overall revenues? Uniformly contribute according to the current number of revenue streams

STRENGTHS	WEAKNESSES
Simple way to show the features and opportunities of V2X communication Allows to follow the field tests in real-time, even remotely Logging and recording features reduce the costs of field testing Rapid development of new or customized messages	ETSI G5 related standards and protocols handles very large amount of possible traffic situations Complicated to cover all of them, as well as to implement all features what the protocols enable

V2X communication may complement and improve sensor-based environment detection of the automated vehicle	General 3D positioning is expensive and hardly possible
OPPORTUNITIES	THREATS
Demonstrate and disseminate our special knowledge on V2X communication for partners Simplifies the monitoring and maintenance of V2X devices Possibility to cooperate with big automotive companies and their suppliers V2X communication may be considered as a back-up to sensor-based relative vehicle positioning, to ensure fail-safe operation of mission critical applications	Only a few potential customers More simple integration is required Lack of support of end-to-end procedures Various and expensive V2X capable devices/products

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Key partners	Key Activities	Value Proposition	Customer relationship	Customer segment
- Automotive OEMS, in particular those located in Germany, such as VW, Daimler, BMW - Tier one suppliers that provide core technologies are an important partner - Research institutes and universities focusing on driver behavior are also ULM major partners	- Basic human factors research in the driving context - Research on driver vehicle interaction concept and strategy - HMI concept and Prototype design - Usability test - Knowledge transfer to our key partners	As a university, ULM focus on human factors research in different domains, especially in the driving context. The value proposition of ULM depends on its ability to the development of driver vehicle interaction concept and also the evaluation of driver vehicle interaction strategies and modalities. As a research organization, we don't provide products, but we help to transfer the knowledge in the human machine interaction domain to our key partners.	- Trust in fulfilling customer requirements and timelines - High quality process - Broad expertise in state of art of the knowledge on driver vehicle interaction	- ULM primary partners are the automotive OEM located in Germany. We focus on all cars with highly automated functions. - Our important customers are European Commission and other EU bodies, federal funding provider, such as Deutsche Forschungsgemeinschaft (DFG), Bundesministeriums für Wirtschaft und

- Company/institute offering test facilities in real driving condition	**Key Resources** Human Resources: - Human factors specialist - Computer scientist - Psychologist Infrastructure - Static driving simulator		**Distribution channel** ULM has established a long-term collaboration with its partners, based on collaborative project activities. We organize regular workshops with our stakeholders. Moreover, we publish our research work in the international journals with high impact factor and also present our research in the international conference. Besides, we give invited talks at public events organized by government.	Technologie (BMWi) and Bundesministeriums für Bildung und Forschung (BMBF).

Cost structure

- Mainly personnel resources costs
- Costs of the equipment (e.g. software for HMI development, driving simulator components) to perform the design, implementation and test human machine interaction

Revenue Stream

- Special knowledge on human factors about driver behavior
- Activity of consultancy, concept development of human-machine interaction
- Support for usability test and evaluation
- The research activity is charged by the third-party funded research project

STRENGTHS	WEAKNESSES
Specialized expertise on human factors about driver behaviour and human-machine interaction National and third-party funding supports research activity Strong cooperation with universities, research institutions and automotive OEMs located in Germany Excellent scientific track record Key infrastructure (static driving simulator and a real car used for demonstration) to test possible scenarios	Complex testing and verification of new technology Development of prototypes Development of products
OPPOTUNITIES	THREATS

Increasing market demand for new development and new solution raises funding availability Parts of the results could be transferred to other domains Demonstrate and disseminate our special knowledge on interaction strategy Possibility to cooperate with big automotive companies and their suppliers	Data Protection laws may decrease availability of real data Conservative parties prohibiting and slowing down introduction of new technologies and their licensing Some key technologies are owned by third party companies