Digital Transformation Monitor

Autonomous cars: a big opportunity for European industry

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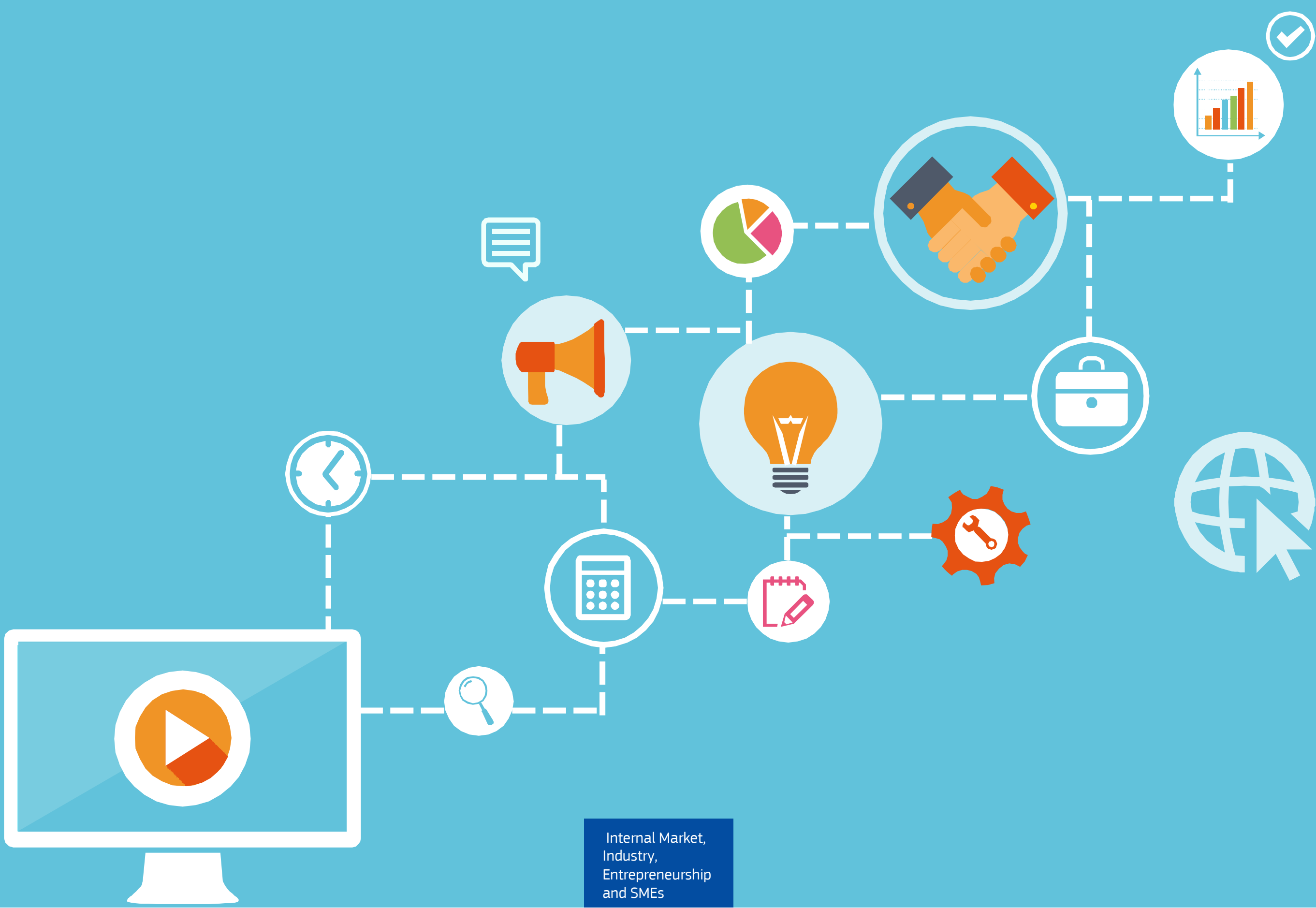

Internal Market, Industry, Entrepreneurship and SMEs

Autonomous cars: a big opportunity for European industry

The prosperity of connected cars also propel the progress of autonomous driving, which is commonly agreed by the auto industry as "the capability of a car to drive partly or fully by itself, with limited or no human intervention". Semi to high autonomous cars has been set to the short-term objective of 2020 by the auto industry. OEMs, Tier 1 suppliers and new entrants are all aligning their strategies with the evolution of autonomous cars.

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Autonomous cars: redefining the industry

Connectivity on the fastlane

Beyond connectivity-enabled functions, an autonomous car will understand its environment and the passengers. It will also "learn" to react and adapt to different situations during the entire driving process.

More innovations coming to the vehicle

Autonomous car implies the capability of a car to drive partly or fully by itself, with limited or no human intervention. Three primary functions can be fulfilled:

- **Safety**: Ability to sense and alert the road problems and automatically take in-time actions to prevent potential accidents. Today's safety packages generally refers to Advanced Driving Assistance System (ADAS). It covers features such as automatic braking, collision protection, and emergency assistance. As the technologies get mature, ADAS will soon become part of the autonomous driving package.
- **Connected car features:** Telematics and infotainment services that exist today within cars having connectivity features. The objective is to improve the car's operation. Remote car lock/unlock, optimized fuel consumption and entertainment will be among the basic services. Those packages will be offered in the form of subscription-based services, aftermarket systems or simply through smartphone apps integration.
- **Autonomous driving**: Capability of automating the activity of driving the car. Features will include adaptive cruise control, self-parking, highway autopilot and more. It is commonly accepted that the automated driving could be framed at six levels as showed below, with regard to howthe system plays in the dynamic driving tasks on a sustained basis.[1]

Figure 1: Six levels of Automated Driving Systems development

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

Source: SAE International STANDARD J3016, 2015[20]

Relying on a set of technology breakthroughs

Apart from connectivity and short-range communication, autonomous cars are equipped with sensors and laser systems to monitor the road and traffic conditions.

The artificial intelligence (AI) and machine learning combine external data to car data, enabling a wealth of intelligence to increase the learning and understanding capability. The cars will be likely to adapt to the moods of driver as well as to the traffic and weather conditions.

Autonomous cars well on-track

Roadmap of development

A major of auto manufacturers focus on the partial to high automated cars with a short-term objective of 2020. This is the critical year when high automated cars (Level 4) are most likely to be available.

At this level of automation, hands-free cars will still need human control over vehicles in defined-use cases. The full automation is expected to debut much later – within the following 5 to 10 years.

> Today's car processes up to
> **25 gigabytes**
> data per hour. [2]

Different approach to the introduction of autonomous systems

Tesla's Autopilot is so far the only partial-autonomous system on the market. Meanwhile, BMW, Volvo, Nissan, Mercedes, Audi, GM, Ford and Toyota are the forerunners introducing several autonomous features, such as departure warning and auto-parking.

Players are taking different approaches for the implementation. Most traditional automakers are introducing autonomous systems progressively into their existing models, preparing the customers adopting the new features slowly. Whereas some manufactures like Ford and Renault, and the Internet 'upstarts' - Google and Apple, are testing the water of the fully autonomous.

Intelligence transport system (ITS)

Compared to the connected car per se, the self-driving car is more dependent on the connection to the outside. Apart from the operator's network (currently 3G and 4G for connected cars), there is a greater need to communicate with other autonomous cars (vehicle-to-vehicle, V2V), with infrastructure (V2X) and with traffic facilities and central. For example, the stop-and-go mode for a congested traffic situation relies on the communications with other vehicles, facilities and central ITS station.

To meet the wider communication demand, Intelligent Transport Systems (ITS) is being developed. The goal is to create standards and specifications for the use of information and communications technologies (ICT) in future transport systems.

ITSs are not restricted to road transport as they also include the use of ICT for rail, water and air transport. Figure 2 shows intermodal communications will empower a variety of services, such as travel assistance, passenger information and trip planning.

At current stage, basic services can be warning drivers of upcoming roadwork, or changing speed limit. Auto manufacturers are beginning to integrate the V2V communication into their autonomous cars, for example, Mercedes' all-new E-Class. Meanwhile, Netherlands, Germany and Austria have been starting the cross-border ITS project since early 2015.

Figure 2: The Intelligence transport system (ITS)

Source: ETSI, 2015

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Revealing full potential and opportunities

Revenue restructuring

Over the period of 2015 to 2020, the vehicle price will remain half of total consumer spends on the car over an average 5-year life cycle.[2]

Connectivity-enabled revenues, despite small share- approximately 7% of total expenses[2] for a premium car model by 2020, holds many potential to trigger a significant redistribution of revenues.

As Figure 3 indicates, the total revenue of three product and service packages is expected to increase 24.3% from 2017 to 2022, up to 142 billion EUR.

The share of autonomous driving in connectivity-enabled revenues is expected to surpass that of connected services package by 2022. Assisted driving features, as the early stage of autonomous cars, accounts only 24% of revenues, whereas it will grow to 35% by 2022, almost catching up to the safety product sales (37%).[3]

Data golden mine

Car holds potential to be another mobile device carrying a huge amount of data as smartphones. Some plug-in hybrid cars generate 25 GB of data in just one hour.[4] The sheer amount of data available are not just from the car itself through sensors, controllers and processors, but also come from external - the road infrastructure, cars in the surrounding and the entire Internet.

The data-driven services remains the top opportunity for automotive makers. Beyond "traditional" data empowered services such as telematics system, OEMs and Tier 1 suppliers are also investing in new business such as predictive maintenance and mobility services, aiming to better adapt their positioning to the market trends in the long term.

Predictive maintenance

Autonomous cars cannot go apart with sensing technologies, data science and machine learning. Those technologies, in return, improve the predictive maintenance of connected car era to a new level, by identifying the correlation between multi-sourced data and specific types of failure and repair work.

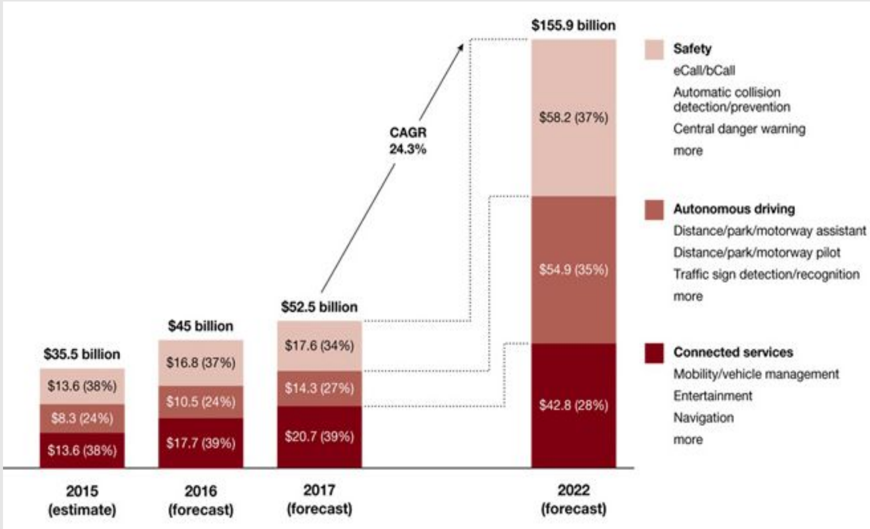
The benefits of predictive maintenance are multifold. Lower repair frequency and overall maintenance costs are direct benefits, as customers can get immediate alerts before the failure occurs and minimize repair work.

Improved vehicle performance seems to be the indirect welfare. Automakers will be capable of identifying the fault pattern of a particular equipment of a given car model. It thus provides a feedback loop that enables automakers and dealer to improve quality and customer satisfaction.

From 2015 – 2022, revenue from autonomous driving is expected to increase from

7.6 bn to 50 bn EUR[3]

Figure 3: Estimated autonomous car revenue by product package, 2015 - 2022



Note: Due to rounding, numbers shown here may not add up precisely to the totals provided.
Source: Strategy &, 2015 [3]

Although the development remains at early stage, many new services based on it could be imagined in the coming years: extended warranty due to optimized car performance, or flexible repair tariff depending on warranty claims. BMW has being testing similar services since 2015.

Redefining the insurance industry

Facing the proliferation of data generated by autonomous cars, insurers begin to rethink the business model as well. Pay-as-you-drive (PAYD) is an example showing how insurers tailor their portfolios to new landscape.

PAYD is a type of auto insurance whereby the costs are dependent upon type of vehicle used, measured against time, distance and place. Thanks to more advanced sensors and intelligence systems within autonomous cars for usage monitoring, drivers could have flexible premium fees, and have optional value-added services such as tracking of stolen vehicles.

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Data security and privacy concerns remain widespread. 35 % of consumers are willing to trade driving data for an insurance discount of 10 %.[2] US car insurers already offer discounts of up to 30% based on individual driving telematics data. It is believed that this data-based discounts will continue, leading to a lower standard premium level by 2020, particularly triggered by the availability of ADAS features for semi to high autonomous cars.

Car ownership shifts to mobility pattern

Car sharing or car pooling services introduced by Uber and Lyft lead a car-as-a service trend - consumers purchase mobility services instead of owning the means of transportation. Apart from independent players like Uber, car sharing services also lured major automakers including General Motors, Volkswagen, Daimler and BMW.

In addition, manufacturers are preparing themselves to reposition in the future autonomous driving era, where a network of on-demand autonomous cars will be built through the partnership of OEMS and Uber-like companies. GM, Toyota and Volvo are at forefront, among others, to undertake such collaboration.

Auto maker	Partner for autonomous cars-as-a-service	Launch time
General Motors	Lyft	2016
Volvo	Uber	2016
Ford	Uber	2016
Toyota	Uber	2016

Transformation of adjacent industries

Apart from the consumer market, some manufacturers also eye on the transportation and logistics domain, particularly through a B2B approach. Promising services include fleet management, automation of delivery and pickup services, and self-driving truck platoons. Truck platooning is an IoT application into autonomous trucks, allowing second and third trucks in the line to mimic each of the first truck's actions without driver intervention.

Volvo, Scania, Daimler, MAN, DAF Trucks and Iveco have initiated a successful trail - European Truck Platooning, in which self-driving truck platoons converged in Rotterdam in April 2016. In fact, with the intention of integrating driverless tech into commercial trucking in the near future, the expected benefits can be reduction of costs and carbon emission, reduced accidents, and bypassing the rigid regulation limit of drivers' working hours.

Increased road safety

Human errors and inattention account for more than 90% of road accidents[5], typically caused by typically speeding, alcohol, distraction, fatigue. Autonomous driving, as human errors and judgment are likely to be eliminated, could reduce the accident rate and auto fatalities. A study[6] found that the crash rate for self-driving cars was 3.2 crashes per million miles, opposed to the average human-driving of 4.2 accidents per million miles.

Nevertheless, the autonomous cars are still years away to meet the safety standards. Because even semi to high automation still need human intervention at specific cases. Following the fatal accident of Tesla in 2016, the OEMs such as Google, Audi and BMW continue testing the autonomous cars, in order to tackle the safety challenges.

Social costs reduction

With regard to societal effects, autonomous cars will lead to the dropping down of the public costs associated with accident prevention and management, as well as healthcare and other social costs linked to car accidents.

Beyond that, optimized routing and synchronized driving of autonomous cars may hopefully reduce vehicle emissions, as well as mitigate the burden for infrastructure investment (for instance, additional lanes or traffic signs).

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Looking forward to the future…

Standardisation and regulatory drivers

Steady progress of standardisation

A number of initiatives around standardisation are proceeding, addressing the technical and infrastructure hurdles. The family of Wireless Access in Vehicular Environments (WAVE) standards are established to support a reliable V2V and V2X wireless communication. The European Telecommunications Standards Institute (ETSI) is involved in the ITS system.

More recently, in 2016, a 5G Automotive Association was formed by key players like Audi, BMW, Daimler, Huawei and Qualcomm. It focuses on technical and regulatory issues leveraging next-generation mobile networks, and committed to push forward the commercial availability and global market penetration.

Improved regulatory environment

Regulators are working on removing the barriers to the development and adoption of autonomous cars by creating a homogeneous legal framework. Clear standards for OEMs and consumers are being developed, particularly in the areas of data privacy, cyber-security, and interoperability across borders.

European Commission is indeed working hard to enable interoperability and launched the US/EU Standardizations Harmonization Working Group in 2014.

Further, Google formed a coalition with Ford, Volvo, Uber and Lyft in April 2016, to lobby lawmakers and regulators on the legal barriers.

Earlier 2016, the National Highway Traffic Safety Administration (NHTSA) of the US has admitted that the system behind a self-driving Google car could be considered the driver under federal law, which was seen a major step forward.

Customer utilities

There would be substantial benefits for customers. Apart from safer driving and lower insurance premiums mentioned before, time efficiency will be another advantage.

By eliminating the need to steer the vehicle, semi-autonomous cars will gain about one hour to each driver's day. The work-related activities would be possible to undertake in-car, and are expected to achieve 10% - 15% productivity.[3] Besides, improved traffic flow will lead to less overall time spend on the road.

Many challenges to overcome

Questions around cultural concerns and willingness to buy

Despite the optimism of industrial players, customer acceptance remains questionable considering the efforts and costs in driving habits switching, learning, safety concerns and significantly increased prices.

Many customers still enjoy driving and do not want to cede any control to complete automation with no steering wheel. A survey found that 96.2% of people would like to have a steering wheel as well as accelerator and brake pedals available even if their vehicles were self-driving. [7]

Indeed, the cultural pattern of driving also varies from region to region – as illustrated by the dominance (by far) of automatic transmissions in the USA, while manual transmission is dominant in Europe.

Accountability and liability

Despite the efforts of regulators and government spin in the regulation and standardisation, many doubts exist around the autonomous cars, particularly on the accountability and liability in an accident. Allianz claimed that currently there is no action on the liability law, and a human will be still be held accountable in the near future. [8]

In addition, there is still no clarity in certain areas such as for a steering-wheel-less case or a driverless bus in public transport. For instance, current US Federal regulations stipulate that a turn signal should be linked to a steering wheel's movement. How this will be reformalised to no-wheel case should be figured out.

Semi-autonomous cars will gain approximately

One hour

to each driver's day.

Data security and privacy

There also exist considerable need for clear legislation and a legal framework that will support data security and privacy before a full rollout. It is consensus that consumers will be data owners, whereas data access and exploitation remains unregulated.

On top of that, we see challenges in software reliability and assuring cyber-security if cars are connected to traffic management centres and to the Internet on a large scale. Cyber-security standards need to be agreed upon to define the minimum security embedded in the hardware; as well as what the boundaries are for software and connectivity.

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About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.

Web page: https://ec.europa.eu/growth/tools-databases/dem/

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