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Smart Mobility European value chain analysis and workshop report

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RE	Restricted to a group specified by the consortium (including the Commission Services)	
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1. The content of the deliverable

This deliverable provides an overview of the stakeholders in the mobility value chain and aims to identify several types of collaboration opportunities, through the complementarity of skills and technologies on the one side, and the market needs on the other. The evolutions in the "traditional" value chains, induced by the technological breakthroughs and the emerging business models, are explained through from technological and financial perspective.

Considering that the growth of the start-ups strongly relies on market needs and opportunities, the analysis will cover all the key technology bricks and stakeholders able to contribute to their development and aims to offer a clear picture of the existing landscape and the opportunities that are emerging for each stakeholder in the value chain.

2. Introduction

More and more people and goods are moving across towns and across the globe, increasing mobility and fostering the development of new solutions for transportation as new needs emerge. Along with those new needs, new technologies are developed, new actors appear and historic ones must adapt to face evolving business models.

> *"By 2030, annual passenger traffic will exceed 80 trillion passenger-kilometers - a 50 percent increase compared to 2015; global freight volumes will grow by 70 percent compared to 2015; and an additional 1.2 billion cars will be on the road - double today's total " [**Global-Mobility-2017**].*

Mobility is extremely linked to the concept of Smart City, notably because the main challenges addressed by these verticals are quite similar: traffic linked to congestion, pollution, and noise.

If we were to ask people about the future of mobility, the vision will surely look the same:

1. Easy trips from one place to another.
2. Minimum and quality time spent on transportation.
3. Zero pollution.

Those 3 points refer to many technological areas yet to be mastered.

Easy trips induce appropriate means of transportation depending on the need, from short to long-range distance (traveling, commuting…), with access to all the information needed to be able to make a choice - from availabilities to prices, considering the flows of people but also goods.

This information, provided through data management, is also a key to value the time spent on transportation with infotainment for example but many other services, not only digital-based will emerge to raise the quality and the safety of the trip, especially when people will be able to use the travel time for other activities than driving.

Environmental impact, for any transport mode - road, rail, waterborne and air transport, is also a big concern for the stakeholders in the value chain.

This short introduction highlights, without naming them, different concepts of mobility:

- Autonomous Mobility
- Connected Mobility
- Electric Mobility
- Smart Mobility

For the analysis of the value chain, a focus will be made on Connected and Autonomous Mobility, representing the technological areas impacting greatly the traditional value chain model with disruptive innovations.

In this race for the future of mobility, new technology providers and especially startups, play a crucial role by disrupting the entire value chain.

3. The Mobility Value Chain shifts

The main factor of influence is the fact that mobility is shifting from ownership to mobility as a service **[Deloitte-2017]**. Why should people own a car? To be stuck in traffic? To pollute the air and the landscape? To waste time and energy searching for a parking lot? To pay all the expenditures associated with the car, the maintenance, the fuel, the license, parking, fines …? The argument of time-saving is not even relevant when it comes to trips inside big cities.

In this perspective, Original Equipment Manufacturer (OEM), the traditional actors of Mobility, must adapt quickly to anticipate these changes. Vehicles will not disappear but our way of interacting with them will not be the same.

A first change is a replacement of traditional fossil fuel for alternative sources of energy, mainly electricity and hydrogen. This is a continuous technological challenge for OEMs regardless of the mobility technology developed.

A second change is the accelerated development of autonomous solutions to enable the user to have eyes off the road and hands off the steering wheel. This second change is the real issue in the survival of OEMs because it is what will give them a competitive advantage. But the know-how and the technologies required for them are either totally new or out of their traditional field of expertise. To be ahead in this race for technological knowledge, investments in startups seem to be the strategy adopted by many OEMs because it allows to pick off-the-shelf technologies/products to significantly reduce product development time and the time-to-market **[Singh-2017]**.

3.1. The road towards full automation

Self-driving vehicles (SDVs) are expected to be commercially available from 2025, corresponding to the final level of Automation as defined by the Society of Automotive Engineers[1] (see Figure 1 below), and have the potential to create a transport revolution.

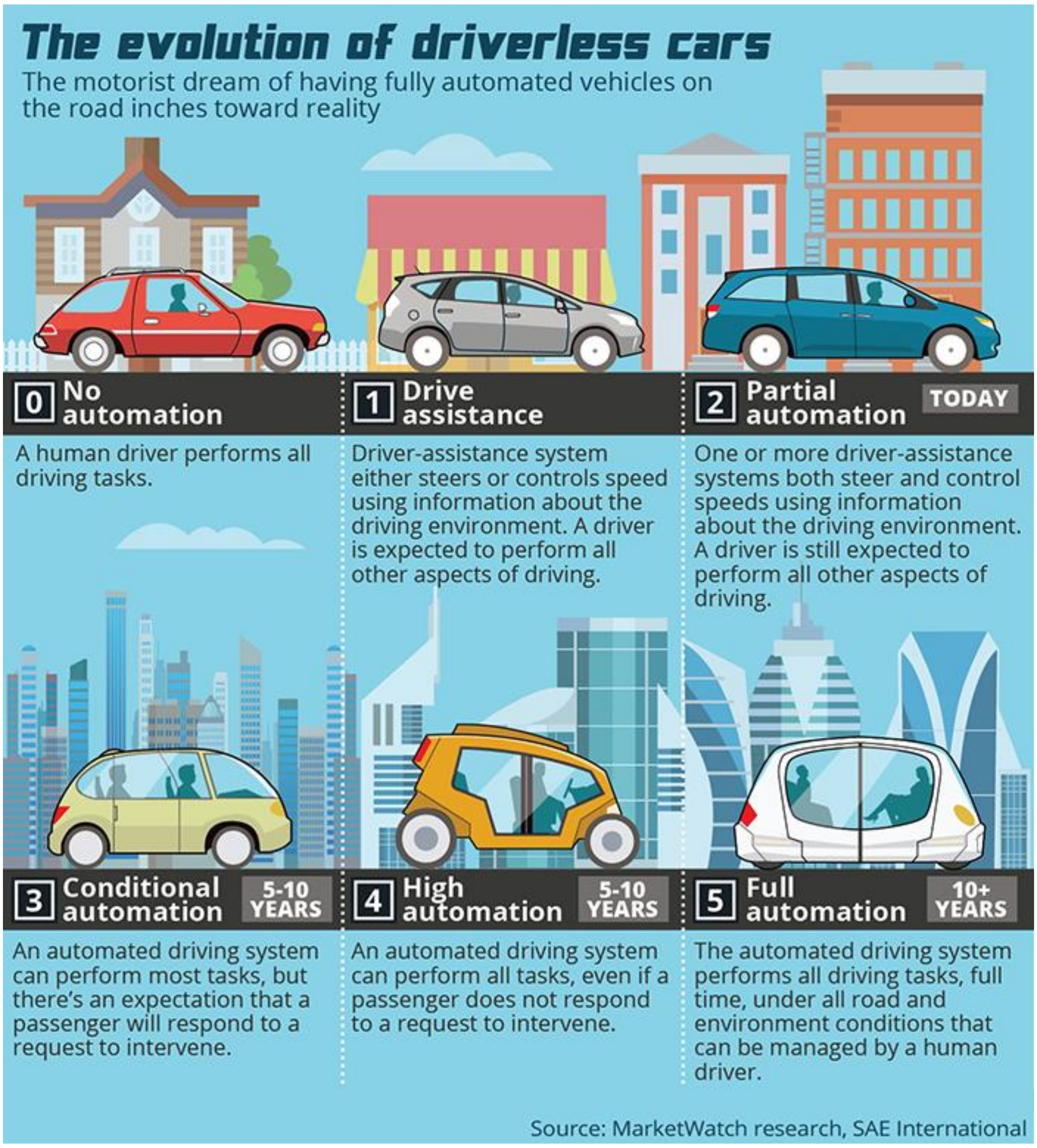

*Figure 1: Automation Levels Time Line [**Assis-2015**]*

A study by A.T Kearney estimates that the annual market just for special equipment (onboard control, guidance, and communication systems) will reach $130 billion in 2030. Mobile apps facilitating car-to-car[2] telematics (V2V: Vehicle to Vehicle) and communication between car and other entities (V2X:

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[1] SAE International is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in various industries.

[2] Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, collectively referred as vehicle-to-everything (V2X), is a wireless technology aimed at enabling data exchanges between a vehicle and its

Vehicle to everything) will reach $86 billion. Finally, the market for fully autonomous vehicles (level 5 SAE) is expected to reach $95 billion.

Apps, equipment, and vehicles related to autonomous driving will pull in $282 billion in revenues by 2030, representing 7% of the total automotive market. And the market is expected to almost double to around $560 billion between 2030 and 2035, representing 17% of the global market automotive market. This big market in expansion will create fierce competition in the next incoming years and the landscape of mobility stakeholders may drastically change if their strategy to keep up with technological breakthroughs in autonomous solutions is not adapted.

The competitive landscape of Mobility will drastically change due to autonomous driving, as actors from the Connected Mobility are going to seek for more interactions with the consumer. OEMs are directly threatened by this shift in the mobility habits toward more digital interactions and will no longer be at the top of a pyramidal value chain with suppliers below. Instead, we are moving to a combination of Hubs with the finished vehicles at the center. All Hub being indispensable to the finished vehicle: OEMs, Tiers-x suppliers, Device manufacturers, Telecom companies, online players and IT suppliers.

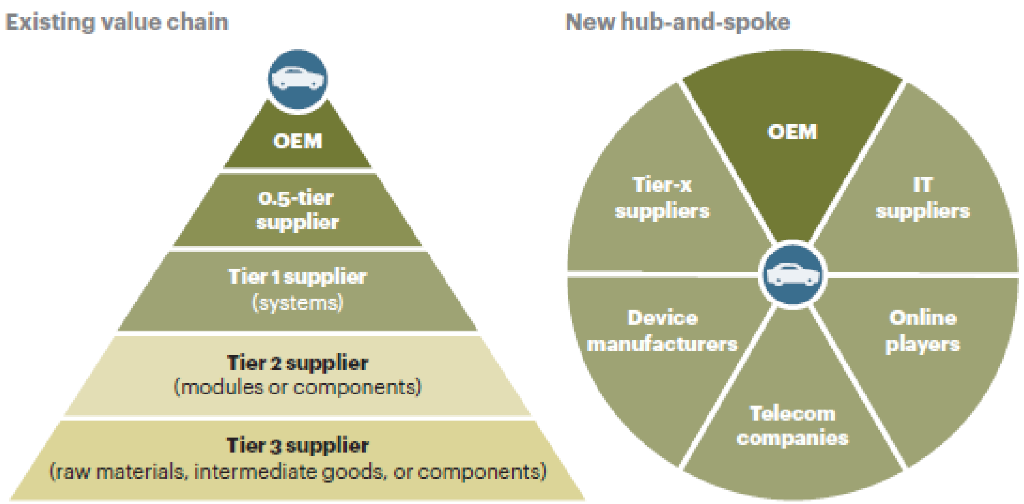

*Figure 2: Autonomous driving disrupting the automotive industry [**Kearney-2016**]*

For decades, OEMs were responsible for end-users relationship but it might not be the case any more in the next decade. The challenge for automotive OEMs in this new landscape is to compete with multibillion-dollar companies from different verticals, with strong Research & Development teams, regional or global market leadership positions, and a strong appetite for game-changing growth opportunities. It is the case with Microsoft, Google, Samsung, Siemens, Facebook… The next value chain will be a mix of new and old big-players, wildcards and specialists.

surroundings : https://www.st.com/en/applications/telematics-and-networking/vehicle-to-everything-v2x.html.

3.2. A more predominant role for public actors

As the race towards core self-driving technology becomes fierce, the need for more communication and connected infrastructure is required but few startups are working in the field of Vehicle to Everything (V2X) because at the moment this technology does not seem to be set as a prerequisite for the first deployment of Autonomous Vehicles on roads, considering that driverless cars are running in limited or dedicated areas.

In a near future, autonomous vehicle-based mobility services and traditional cars will certainly coexist and, in that case, connected infrastructure could help in managing the cohabitation with other cars and with pedestrians who will be unfamiliar with such technologies. For example, connected traffic lights could help manage precedence between all road users. Wider use of autonomy in transportation will require infrastructures that are able to communicate with the vehicles and analyze the data. It could indeed appear as considerable leverage to develop more secure mobility services, improved traffic management, and congestion reduction, and improve the sharing of roads between all vehicles and pedestrians, although very few use cases are being presented for the moment.

Infrastructure providers and city administrators will play a crucial role in the Mobility Value Chain as they are the one collecting data with sensors implanted everywhere in the public space: road, streets, and buildings. They are key partners to develop Intelligent Transport Systems and provide sustainable, convenient and affordable end-to-end urban trips.

The figure below shows the vision of an integrated mobility ecosystem through three components: the mobility services for end-users, the infrastructure that enables integration and the stakeholders that deliver these services.

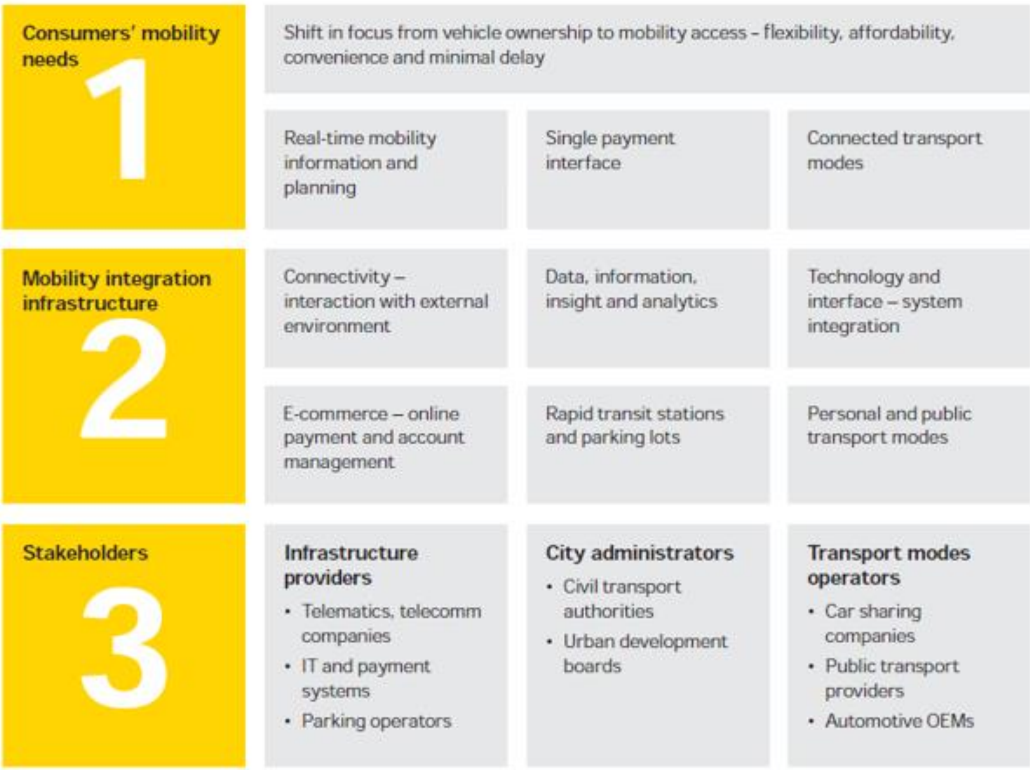

*Figure 3: The vision of an integrated mobility ecosystem [**Hanley-etal-2013**]*

These stakeholders are also crucial for the development of the actors of the mobility value chain and especially startups by providing them facilities and/or real-conditions field of experimentation in Big Cities. To be able to test new technologies and services in real conditions significantly reduce the time-to-market for startups and it's a win-win situation for the public actors that can provide additional mobility services within the territory.

3.3. The recent investments in the field of mobility

It is interesting to note that Mobility is no longer the prerogative of traditional actors such as OEMs or Transport Operators. Startups are now connecting also with Unicorns that want to provide new mobility services to extend the scope of their digital applications and to enhance the customer relationship. Transport Operators can consolidate their offer by adding complementary mobility means and OEMs can exploit their own products.

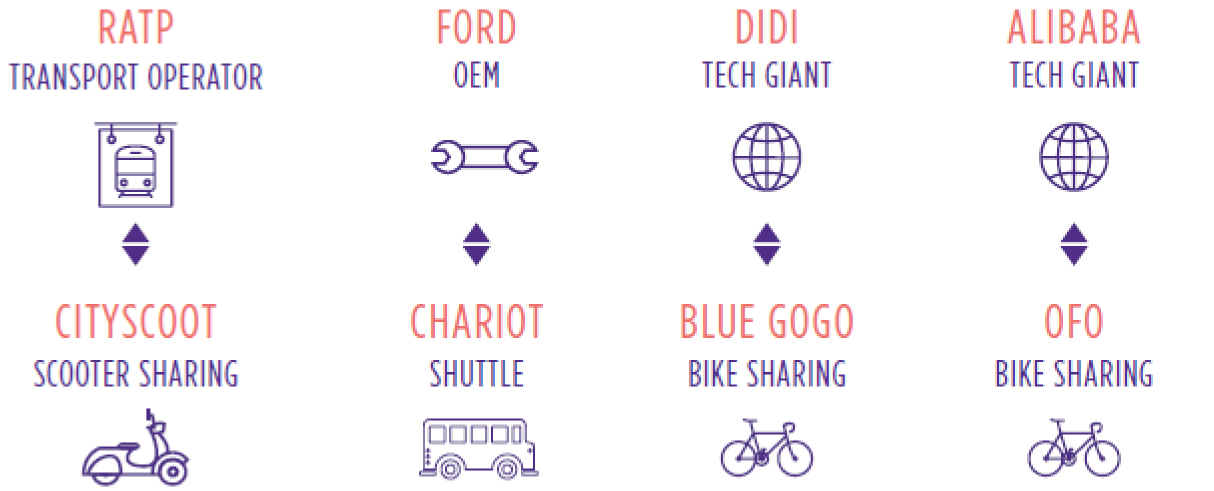

*Figure 4: Examples of strategic investments and acquisitions **[Stoupy-etal-2018]***

The shift operating in the mobility value chain will likely affect far more than transportation and automakers-industries with the rise of data from insurance and health care to energy and media should reconsider how they create value in this emerging environment.

4. Technological Clusters within the Mobility Value Chain

The Mobility Value Chain refers to different technologies and clusters that need to be explained: Smart Mobility, Autonomous solutions, Connectivity and Electrification. Our analysis will demonstrate the weight of each cluster in the landscape through the scope of investments and a special focus in this report will be made on the most relevant ones for our comprehension of the issues met by the traditional mobility value chain.

4.1. Investments Landscape

10 technological clusters emerge from the mobility landscape within the 4 different concepts of mobility as shown in the figure below.

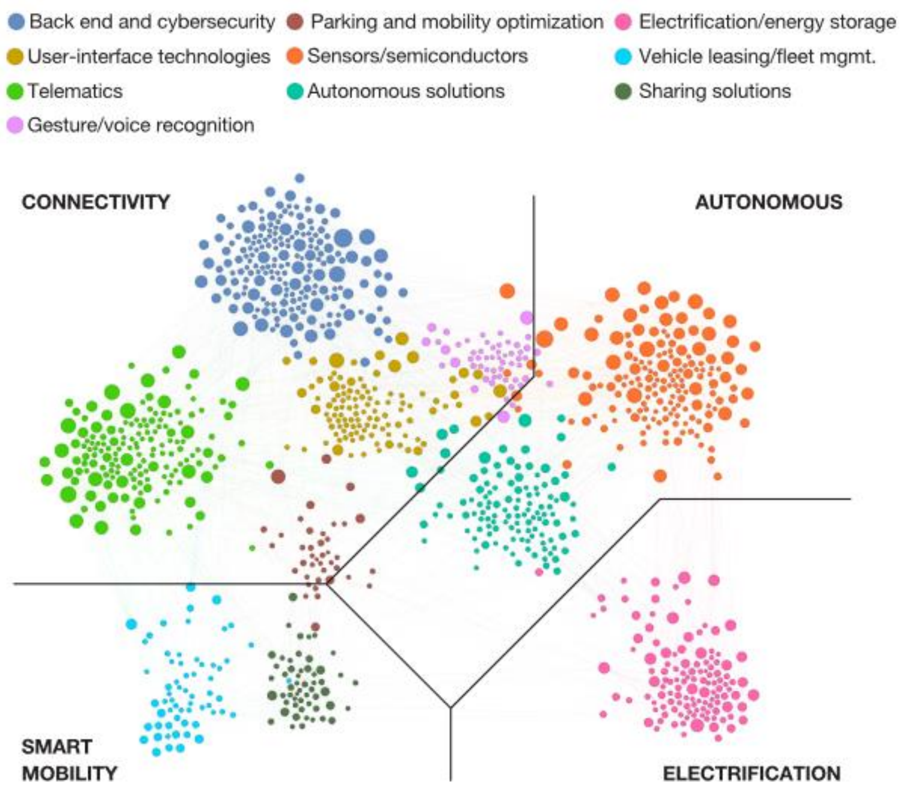

*Figure 5: Analysis of the new mobility startup and investment landscape across ten clusters [**Kässer-et-al-2017**]*

4.1.1. Smart mobility

The "Smart Mobility" cluster mainly gathers all the solutions of Mobility as a Service[3] (MaaS). MaaS is a data-driven, user-centered paradigm, powered by the growth of smartphones. Thus, fostering efficiency of MaaS requires widespread penetration of smartphones on 3G/4G/5G networks, high levels of connectivity, secure, dynamic, up-to-date information on travel options, schedules, and cashless payment systems [**Deloitte-2017**].

To enable these conditions, a diverse range of actors need to cooperate: from mobility management players, telcos, payment processors, public and private transportation providers, to local authorities with responsibility for transportation and city planning.

With the growing number of new transportation technologies and solutions, we can observe a correlated growth of services for mobility. Indeed, a lot of startups and even big companies, through the development of smartphone applications, enable the user to assess the best way for traveling/commuting from point A to point B.

A lot of actors emerge in these clusters as the time of Research and Development is clearly reduced compared to Connectivity, Autonomous, and Electrification. Indeed, mobility services are based on

[3] Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand : https://maas-alliance.eu/homepage/what-is-maas.

data processing developments, a skill accessible by the biggest number. As this cluster is not affected by the same issues as DeepTech, we will not focus our analysis on it.

4.1.2. Electrification

Electrification or Electric Mobility is also a great technological and societal challenge because the need for alternative and carbon-free energy is urgent. Indeed, figures from the European Manufacturer Automobile Association shows that new electrically chargeable vehicle (ECV) registrations in the European Union (EU) and EFTA countries increased by 38.7% in 2017, but despite this strong growth in electric car sales in Europe, electrically chargeable vehicles still have a market share of only 1.4%, representing one in 60 new cars [**Bekker-2018**]. The challenge does not only reside in the technology but also in the infrastructuture that limits the adoption as well as in changing the perception and the habits of users.

Together with the adoption of Electric Vehicles (EVs), technologies and infrastructures to charge them are developing as well. In several European countries, the public decision makers have taken the lead in installing infrastructures where Plugin Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) drivers can plug in to charge. EV charging has some marked differences from conventional Internal Combustion Engine (ICE) refueling, and as a result, drivers show a different charging behavior. Technological developments improving the driving range of Battery Electric Vehicles, as well as increased availability and speed of charging infrastructure, could change charging behavior and the need for charging infrastructure in the future [**ARF-2014**]. Research shows some of the top reasons for rejecting EVs are related to charging infrastructure or driving range [**Peterson-2015**]. Indeed the main challenges are exclusively around infrastructure as opposed to the product. Problems have been identified in different areas: the availability of charging infrastructures, the grid capacity, the lack of common/universal connector type and the weak & relatively under-powered public charging networks [**TE-2017**].

The challenge for Electric Mobility is the improvement of the conditions for broad market acceptance in the electrification of transport by dealing with the main barrier to adoption: the charging infrastructure. The idea is to design charging infrastructure for electric vehicles, but also for other means of electric transportation and anticipating also the arrival of autonomous vehicles. The user experience must not only equal that of a gas station but must exceed it.

Mobility as a service and more specifically car-sharing could represent good opportunities for EV adoption by removing barriers such as the cost of buying a car and also alleviate the "range anxiety" issue. Car-sharing fleet operators could possibly benefit from lower fuel and maintenance costs because they should be able to realize higher utilization rates (especially in dense, urban areas) as compared to private car use. As the share of EVs in car-sharing fleets grows, more customers can get familiar with the new technology – potentially leading to an increase in the proportion of prospective car buyers that is open to buying an EV [**ARF-2014**].

Electrification is a big issue for the future of mobility but this cluster is not linked to others as the need for greener energy will be key for any incoming development, from existing means of transportation to autonomous ones. We will thus not focus our analysis on this cluster neither.

4.1.3. Connectivity and Autonomous solutions

We are not going to dissociate these 2 clusters as they have common and interdependent activities such as gesture and voice recognition and autonomous solutions, along with sensors. The result of the association of Connected and Autonomous solutions clusters is the future of ADAS (Advanced Driver Assistance Systems)[4]. ADAS are systems developed to automate, adapt and enhance vehicle systems for safety and better driving. Advanced Driver Assistance Systems aim to drastically reduce road accidents and the associated casualties by helping drivers avoid collisions altogether. These systems react faster than any human, are constantly vigilant, and are already being adopted and deployed across various car segments, from premium to economy models. Adding a connectivity layer to the sensors and systems embedded in the vehicles to assist the driver, will result in offering them the possibility to interact with the other vehicles and the elements of the transport infrastructure and lead to the paradigm of "Cooperative Intelligent Transportation Systems". The added value would consist in having information about the zones beyond the coverage of the embedded sensors, receive notifications and warnings about dangerous zones and/or accidents, as well as an overview of the traffic on different zones.

ADAS systems constantly monitor the vehicle surroundings, alert the driver of hazardous road conditions, and take corrective actions, such as slowing or stopping the vehicle. These systems use inputs from multiple sensors, such as cameras and radars. The fusion of these inputs is processed and the information is delivered to the driver and other parts of the system. The same sensor technologies can be used both in the current ADAS systems and in the upcoming fully autonomous driving systems (level 4 and 5). Camera-based technologies provide high-reliability and adaptability for a wide range of driver assistance applications, for example, lane keeping, pedestrian detection, traffic sign recognition, rearview camera, driver monitoring, and electronic mirror.

Autonomous solutions collect and interpret data and send them to the system and/or driver to convert it into actions. Semiconductors manufacturers are crucial in this autonomous value chain as they are the ones able to solve the problem of processing high-amount of collected data.

According to Yole Development [**Celier-etal-2017**], the global market for sensors and MEMS (Micro-Electromechanical System) for automotive is expected to grow from $11 billion in 2016 to $23 billion in 2022. Despite a growth of only 3% year by year of the number of cars sold by 2022, the sensor market for the car should grow on average 8% per year in number of parts and 14% in value.

A study published by ABI Research [**Hodgson-Bonte-2017**] also shows that the LiDAR market could reach $13 billion in 2027, eight years after a massive commercial deployment estimated for 2019.

[4] https://www.st.com/en/applications/adas.html

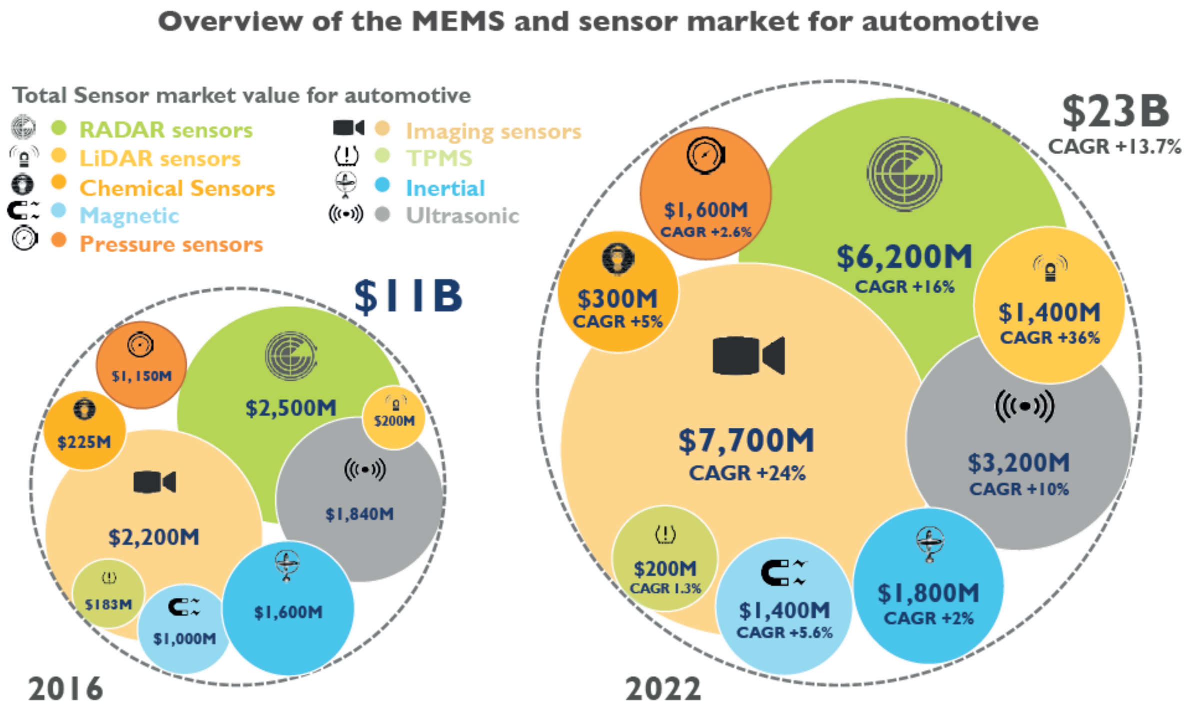

*Figure 6: Overview of the MEMS market and sensors for the automobile [**Celier-etal-2017**]*

4.2. Investment trends

The figure below shows an important increase of average yearly investments from the period 2010-2013 to 2014-2017 toward 2 technological clusters specifically: "Sharing Solutions" and "Autonomous Solutions".

In this period of time, the amount of investments is bigger for the cluster "Sharing solutions" ($36.5B against $24.1B for "Autonomous Solutions") but the growth in average yearly investments in the same period is 2 times bigger for the Autonomous Solutions" cluster (x64 increase in average funding against x32 for "Sharing Solutions").

Despite the fact that investments are mostly directed toward Smart Mobility, the decisive race for competitiveness advantage in Mobility is clearly oriented toward Autonomous Mobility with an impressive increase of yearly investments over the past 5 years, largely connected to the rise of DeepTech[5] start-ups in the field of sensors for automotive.

[5] Deep Tech refers to fundamental breakthroughs in science and engineering that profoundly impact industries and people's lives : https://deep-tech.org/deep-tech-definition.

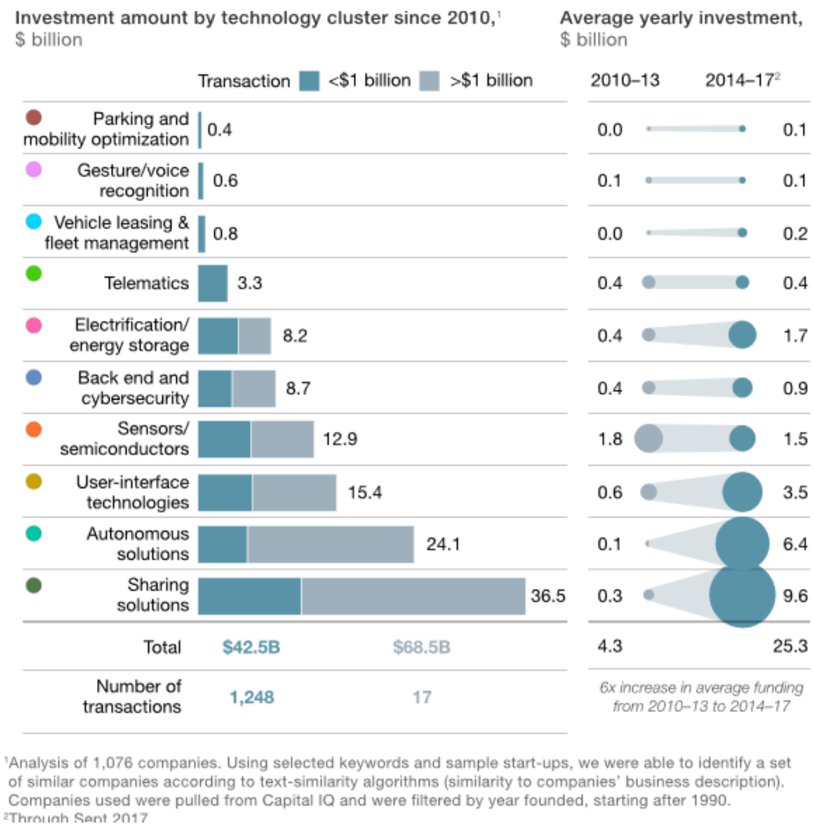

*Figure 7: Investment activities across the ten clusters [**Kässer-et-al-2017**]*

5. The rise of DeepTech startups

The traditional value chain of automotive is shaken by the rapid development of disruptive technologies. The level of safety required for the implementation of connected and autonomous vehicles led to the development of new and/or more efficient than state-of-the-art technologies. DeepTech startups are thus key to guarantee a competitive advantage for every actor of the value chain.

5.1. The chase for DeepTech

An analysis of the connected and autonomous vehicle landscape is showing that the investors are looking for far beyond state-of-the-art innovative startups in the field of self-driving-vehicle as we have seen that the research and development efforts in this field are relentless. It is not an easy task to forecast the landscape of start-ups directly or indirectly working on autonomous vehicles since it is a fast-moving landscape and large corporates (both OEM & tech companies) observe them carefully in order to identify the next potential unicorns. The picture below shows us a mapping of DeepTech startups to watch in the field of SDV and the associated technologies.

Every major car manufacturer in the world wants to be an early mover to avoid competitive disadvantage. They are joined by automotive suppliers such as Bosch and Delphi Automotive. The technology-intensive aspect has drawn in tech companies, that see their core competencies involved; Google's self-driving cars have been the poster children of the sector for several years, but Apple, Microsoft, Alibaba, and Baidu are increasingly involved and players such as Intel, NVIDIA, and Qualcomm are investing in making the microprocessors required. Fleet operators are also involved, including rideshare and logistics companies that are likely to be the earliest adopters and have a ready supply of vehicle miles to supply data for machine learning **[Kerry-etal-2017]**.

Billions are invested to keep up in this race with competitors and to save "engineering time". One of the most noticeable investments in the field of SDV is a good illustration of the strategical shift operating in the Mobility value chain, with INTEL - the Big US tech giant in the semiconductors - acquiring a DeepTech SME in the field of ADAS - Mobileye.

"Intel and Mobileye announced on March 13, 2017 that they had entered into a definitive agreement pursuant to which Intel would acquire Mobileye. Under the terms of the agreement, Cyclops Holdings, LLC, a subsidiary of Intel commenced a tender offer to acquire all of the issued and outstanding ordinary shares of Mobileye for $63.54 per share in cash, representing a fully-diluted equity value of approximately $15.3 billion and an enterprise value of $14.7 billion.

The acquisition couples the best-in-class technologies from both companies, including Intel's high-performance computing and connectivity expertise and Mobileye's leading computer vision expertise to create automated driving solutions from the cloud through the network to the car.

*The combination is expected to accelerate innovation for the automotive industry and position Intel as a leading technology provider in the fast-growing market for highly and fully autonomous vehicles. Intel estimates the vehicle systems, data and services market opportunity to be up to $70 billion by 2030. The transaction extends Intel's strategy to invest in data-intensive market opportunities that build on the company's strengths in computing and connectivity from the cloud, through the network, to the device." **[Intel-2017].***

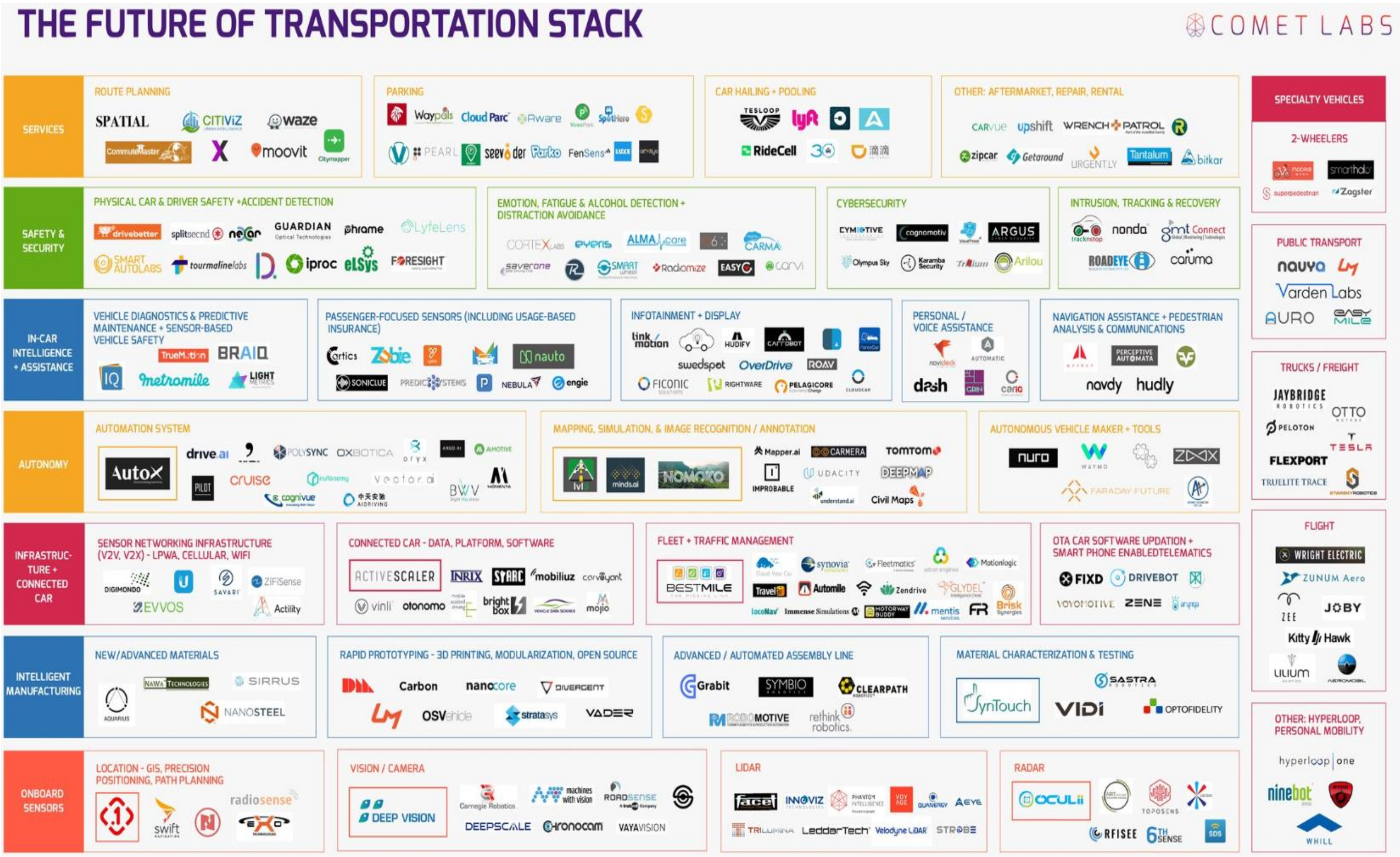

Figure 8: The Mobility start-ups landscape **[Stewart-2017]**

5.2. The DeepTech enabling the emergence of Autonomous and Connected vehicles

The growing problems of pollution, congestion, energy savings, time spent and user safety have inevitably led players to rethink mobility. New uses then emerged, no longer based on ownership but on use, and driven by the rise of digital technologies, transforming the mobility landscape and introducing new societal and technological challenges.

These new challenges are addressed by the European Directives on Intelligent Transport Systems (ITS) and addressing them requires the development of new technologies to ensure a maximum level of security for the user. To maximize these safety aspects, the vehicle of tomorrow must be connected, the first step before considering a complete and secure autonomy.

As resulting from the Figure 8, even though the most successful models revolve currently around digital platforms for shared mobility, sensors and embedded processing are at the core of the future autonomous vehicles. They offer the vehicle and essential function: the ability to perceive their environment and to potentially detect, classify and track all the existing objects through additional processing The most precise and thus reliable solutions, but also the most capital intensive and thus the most costly for the moment, are coming from the field of photonics. Different types of cameras and sensors (infrared, high dynamic range, fast, stereo, Time-of-Flight …) for machine vision, as well as the graal of perception systems – the LIDARs – are representative solutions from the field of photonics.

Photonics covers crucial aspects of autonomous mobility by providing key technologies for capturing and receiving data. In addition however, complementary technologies such as BigData processing, embedded real-time systems and artificial intelligence allow to exploit the data issued from the sonsors and to extract essential information for driver assistance or machine decision-making. The Table 1 hereafter provides an overview of the applications of photonics technologies in the field of intelligent mobility.

Capitalizing on communications technologies and the emerging Internet of Things (IoT), the Internet of Vehicles (IoV), begins to take shape around V2X ubiquitous communication technologies (Vehicle-to-Everything). To be autonomous, the vehicle must be able to understand its environment, not only by sensing and mapping the static or dynamic elements but also by communicating with the smart elements. Considering the throughput needs, the dominant standard will be undoubtedly the emerging 5G even though some specific use-cases (such as detecting the RED/GREEN lights status) will allow IoT-like (thus low data rate technologies) to play an important role. Also, Visible Light Communications – the emerging LiFi could play an important role for the point-to-point (V2X) communications or the emergence of ad-hoc (contextual) vehicle and smart objects networks.

The connectivity is also essential to enable the development of high added value mobility services, that are much more efficient, comfortable and of course secure. This data is used to offer the driver and the passenger(s) a disruptive transport experience by providing services and features - also called infotainment - instant, similar or complementary to those accessed by smartphone. New display and augmented reality technologies will not only assist the driver by providing key data and creating new, more intuitive interior and also exterior environments but also by providing access to a completely digital in-vehicle environment.

IMAGING AND DETECTION	
Cameras	• Monitoring the condition of the driver
Cameras / LiDAR / Stereovision	• Vehicle Environmental Mapping, • Collision Avoidance • Line crossing alert, • Visibility in degraded conditions, • Obstacle Detection.
Thermal Imaging	• Passenger detection
Active and Passive Infra-Red Sensors	• Night vision • Pedestrian protection
Mirrors, Fresnel Lenses, ...	• Blind spot detection
Photodiodes and Infra-Red sources	• Rain detection • Brightness monitoring
LIGHTNING	
LED	• Reductions in energy consumption • Adaptive light adjustment
COMMUNICATION	
Visible Light Communication / LiFi	• Vehicle to Environment Communication (V2X) • Improved traffic and safety on the road
Cameras	• Recognition of traffic signs
Cameras/Laser Scanners	• Automatic Speed Adjustment
HUMAN MACHINE INTERFACE	
OLED / holographie / 3D	• Interactive dashboard displays • Infotainment
Augmented Reality	• Intuitive “Getting Started” • Recognition of movements

Table 1: Photonic Technologies for intelligent transportation systems ***[EPIC-Tematys-2015]***

To make a distinction beteween overlapping technologies and applications in the field of Smart Cities, we have decided within the scope of the Mobility domain to focus exclusively on embedded technologies for driver assistance and vehicle autonomy and connectivity.

5.3. Overview of patents submitted in Europe

The pinnacle of self-driving vehicles (SDVs) is expected to be in 2025 with full automation technologies mastered. But before reaching this point, R&D investments and real conditions tests should pursue intensively to validate this horizon. The European Patents Office[6] (EPO) has underlined a significant increase since 2011 in the number of self-driving vehicles EU patents applications (18 000) revealing a major interest in this field and revealing a shift in the traditional automotive technological landscape **[Ménière-etal-2018].**

[6] The European Patent Office (EPO)[notes 1] is one of the two organs of the European Patent Organisation (EPOrg), the other being the Administrative Council. Within the European Patent Office, examiners are in charge of studying European patent applications, filed by applicants, in order to decide whether to grant a patent for an invention. The patents granted by the European Patent Office are called European patents.

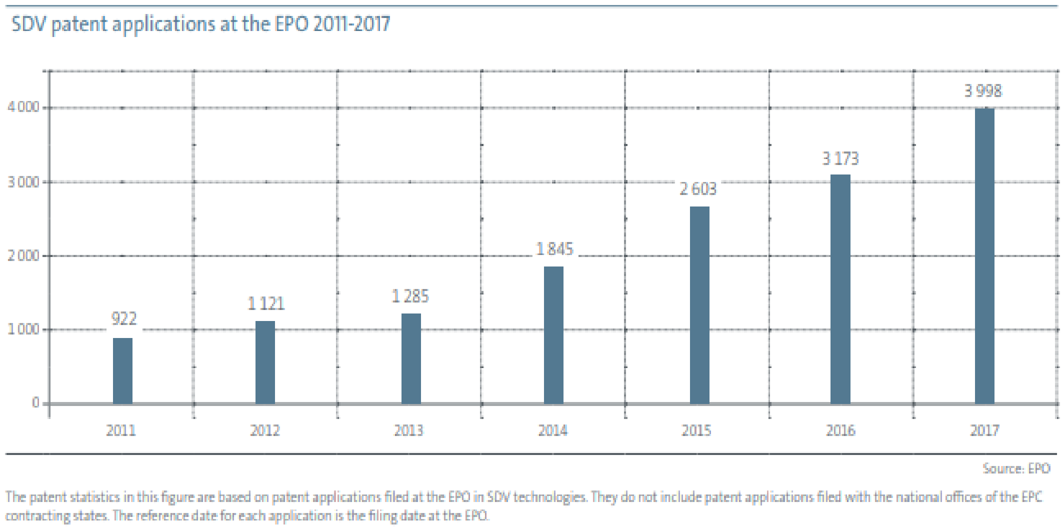

Figure 9: Self-Driving Vehicle patent applications at the EPO 2011-2017 ***[Ménière-etal-2018]***

It is worth noticing that the increase is stronger in recent years; in 2017, nearly 4.000 applications were submitted, representing 2.4% of all applications at the EPO in that year, showing that SDVs is a major topic among all technological field of R&D.

Within Europe, SDV innovation is largely driven by Germany with 2,151 European patent applications for autonomous cars made between 2011 and 2017, representing 14.4% of all patent applications received by the Office over the same period in the same sector. However, France (715 requests) and Sweden (703 requests) also show significant innovative activity. The next players in the top 5 of the main European countries filing patents on technologies of automated driving, are the United Kingdom (439) and the Netherlands (419). If we consider the top 10, the following players are Finland (300), Switzerland (211), Austria (120) and Italy (93).

Almost two thirds of the patents applications came from Europe & the USA. US applications are dominating in Communication and Computing technologies, while European applicants stand out in Vehicle handling, Smart logistics, and Perception, analysis & decision. All technological fields of expertise related to SDVs are covered by European R&D organizations showing that Europe is not as much specialized in some sectors as the US companies.

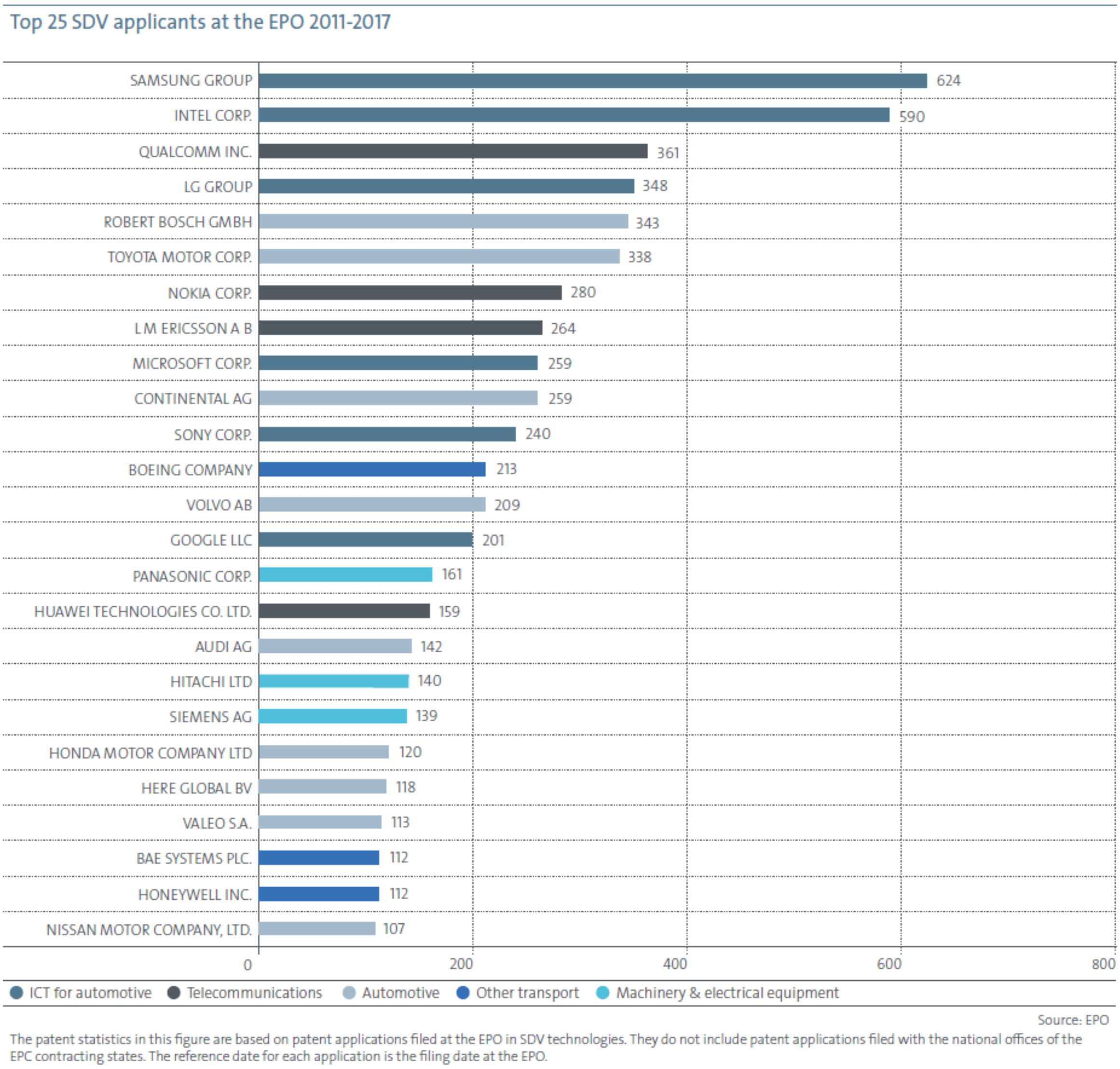

Figure 10: Top 25 SDV applicants at the EPO 2011-2017 ***[Ménière-etal-2018]***

The Figure 10 above shows us that a broad range of innovators from different industries have been actively filing such applications in recent years. But only 40% of all SDV applications at the EPO currently originate from the top 25 applicants, while the remaining 60% are distributed between hundreds of other applicants, including smaller ones. It illustrates the potential from startups and SMEs to find their place in this market. The predominance of automotive companies in Europe and US tech-companies is another major conclusion.

It is also interesting to note that in the top 10 companies who have submitted the highest number of patents applications, only one is an OEM, perfectly illustrating the shift in the traditional automotive value chain and the opportunity seen by major tech actors.

6. Conclusions

6.1. A market full of opportunities

As we have seen that the traditional automotive value chain is no longer up to date with the development of autonomous solutions, a lot of actors will try to take a share of the cake, breaking the monopole of OEMs at the top of the no longer existing pyramid.

With OEMs seeing their position as a leader in the value chain decreasing, innovative startups and SMEs are benefiting from it. The fields of expertise required for autonomous solutions are now legions, combining more software technological bricks with hardware ones because the key success to a connected and autonomous solution is Artificial Intelligence (AI).

Indeed, traditionally it was really hard for start-ups to take a place in the existing value chain because OEMs already had tiers-X suppliers for decades providing them technological solutions to integrate. But now, with the revolution of Mobility and the emergence of disruptive technologies cards are shuffled and any innovative actor with added value can interest stakeholders in the new mobility value chain.

Opportunities also exist for big companies seeking to strengthen their position as market leader or new markets to conquer. Mobility now being considered a service, it opens new horizons for big companies to provide extra services for a better customer relationship.

Big market leaders in Communication and Computing technologies are also clearly aware of their importance in the value chain as autonomous solutions will require high-performance computing technologies to treat the huge amount of data collected for AI solutions. And investments are clearly showing this trend with the unprecedented amount invested by these actors in innovative SMEs and startups.

6.2. Some barriers to lift

Changes are operating so-fast in the mobility landscape that product development time and time-to-market are key aspects for competitive advantage. We have seen that the strategy adopted by big companies to face that challenge is mainly by acquiring the DeepTech and Digital start-ups but it does not change the issue of development time for the startup itself.

The development of solutions for the autonomous and connected vehicle are rather capital intensive, needing strong R&D investments to develop beyons state-of-the-art technologies, so a lot of startups are emerging from academic research. It is to be noted that Israël is a model of excellence in the emergence of DeepTech startups for the automotive market and especially in the field of machine vision and sensors. Indeed, the number of start-ups working on the autonomous vehicle in this country has literrally exploded. In 2013, the Ecomotion sectoral association identified 87 start-ups working in intelligent transport, of which 35% specialized in autonomous vehicles. In 2017 the number is 520,and most of these companies focus on the BtoB market. Dror Meiri, the vice president of the DeepTech start-up AdaSky said "*The Israeli tech industry has great expertise in providing cutting-edge BtoB technologies to international companies, and in the automotive industry, all the innovation around technology today is Israel's and Silicon Valley's comfort zone, and we have no industrial heritage to* *protect: we do not know how to make cars like Detroit and Stuttgart* ***[Jeetech-2018]."*** This demonstrates that the car manufacturers are no longer the only key players in the automotive industry now. It is Israel's own policy to support start-ups in advanced technologies with a fairly longer-term perspective, but with massive returns on investment.

A focus should thus be made in Europe to support DeepTech startups to accelerate the development time by allowing them to access funding more easily.

Technologies must also be tested in real conditions to validate Proof of Concept (PoC). It is a key aspect of R&D because disruptive innovations mean change of habits for users and the adoption of the technology is not guaranteed. Public stakeholders such as Transport Operators and City Administrators must play a role of facilitator to let startups access experimental environments to develop PoCs. Public actors must lift the administrative and time-consuming barrier of experimentations in real conditions.

With such a big landscape in the field of Mobility, the identification/scouting of relevant technologies is essential to create collaborations across the value chain and reduce the information asymmetry.

6.3. Our hypothesis

OEMs have to be particularly careful in this new landscape of mobility because the added-value in the value chain has moved in the favor of highly innovative companies. They will not be erased from the landscape obviously because of their know-how, critical size, regulation protection… Also because electrification is a key aspect of mobility too and it is a hot topic in the hand of engineers from OEMs. But it is probable that new actors integrate the value chain in the next decade to design and assemble the finished vehicle, competing directly with OEMs as we are moving from mechanic to Artificial Intelligence, from Vehicle to Intelligent Robots (Robot-taxis).

As AI becomes the standard in automotive, tech giants claim a new status of pillar in the mobility value chain and will keep on investing billions to catch up with this new emerging market and erase competitors.

Roadmaps seem really optimistic when speculating about the arrival of the autonomous vehicle. If we put aside the fast technological developments happening, we tend to underestimate the adoption factor of such disruptive technologies. Because it is highly correlated to the degree of trust you put in computing sciences (security of the system) and no longer to your driving skills, the adoption is far from obvious. The public space is not yet designed to support the development of infrastructures and road for autonomous vehicles in big Cities, like Paris for example.

Technologies are adopted if they bring undeniable added-value to the user. So even if you can create added-value by not driving (also the case in public transportation), the determinant factor will always be the same when it comes to mobility: time and money and business models are still blurring currently.

The race toward the future of mobility made us forget the true essence of traveling: a convenient, fast and cheaper mean of transportation. And the quick adoption of micro-mobility systems in big cities perfectly illustrates it: ownership (available directly), convenient (small), cheap and fast.

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