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D2.1
Report on user expectations, goals, ideas, reservations and requirements

SCOUT

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Authors:
Yves Page
(yves.page@renault.com)
Antonella Toffetti
(antonella.toffetti@crf.it)

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1 Glossary of terms

AD = Automated Driving

AV = Automated Vehicle

CAD = Connected and Automated Driving

CAV = Connected and Automated Vehicle

DG = Directorate General

DSRC = Dedicated Short Range Communications

EU = European Union

HMI = Human Machine Interaction

IT = Information Technology

OEM = Original Equipment Manufacturer

SA = Situation Awareness

STAMP = Systems-Theoretic Accident Model and Processes

VRU = Vulnerable Road User

V2I = Vehicle-to-Infrastructure

V2V = Vehicle-to-Vehicle

2 Executive Summary

Expectations towards Connected and Automated Driving (CAD) are high in general. Current promises of CAD are mixed between reasonable expectations from users and stakeholders who are aware of the reality regarding CAD and excessive expectations of other users or even stakeholders, having a very optimistic view towards the development and deployment of CAD. Sometimes, too high expectations can be far beyond what CAD can offer in the short-term or even mid-term range. Beside increased safety, free-time and mobility as well as lower emissions, land usage, incidences and presumably lower insurance costs, CAD can also have great impacts on economy, thinking about new entrants, new challenges, new employment and more competition in the automotive world. The biggest challenges are of technological nature: the technology has to be reliable, robust and performant, and has to show a better overall performance than a human driver would do. The success of the CAD story heavily depends on the reliability of technology and on the costs but also on the introduction and/or adaption of the relevant legal frameworks. At the end besides technological and legal hurdles, the user with its reservations and concerns “decides” on the successful implementation of CAD.

This report proposes a review of main stakeholders involved in CAD in Europe. Furthermore it includes a review of expectations and reservations related to CAD from a general viewpoint as well as from each user and main stakeholder’s perspectives.

3 Objectives of the document

This chapter aims at defining the different terms (users, expectations, goals, reservations, etc.) and presenting the following questions/objectives of the report:

3.1 Q1 - Who are potential individual users and relevant stakeholders along the value chain of connected and automated driving?

This will be done by the presentation of the socio-technical system involving all participants of the Automated Driving (AD) world in a country or a region, e.g. Europe.

3.2 Q2 - What are the goals of these users and stakeholders?

Once the system and its elements are presented, the numerous users and stakeholders will be clustered in order to identify the clusters' goals. For example end-users goals are related to purchasing safe and comfortable vehicles whereas OEM's goals are to attract more and more customers and make profits. Another example is the willingness of EU Commission and DG's to deploy safe Connected and Automated Vehicles by increasing the competitiveness of the European Industry.

3.3 Q3 - What are the expectations and reservations from connected/automated driving?

Expectations (e.g. safety, efficient traffic, access to mobility for the disables, more parking space, etc.) as well as fears and reservations will be presented for each categories of users' perspective.

3.4 Q4 - How can the hurdles be overcome?

Once the socio-technical system is described, different users and stakeholders are presented, and reservations regarding deployment of AD are clearly stated, the challenge is of course to identify how the hurdles or roadblocks for deployment could be overcome. This will be done reservation by reservation, systematically, as identified in the previous step.

4 Methodology

In this chapter, we propose a specific methodology for answering the previous questions.

4.1 Q1 - Proposition of a control structure of the Road Transport System to identify all users and stakeholders categories

The Systems -Theoretic Accident Model and Processes (STAMP) safety model, well-known for the design in safe engineering, will be used to describe the socio-technical system for AD, at a macroscopic level. Briefly, this model allows structuring the relationships between actors of the system according to a hierarchical control structure. Actors' relationships have two types:

1. Control: for example the regulation can be seen as a control of the upper layer of the system, the public authorities, upon other actors below.

2. Feedback: each actor receives information from others.

This model enables a correct identification of users/stakeholders and their interactions according to this control/feedback structure. An example of the STAMP control structure is given in Figure 1 for the French Road Safety System (Alvarez, 2017).

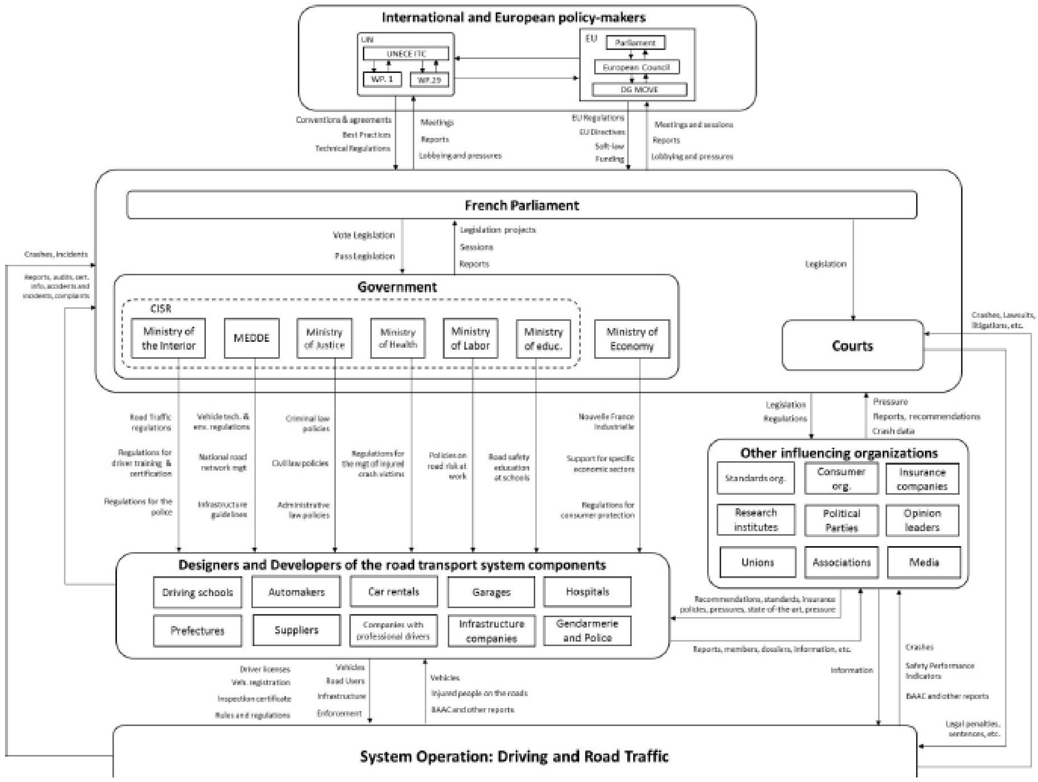

Figure 1. Example of a system control structure (Alvarez, 2017)

4.2 Q1/Q2 - The Porter’s Five Forces Model, including examples of EU regional activities

Porter's Five Forces model identifies five competitive forces that play a role in industries and it helps to determine their weaknesses and strengths. Figure 2 depicts these forces, which are Competitive Rivalry, Supplier Power, Customer Power, Threat of New Entrants and Threat of substitute products.

The model shows how those key forces interact in a business situation. It will be used to address goals and threats of different stakeholders in the case of Connected and Automated Driving (CAD).

Figure 2. The Porter's 5 Forces model (Porter, 1979)

4.3 Q3 - The Matrix of interdependences between Goals/Challenges and Reservations/Expectations

This matrix is an outcome of the project. It shows in a simple way how social goals/challenges on a first axis and users' reservation/expectations on the second axis are interrelated. This has been done mostly with the help of an extensive literature/publications review.

4.4 Q4 - Hurdles

No specific methodology is proposed here. Overcoming the hurdles and reducing the existing reservations claims for a few principles that will be briefly presented in the report.

5 General Concepts

Automation

But beforehand, the classification of automated/autonomous driving system is defined. There are still many classifications available in the literature, each of them having advantages and disadvantages. The most known one and used one is the classification proposed by the SAE International standard J3016 (SAE, 2016). It proposed a 6-scale classification of automated / autonomous systems depending on the Operational Design Domain (ODD) and depends on the fact if the driver or the systems is in charge for:

- The Dynamic Driving Task (DDT)
- The Object and Event Detection and Response (OEDR)
- The Fall-back solution (Driver or System)

Figure 3 (extracted from SAE J3016) explains how these above-mentioned criteria define the classification that ends up into the 6 classes from level 0 (conventional driving) to level 5 (full automation in all ODDs). Debate between automation and autonomy is beyond the scope of this report, in which the word ‘automation’ is preferred and used.

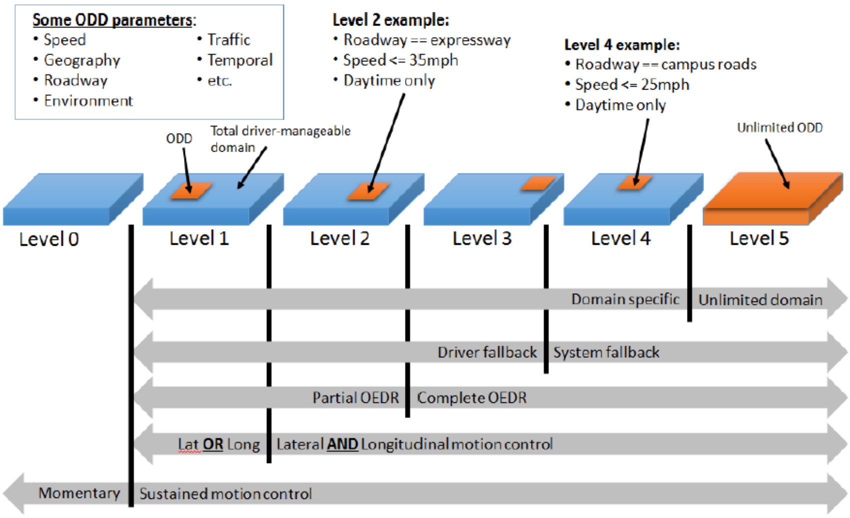

Figure 3. Levels of automation (extracted from SAE J3016)

Connectivity

As for connectivity, professionals and also the public now seem to be very much aware of what we call ‘the connected vehicle’, meaning vehicles connected to other vehicles or to infrastructure. This is actually a technical definition that hides two different functional definitions of connectivity:

1. The first option describes a driver or a passenger that can be connected with the external world via a nomadic device (for example a smartphone or a tablet) which has nothing to do with the vehicles. The driver just uses the device while driving (or during a trip as being passenger) as he/ she would use these devices outside the car. This is just the general continuation in the car of the nowadays very popular ‘connected life’. We refer to this as ‘connected user’

2. The second option is a driver or a passenger that can be connected via an integrated device which is embedded in the vehicle and can offer different types of services. These services could be redundant to the services available with a nomadic device. Of course the connected vehicle mediates between the driver (and the passengers) and the external world. The connected vehicle can also give information to the rest of the world in case it is itself a sensor (for example if it detects slippery road and sends the information to surrounding traffic).

In both cases, the services provided by connectivity (nomadic or integrated) can be classified according to the following taxonomy:

- Safety systems: the service has a primary objective to prevent accidents and injuries. For example car-to-car communications can help in preventing accidents at intersections where visibility is reduced by buildings, trees, bus stops and any kind of fixed or mobile masks to visibility.

- Driving assistance: the service has a primary objective to help the drivers in performing a driving task (navigation, guidance or control). For example a navigation system helps the driver in choosing the route and to follow directions that are proposed by the system.

- These two categories can easily be grouped together since driving assistance systems often have a safety aspect.

- Traffic information: the service has a primary objective to help the driver knowing more about the traffic ahead, e.g. a congested route, road works along the trip or road closure as well as services related to transport, usually called Intelligent Transport Systems, such as highways remote payment.

- Services not related to transport, often called infotainment (internet in the car, watching or downloading videos and many other applications currently available on smartphones and tablets, etc.).

Furthermore, the vehicle can be considered a sensor itself and deliver information to the rest of the connected world. This could e.g. contain information about the grip of the road surface at a particular location, the radius of a curve or an especially dangerous zone, etc.

The connection is ensured by different kinds of technologies such as 3G, 4G and DSRC, which are explained in detail in D3.1 and present high performances as well as limitations. Therefore, and especially for connected safety systems and driving assistance systems, the functions work under particular circumstances called 'use cases' and not in any circumstances. For example, as connected technologies usually use GPS to localize a vehicle or a connected device, this information is known to be not very accurate (a few meters accuracy) which prevents its use for imminent impact avoidance for example (at least for the moment).

Moreover, international standards of principles edict some consensual rules for Human Machine Interaction (HMI) in order to design interfaces/interactions, which are not distracting drivers. These apply for any kind of manipulation the driver is in charge of (radio tuning, navigation system use, etc.) and any kind of feedbacks (visual, acoustic, vocal…) he/she receives.

These systems are in full expansion, although still in pre-deployment phase. They deserve a lot of attention, especially to hinder possible distractive effects, to select, amongst all systems, those which have the largest expected safety benefits, and of course to prevent cyber-crime.

6 Outcomes

This chapter is devoted to answer the questions raised in chapter 3.

6.1 Q1 - Who are potential individual users and relevant stakeholders along the value chain of connected and automated driving?

The STAMP control structure is a hierarchical structure linking all actors of a socio-technical system, at all levels of development and exploitation (Leveson, 2012). The example in Figure 1 has been proposed by Alvarez to depict the socio-technical system for Automated Driving in France but it is of course transposable elsewhere. It starts at the highest level, European or even global level with bodies in charge of regulating, standardizing, providing guidelines and financing research or innovations. Then it goes down to the public authorities in a country. In the case of France, it concerns government, parliament and Justice (courts) corresponding to the 3 powers (executive, legislative and judicial). Below, the control structure shows designers and developers of the road transport systems components, including all economical stakeholders such as the automotive industries, the road operators, telecom operators. At that level we also find public authorities in charge of local governance and enforcement (local authorities, local police), hospitals, rescues services, road or land transport companies and other bodies. On the other hand, one can find influencing organizations or institutes such as press media, research institutes, insurance companies, opinion leaders, etc.. At the bottom of the control structure, on the last level, there are mainly the end-users, i.e. the drivers and road users (pedestrians, pedal cyclist, powered-two-wheelers, etc.). All actors of the road transport system are therefore present in this representation. The picture is supposed to be as comprehensive as possible. Of course, each box can be broken further down into smaller components. For example, there are many car makers designing, producing and selling cars and there are also many suppliers.

The so-called “control actions” from one level to the other ones (represented by an arrow) are of different nature: regulation, guideline, enforcement, incentive, economics, etc., and the feedbacks (not shown in Figure 1 for simplicity reasons) are actually the information that an actor receives from another actor.

The description of these control actions are beyond the scope of this report. Figure 1 is considered helpful in identifying all actors (or so-called users) intervening in the connected and automated driving world.

Another way of representing more in details part of this world (mainly layers 3 and 4) is to use the Porter’s Five Forces model which is an economical representation of the competition between actors/stakeholders on a market. A competitor is defined as an actor likely to reduce a firm capacity to generate profits (Figure 4).

According to Porter, five forces determine the competitive structure of an industry for goods and services (Figure 4):

1. Negotiation power of clients (right-end side of Figure 3)
2. Negotiation power of suppliers (left-end side of Figure 3)
3. Threat generated by substitution products or services (bottom)
4. Threat by potential new entrants of the market (top)
5. Intensity of rivalry between competitors (centre)

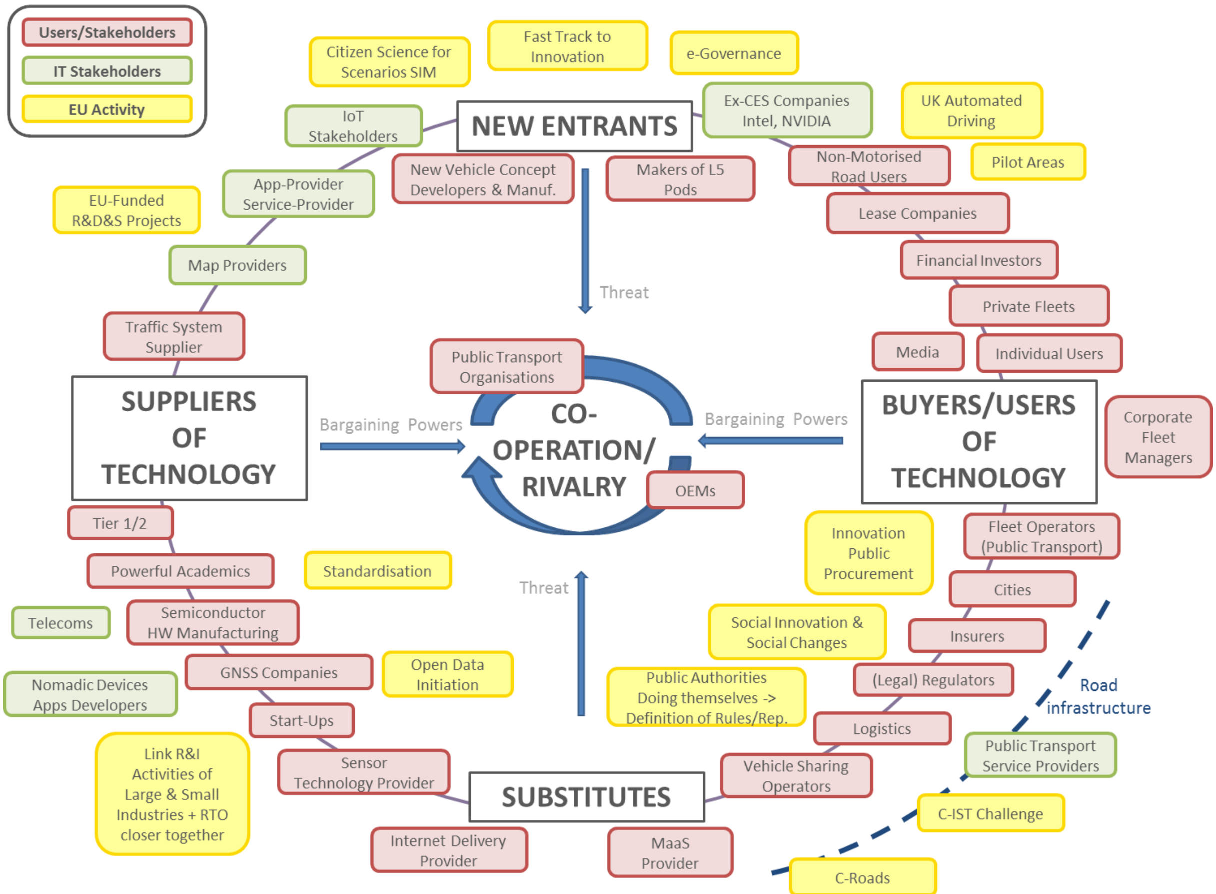

Figure 4. Porter’s 5 Forces Model applied to Connected and Automated Driving

Public authorities are not explicitly mentioned in this representation (see however ‘Legal regulators” in the right-bottom-hand side). They were added to the model and therefore our Porter’s 5 Forces Model is modified to a 5 (+1) Forces Model.

Figure 4 is also helpful to identify the details of economical actors that do not appear explicitly and in details in the STAMP hierarchical structure. However, we will not refer systematically to each and every actor in the rest of the document. As specified in the upper left corner legend in Figure 4, we decided to cluster all actors into 3 categories:

- Users and stakeholders (in pink)
- IT stakeholders (in green)
- EU activities (in yellow)

In the rest of the document, we grouped the actors according to a mix between the STAMP control structure and the Porter model otherwise there would have been too many actors with, at the end, similar expectations and reservations for many of them.

6.2 Q2 - What are the goals of these users and stakeholders?

This question was addressed two-fold:

- First we made a publication review in order to collect the expressed motivations for connected and automated driving

- Secondly, we organized a SCOUT workshop in February 2017 with different stakeholders in order to bring details into the motivations found in the literature. Three kinds of motivations arose from this workshop:

  - General motivations expressed by everyone. For example, everyone agrees that road safety, free time while traveling and accessibility to mobility to elderly and disabled are shared social goals related to the deployment of CAD

  - Specific motivations expressed by stakeholders in particular. For example, some OEM's express that safe and reliable AD technology can provide competitive advantage on high-end markets

  - Motivation of an actor as seen by other actors. For example OEM's suspect that end-users would like to have full (and not partial) free-time at the wheel and would expect full confidence in the safety of the technology

Consequently, we propose in this section to start with goals and expectations in general, and to go through the specificities for a selection of stakeholders in a second sub-section. It has to be stated that, although automation is rather understood quite realistically by professionals, it is very often a representation of something that is not fully known by end-users. Most of them have too high expectations and naive ideas about road automation and consider it as full automation rather than as a continuity between conventional driving towards full automation. Expectations are therefore very often focused on full automation and rarely on conditional or partial automation.

6.2.1 General Goals and expectations

CAD is often viewed as a promise for social and societal benefits. Many of the expected benefits are not demonstrated yet. They are often guesses or targets and only few studies about the a priori social benefits are available by now. Some of them concern reduction of emissions or accidents but methodologies to estimate the potential benefits are still under investigation. Actual benefits are of course not available since the deployment of CAD is just starting at its earlier stage and for the lowest levels of AD only (SAE levels 1 or 2 if we refer to the SAE J3016 standard). SAE levels 3 and above (Figure 4) are still under experiments, mainly in the USA, Europe, South-East Asia, China and Japan.

Expectations also vary depending on the levels of automation and the real contents of connectivity (for example C-ITS provides safety services such as notification of incidents or accidents on the route ahead; other services provide entertainment for a better life on board). We first present general considerations about goals and expectations, regardless the level of automation. However, there are higher expectations for higher levels of automation. We do not address goals and expectations of SAE level 2 and below, as they are mainly related to comfort and delegation of driving tasks. Our focus will be SAE level 3 and above. We first address the general aspects before presenting the specificities.

The following general goals and expectations are clustered in certain topics.

Safety

Reduction in road fatalities and severe injuries during accidents are the main common goal addressed by all users and stakeholders.

Assessment of the expected safety benefits of automated driving system is just starting and the few available studies are not entirely convincing since they usually assert that 90 % of accidents are due to human errors (meaning implicitly the driver) and that removal of drivers would remove accidents. Driver error is most often the consequence of a combination of different factors (human, technical and situational) that prevent the driver to correct a critical situation. Error is a symptom of a malfunction (that sometimes leads to an accident), but not a primary cause of the malfunction: accident causes are found before the error and their influence is direct or indirect, depending on when we go back in the accident analysis. For example, combination of fatigue, speed, and grip problem is a group of factors that impact the situation at the end of the accident process that ends up with a guidance error and finally a loss of control. But, one can identify other intermediary causes such as road configuration which could someway favours a little bit speeding before entering a difficult bend, lighting that does not allow a good bend visibility, etc.; as well as causes even more 'indirect' but also predominant in terms of accident prevention such as education, information, social culture towards speed, driving, risk, safety, etc..

An additional way of presenting things consists of considering drivers errors as limits of adaptation of drivers to critical situations to which the current traffic system confronts him/her to. We have also to consider that 'Human Factors' are what actually makes the driving system work, more or less efficiently, despite its shortcomings, thanks to adaptation capabilities that are inherent to the humans.
If the driver is removed from driving, driver adaptation is also removed, which then has to be compensated by automated systems with certain learning processes.

Effectiveness studies will progressively largely be published and disseminated and will allow a better understanding and knowledge about expected and observed effectiveness of Automated Driving systems.

Anyhow, if the automation progressively replaces the driver, in a few situations and stepwise in more and more of them, it has to be at least as good as the driver in recognizing the road and traffic pitfalls, adapt to them and not default as much as the human driver. These are the main expectations from users and stakeholders. And these actors have same high expectations towards the transition period in which full automated vehicles will co-exist with semi-automated vehicles, which is one of the key safety challenges along the roadmap to full automation.

Free time and comfort

If the driver is released from driving, there are other possibilities to use the additional time exploit the benefits of automated driving.

Amongst side activities could be possible in an automated vehicle are:

- Entertainment (e.g. watching videos/movies, play videogames)
- Personal care (e.g. make up, shaving)
- Relaxing/Off-time (e.g. sleeping, resting, eating)
- Free-time (e.g. doing soft gymnastics, reading books, texting)
- Working (e.g. using handheld Phone, e-mailing, using Internet)

Most of these activities would be mainly possible at SAE levels 3 and even above, sometimes for just a few seconds, sometimes for a few minutes, or for more. Some activities are not compatible with SAE level 3 as it requires the driver to take over conventional driving on request within a short lap of time. Sleeping, for example, is therefore not compatible with SAE level 3 whereas it is for higher levels in certain conditions (driver is not required to take over except at the end of the use case) Engagement in side activities implicitly means that the system drives safely and that there are not so many take-over requests that are supposed to stop and/or delay a side task, which could be considered as a negative point. Some of the tasks above are already done, legally or illegally, such as phoning or texting. In that case, user's expectations would not be to perform them, but to do them safely.

Mobility

Mobility is related to passenger transport and goods transport. Mobility is a tremendous issue that would deserve much attention but we can highlight some aspects in this report.

As far as the varied CAD roadmaps are concerned, we can distinguish between 3 categories of target AD mobility:

- Individual passenger mobility via CAD private vehicles
- Collective mobility via CAD public transport like buses, trams and shuttles
- CAD freight or goods transport

Each of these categories of mobility could benefit of CAD, either for urban or for inter-urban transport, making them more available, smoother and seamless. As a whole, it would be easier to get from point A to point B, at anytime and anywhere, even where there is just a few people and where public transport seems to be too costly compared to its benefits. The following section is describing use cases related to those three categories.

Personal mobility via CAD private vehicles

Today, the most frequent AD targeted use cases are the following:

- Traffic jams, noticeably on highways first and then in more complex areas such as cities
- Driving on highways/motorways at higher speeds, where the traffic is simpler than anywhere else due to dual carriage ways, one direction, few vulnerable users such as pedestrians and pedal cyclists and less complex infrastructure (no junction, no roundabout, no traffic lights, etc.)
- Commuting vehicles driving on known routes, where the vehicle can learn the same way day after day (in varied environment conditions)
- Valet Parking: the driver leaves the vehicle at a parking lot entrance and the vehicle can drive to a parking place by its own
- Automated 'open roads' valet parking: similar to valet parking with the difference that the vehicle can find a parking place anywhere (not only in a parking lot) on demand by the driver. It can also work the other way round where the vehicle can leave its parking place and can pick up the driver in another location.
- Robot-taxi: same as taxi and cabs today, but fully driverless.

Collective mobility via CAD public transport like buses, trams and shuttles for instance

- First or last mile: at any time, going from a train/bus/tram/etc. station to somewhere (or reversely) in the neighbourhood not accessible by public transport
- Area servicing, like small urban shuttles today, but with shorter turns-over. This could be done either in a small area (small city for instance, or internal company sites) or in peri-urban areas from city centre to peripheral activities centres like malls, hospitals, etc.
- Enhancement of night mobility where the frequency of public transport is low (in order to avoid too much waiting)
- Adaptation to traffic and demand, for example by adding modular vehicles to existing vehicles in case of rush hours and increase in passengers.

CAD freight or goods transport

Automation of vehicles will transform freight and goods movement industry and offer opportunities such as improving safety, and increasing fuel efficiency. We can think about automated garbage trucks, automated mail delivery vehicles, long-distance truck platooning, transport in private areas and/or difficult sites (mines for example), or last mile delivery.

Accessibility and social inclusion

CAD is also expected to facilitate accessibility to mobility for unconfident drivers, elderly, disabled, and to those who do not have access or only poor access to personal mobility.

Elderly and disabled people could indeed benefit of automated driving because they would not have to drive (if CAD level 5) or would not have to drive constantly would also share vehicles with other occupants (in case of car sharing).

Access to personal mobility could be increased for the ones who do not have access yet, because of the expected reduction in costs due to car sharing and carpooling.

Reduction of emissions

Overall, there is a general representation that automation gets along with electric power and that all CAD vehicles will be electrical. If this is the case (and that will probably be the case for most of them at the end of the day), from well-to-wheel, the effect of automated driving will be to boost electrification of vehicles or electrical vehicles development and subsequently decrease emissions. The question is to what extent CAD will boost electrification of vehicles.

Another expectation is traffic calming. Automated driving is supposed to be less aggressive and less reckless than conventional driving. In this case, driving should be smoother and at a slower pace, giving traffic more fluidity and therefore should end up in less energy consumption and thus, the reduction of carbon dioxide and other noxious emissions, could be considerable.
In the long term, Automated Driving will add value regarding protection of the environment.

Public health

Expectations of effects regarding public health have two directions: on the one hand, it is possible that automated driving will be smoother than manual driving and therefore generate less gas or electricity consumption. Subsequently the environment is better preserved and this leads to lower congestions and therefore less constraints regarding health. AV users can have lower levels of stress due to the smoother traffic flow, less stop-and-go driving, and fewer traffic jams.
Moreover, they can have less personal stress regarding not having to actively drive and health monitoring in cars can be more feasible too.

On the other hand, it is likely that easy or increased motorized mobility leads to less pedestrian walks and less physical activities (e.g. healthier alternatives like biking).

Other possible positive effects on general health conditions for higher levels of automation could rise due to exercises done in the car while traveling, which would have a positive effect on health. Finally, CAD would also offer the opportunity to monitor health while driving (as it is already possible via some health apps) which would have also be beneficial, especially in critical situations.

The final assessment of the opposite effects is unknown and will probably remain unknown a long time since CAD will progressively be deployed and assessment on public health will depend on the penetration rate of CAD variants and use cases, and the effective use of this new mobility service.

Land transport efficiency and traffic congestion

CAD might also have long-term impact on land transport efficiency and most probably on:

- **Parking space:** if the vehicles park themselves, it is likely that less spaces between parking cars would be needed, parked vehicles being closer to one another. For example, self-parking AVs do not require "open door" space to drop off passengers when parked, allowing them to occupy 15 percent tighter parking spaces. With CAD able to drop off their users and then park themselves at remote locations, much of the city parking space could be used in different way (e.g. urban green or other public space)

- **Land space occupation:** it is also likely that, when most vehicles are automated/autonomous, new carriageways would be narrower and would take less prints on the land. It should of course not be soon since conventional vehicles and CAD vehicles would have to cohabit for a long period.

- **Traffic:** automated vehicles in a highway scenario could travel more closely to one another if the application allows for more precise lane keeping and/or smaller car following headway than would be safely possible with a human driver. This could keep traffic flowing more smoothly leading to reduced delay and travel time variability. Similarly on an urban arterial, automated vehicles may have applications that allow for a smaller gap acceptance than would a human driver, also leading to improvements in delay and travel time variability.

At the regional scale, car following, lane keeping and gap acceptance applications could bring significant changes in freeway, arterial, or intersection effective capacity, Along with lower and more harmonized speeds. If automated vehicles go along with car sharing, there will be less vehicles and more intensive use of vehicles, time of non-use being reduced compared to today. Conventional vehicles, automated vehicles with drivers and driverless vehicles should cohabit, especially at the beginning.

New transport services could be provided especially when the vehicle is functioning with connectivity in addition to automation, e.g traffic management. Therefore traffic should be re-designed (less cars, more car sharing, truck platooning performant and smart choice of route then less congestion) to allow all types of vehicles optimize their travel time and ensure safety for all traffic participants.

- **Freight:** driving automation could deliver significant productivity gains to the freight and logistic sector. Truck platooning is expected to follow an incremental pathway consisting in the progressive reduction of the responsibilities of the drivers until full replacement would ultimately occur. Freight distribution could be optimized.

Economy, competitiveness and job creation

The effect of CAD on economy and business models will be intensively discussed in other WPs of the SCOUT project. We proposed above to use the 5 Forces model to describe all potential actors involved in the design, conception, production, regulation, selling, maintenance and use of CAD systems and CAD final products. We did this not for the analysis of the impact on economy but to describe comprehensively all the stakeholders and actors. A more in-depth economic analysis is required.

CAD is a revolution in the automotive world that has not only implications on transport, but also on social life.

Automated vehicles have the potential to create macroeconomic benefits, to the extent that the impacts of automation are large enough to influence labour supply or other determinants of economic growth. One example would be that Level 4 automation (self-driving vehicles) would remove barriers to job access for large numbers of non-drivers, boosting their labour force participation. Among drivers, safety improvements would mean fewer working hours that are lost to crash-related injuries, to congestion and other travel delays, and to the demands of "chauffeuring" children or elderly relatives. Also, when relieved of most or all hands-on driving responsibilities, travellers could spend a portion of their travel time in productive work activities, thereby also increasing labour supply. Then, CAD could be expected to induce a productivity increase, while users enjoy their rides in an automated vehicle.

Vehicle automation and connection are expected to generate new jobs in the automotive, technology, telecommunication and freight transport industry. Increasing driving automation would also have an impact on professional drivers, which would be required to be trained to use the new technologies and might face a lower labour demand over the long term.

However, the effects on income, investment, financial markets, low and high-skilled employment, competitiveness, consumption, world equilibrium are supposed to be significant but, to the current state of our knowledge, still on development and research.

Low insurance costs

If road accidents are supposed to go down to the progressive replacement of human drivers by robot drivers, one can expect a decrease in insurance primes unless the decrease in accident frequency is covered by a high increase of average repair costs due to the high costs of technology to be repaired or replaced in case of damage.

6.2.2 Public Authorities Perspectives

There are different types of public authorities at global, European, national and sub-national levels. Each level and each type of authority has their own specificities. However, the 'Declaration of Amsterdam on cooperation in the field of connected and automated driving' in 2016 can be considered as emblematic of the opinions and expected actions of public authorities. It has been released by Europe's transport ministers, the European Commission and the European Automobile Manufacturers' Association (ACEA) which have reached an agreement on cooperation in the field of connected and automated driving. They have agreed on joint goals and joint actions to facilitate the introduction of connected and automated driving on European roads.

In fact, CAD represents a big challenge, therefore it is essential to adapt traffic rules, improve the digital infrastructure, establish clear rules about liability, secure people's personal data, increase funding for research and innovation, and promote operational testing. Working at a common level will contribute to an integrated approach to automated and connected driving across the EU and should prevent different rules and regulations that will arise within the EU. The agreed joint agenda include the following topics:

- Coherent international, European and national rules

- Work towards the removal of barriers and to promote legal consistency to mainly facilitate the introduction of CAV on the market and enable their cross-border use.

- Use of data: CAV will generate data which can be useful for public and private services, then a clarification on the availability for public and private use and on responsibilities of the parties involved is an important issue

- Guarantee of privacy and data protection: the use and sharing of data generated by CAV needs to respect existing legislation on privacy and data protection

- V2V and V2I communication: in order to maximize benefits in road safety and environmental performance, it is essential to ensure that new services and systems are compatible and interoperable at European level and it is essential also to coordinate investments towards reliable communication coverage, and improve the location accuracy performance

- Security: to prevent from cyber-threats, it is essential to ensure security and reliability of CAV communications and systems. Common trust models and certification policies will be developed.

- Public awareness and acceptance: to raise awareness and increase acceptance of CAV technologies, societal expectations are to be considered

- Using the Society of Automotive Engineering levels (SAE levels) as a starting point, common definitions of CAD should be developed and updated

- International cooperation: in order to have a continuous close cooperation with regions (e.g. US and Japan), global framework and international standards for connected and automated vehicles is a work that needs be paid special attention to.

6.2.3 OEM Perspectives

The main expectation is that CAD could bring a competitive advantage. But further developments are required in the field of electronic components and systems. For instance, a network of processors and sensors within the vehicle has to handle many actions in parallel and at the reaction time less than a millisecond. Another major challenge is to produce technologies that have reasonable cost for the manufacturer and the customer, but provide all the features (high resolution and contrast for the cameras, for instance) guided by safety rules. The new technologies have to also be transferrable to all vehicle types and weather conditions, be stable in wide temperature ranges, be failsafe, have a long lifetime and correlate to high quality standards and requirements.

Another expectation is a better life on board. As self-driving vehicles free up the driver's time, travellers will be able to spend time productively during their journey, and one can envision vehicle interiors that could enable occupants to connect to online retail, offering location-based personalized offers. Opportunities for streaming media and videos, providing entertainment to the passengers during their journey could be implemented in the car. In the future, vehicles can also connect to smart appliances at home and seamlessly provide an experience to consumers as an extension of their homes.

6.2.4 End-Users Goals and expectations

Customer and societal acceptance is one of the key issues for automated driving. Affordability is still seen as one of the biggest hurdles for customers to buy these technologies. Furthermore, societal acceptance is pending with issues like safety, trust, security, privacy concerns, etc. The concerns and the complexity of the problems grow comparing a motorway/highway situation to a complex city environment. Acceptance will depend on the likely deployment scenarios and feelings towards it and may be very different for example towards truck platoons on the motorway or low speed delivery vehicles on separate infrastructure in urban areas. Furthermore, the acceptance is linked to a unanimous understanding and agreement of the benefits from automated driving (comfort, efficiency, safety, social inclusion, etc.). However, this will require a better understanding of the impacts on society as a whole: impacts and concerns addressed by professional drivers; issues and concerns regarding driver monitoring; social inclusion by enabling public transport in remote areas where today it is not feasible; impacts on multimodality and urbanization, etc.

Specifically with the introduction of partial automated driving, the reaction of users towards the system is important. The driver engagement and driver re-engagement for various levels of automation in a safe and conclusive manner is important. Therefore, the various applications for automated driving at different levels of automation have to consider Human Factors as decisive design criteria. HMI design (e.g. visual, haptic and acoustic information, warning and Intervention strategies, etc.) must take into account the role of the driver in highly automated vehicles and enable a safe interaction and usage, minimizing possible loss of Situational Awareness (SA) and on the contrary supporting SA. Further user acceptance for partially and highly automated vehicles depends on Human Factors and the intuitive usability. A proper HMI design, together with training and information, will help in reducing the risk of drivers' abuse and misuse, helping them understanding new capacities and limitations of CAV technology and to act accordingly.

The role of consumer information programmes will be important to explain and build confidence and drive best practice in safety.

The technology should be accessible to all categories of the population. New financing models (with the support of the insurance sector) could also be developed.

6.2.5 Role of ICT as Enabler of connected and automated driving

The overall potentials of automation can only be achieved if vehicles are seamlessly connected to infrastructure. Automated vehicles will be connected with traffic infrastructure, sharing big amount of data in both directions. It is expected that CAV will also make use of information (i.e. react automatically) that is received both from the infrastructure (V2I) and other vehicles (V2V). A car with autonomous functions anticipates and acts independently based on gathered internal and external information (e.g., from other vehicles (V2V), or from infrastructural elements (V2I), or directly from the cloud). This allows the car to supplement its sensory information with real- time updates about other vehicles' behaviour, traffic control, parking spots, toll gates, etc.

The role of ICT manufacturers and suppliers is to continue the development of sensors, software, control systems and services that will lead to affordable autonomous vehicles.

6.2.6 New Entrants Perspectives

The obvious expectation is new businesses. It is supposed for example that Google designs Google cars that people can spend more time on google while driving. On the other hand, companies like Uber invests in automated cars because it allows offering new transport options with lower labour costs.

6.2.7 Public Transport Perspectives

National and international public organisations are interested in research and development in automated vehicles as they see the potential to:

- Improve performance of the different transport systems (national, regional, local) by preventing accidents caused by human error; reducing transport congestion and negative environmental emissions by optimising traffic flows; providing accessibility to people currently unable to drive (e.g. elderly and disabled people) or to those that cannot afford to own a car; etc.

- Sustain economic development in their territories by attracting investors who are pursuing new business opportunities in this area and/or ensuring that existing companies (e.g. car manufacturers) can benefit from a legislative framework that facilitates their investment in these fields.

6.2.8 Telecom Perspectives

Telecommunication companies see potential for new business opportunities in exploiting increasing communication needs among vehicles and between vehicles and infrastructure.

6.2.9 Research Institute Perspectives

Academia plays an important role in the research and development of automated systems, in fact Universities as well as research institutes develop innovative prototypes and cooperate with automotive companies regarding different application of the technologies.

6.2.10 Road Safety Association Perspective

The associations struggling against road violence have usually only one ambition: participating in reducing road accidents and their consequences. As traditional safety measures are producing effects that are levelling off, automated driving is more and more seen as a way to re-boost safety countermeasures even though automated driving is seen as a significant but progressive and long-term effect. On the other hand, connectivity is seen as a promise if it is related to road safety services but also as a danger if connectivity is associated to life-on-board services bringing additional distraction to drivers.

6.3 Q3 - What are the expectations and reservations from connected and automated driving?

In the above chapter, we looked at probable goals of CAD, general ones and more specific ones for each of the stakeholders that we have identified. These goals can also be seen as user expectations.

This chapter looks at the reservations before combining them with the user expectation, describe above, in the form of a matrix of interdependencies.

Despite some doubts regarding the real effects of CAD and its expected benefits (more safety, more free time, more mobility, more comfort, less congestion, less pollution, etc.), stakeholders and users express reservations and concerns about CAD that need to be addressed in the design and development of systems and vehicles.

6.3.1 Reservations

The reservation can be identified as the following:

- **Reliability and robustness of the technology**: it is unclear whether the technology is ready either for semi-autonomous vehicles or for highly automated ones. Some use cases like highway pilot or highway chauffeur seem to be on track but some broadcasted accidents also show that the technology is by no means almighty or can be misused by drivers. There are a lot of experiments and demonstrations worldwide that show that the technology is promising, but there is always a driver capable of taking over control whenever there is a need to do so.

Overall, there are always early adopters who would be keen to use the automated systems, especially if it is proved by experiments that they work well. However, doubts remain regarding the absolute performance of such systems that are still considered to be fallible.

- **Regulation**: There are two kinds of regulations

  - Technical regulations (which regulates how vehicles and roads must be designed and maintained)

  - Traffic laws (which regulates how to comply with the use of vehicles and roads)

As for technical regulations, in Europe, countries are complying with the regulations of the UN ECE World Forum for Harmonization of vehicle regulations (known as WP29). Regulations concerning automated vehicles are still on the way and SAE levels 3 systems are still not regulated. Some ACSF (Automated Controlled Steering Functions) will be regulated by the end of year 2017. But their Operational Domain is limited (highways) and their level of automation is low (comparable to SAE level 2 even though there is no reference to SAE levels in the forthcoming regulation). Consequently, type approval of these SAE levels 3-5 systems are impossible unless specific derogation is granted.

As for traffic laws, most countries comply with international treaties such us Geneva Convention (1949) and/or Vienna Convention (1968) on road traffic and safety and with their domestic traffic laws. As an example, Vienna convention stipulates that:

ARTICLE 8

1. Every moving vehicle or combination of vehicles shall have a driver.

2. It is recommended that domestic legislation should provide that pack, draught or saddle animals, and, except in such special areas as may be marked at the entry, cattle, singly or in herds, or flocks, shall have a driver.

3. Every driver shall possess the necessary physical and mental ability and be in a fit physical and mental condition to drive.

4. Every driver of a power-driven vehicle shall possess the knowledge and skill necessary for driving the vehicle; however, this requirement shall not be a bar to driving practice by learner-drivers in conformity with domestic legislation.

5. Every driver shall at all times be able to control his vehicle or to guide his animals.

*5bis. Vehicle systems which influence the way vehicles are driven shall be deemed to be in conformity with paragraph 5 of this Article and with paragraph 1 of Article 13, when they are in conformity with the conditions of construction, fitting and utilization according to international legal instruments concerning wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles**

Vehicle systems which influence the way vehicles are driven and are not in conformity with the aforementioned conditions of construction, fitting and utilization, shall be deemed to be in conformity with paragraph 5 of this Article and with paragraph 1 of Article 13, when such systems can be overridden or switched off by the driver.

6. 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.

ARTICLE 13

Speed and distance between vehicles

1. 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. He shall, when adjusting the speed of his vehicle, pay constant regard to the circumstances, in particular the lie of the land, the state of the road, the condition and load of his vehicle, the weather conditions and the density of traffic, so as to be able to stop his vehicle within his range of forward vision and short of any foreseeable obstruction. He shall slow down and if necessary stop whenever circumstances so require, and particularly when visibility is not good.

It means that the use of systems (AD or ADAS) is compliant with the Convention if these systems are regulated and if the driver can take control of the vehicle at any time.

Whether or not SAE levels 3 and above are compliant with these articles is still under debate. Consequently, both for technical and usage regulations, the question is: What is the timeframe to authorize automated driving (implicitly highly automated systems)? Probably not before 2020, making it unlikely to see highly automated vehicles on open roads soon.

- **Interaction with Vulnerable Road Users**

Especially during the introduction and transitional stage, a concern could be how CAD will interact with Vulnerable Road Users (VRUs). Some of the in-vehicle safety technologies that are already deployed are specifically able to prevent collisions with VRUs. Although there is ongoing research with new ideas in this field, at present pedestrians and cyclists are largely unequipped with ITS safety equipment which might allow them to interact with automated vehicles. Interaction between current vehicle drivers and VRUs sometimes takes the form of communication through eye contact. This communication should also be able to function even in bad weather conditions. The appearance of automated vehicles in traffic may also change the mobility patterns to the extent of changing the behaviour of VRUs themselves - the simple act of crossing the road may also be transformed. High risk scenarios should be identified and ways need to be found to manage all these different possibilities. This area should be a priority for research and testing.

The problem of interactions between CAD Vehicle and conventional vehicles is also a reservation. A lot of users and public stakeholders fear that co-existence of vehicles with varied levels of automation, including without any level of automation or even no driving assistance systems, would lead to a chaotic traffic that would need to be highly monitored, especially because traffic is still mostly guided by detection of intentions by others, that the automated vehicle still does not know to handle. In other words, the transition period between conventional driving and fully automated driving is seen as a threat for safety rather than a step to better safety.

- **Data Security/Cyber security**

The security of data has to be assured on different levels. Firstly, processing of a large amount of data, their storage and accessibility are essential issues when communication between a vehicle and its environment (e.g. other vehicles, road, infrastructure, service) have to be provided. Secondly, questions on data ownership, data evaluation and interpretation and data misuse have to be taken into account and solved in parallel to technology development. Measures to be implemented to protect data are directly proportional with the harm that would result from loss or unauthorized disclosure of those data.

- **Costs**

Current prototypes of CAD are enormously expensive due to numerous different sensors (lidars, radars, cameras, ultrasonic), HD maps as well as hardware and software developments. Of course, costs will go down as CAD will be deployed but it is still unknown at which pace. Reservations regarding costs could therefore be a hurdle for the deployment of automated and connected vehicles.

- **Liability**

Existing liability regimes (civil, criminal, and administrative) should be applicable to the determination of liabilities in case of an accident involving a CAD vehicle. Of course, these regimes might vary from country to country but there are no dramatic differences expected.

Nevertheless, the question about who could be liable in case of an accident, involving a CAD vehicle in automated/autonomous mode often arises. The question is not trivial. It might not be automatically the car manufacturer because the vehicle was switched on in AD mode. Liability must be evaluated regarding the specific circumstances of the accident and noticeably the drivers' intentional or non-intentional actions, how the system performed, whether the problem was predictable or not, whether this is a failure problem or the fault of third parties, etc.
Regulators would need to provide clear guidance to establish the boundaries of liability for different levels of automation and allow for the identification of the responsible of the accident.

All these doubts and uncertainties might discourage customers in purchasing that kind of systems or, the other way round, can encourage vehicle makers to clarify the risks for liability and therefore take the appropriate measures to also clarify them for the other stakeholders, actors and customers.

- **Difficulty of training / Losing driving skills**

If CAV take over the task of driving certain restricted use cases at the beginning and progressively more and more, in SAE levels up to 4, drivers have or might have to take back the control of the vehicles, at least at the end of the planned automated period or whenever the vehicle sends a takeover request. In this regard, 'driving' might change a lot and the driver might also lose his/her skills (navigating, guidance, control but also higher skills such as consciousness of the situation and attitude/behaviour about road risks). This lack of driving might cause problems if a hazard has to be handled by the driver. With the possible loss of driving skills the following questions evolve. Will the driver be able to drive in complex situation that the vehicle cannot handle? And what kind of training is needed regarding automated driving, which are different from the ones required today?

As CAV technology is developed and deployed, it is likely that the current testing criteria for drivers will need to evolve in terms of skills and knowledge, as well as medical conditions. It is likely that the new CAV technologies will prove to be a challenge for current training systems.
Combining driver monitoring and deep learning computers would make personalized, dynamic training modules possible. However, driver skills monitoring raises important questions about privacy and disclosure of information to authorities.

Losing driving skills and additional training on how to drive CAD vehicles in specific and complex situations can be consequently considered as a reservation regarding the exploitation of CAD.

- **Respect of personal data privacy**

Lots of data is expected to be collected, registered and potentially stored, not only for the system to work properly but also for other reasons such as design feedback, accident research, liability issues in case of a crash or in case of a violation, etc.. As it is still unclear what kind of data and which amount of data is collected, there are a lot of phantasms and also a lot of fears about who will be authorized to get this data. Insurance companies? OEM's? Suppliers? Vehicle owners ? Drivers ? Experts? The Justice? And what are the main interests regarding the data collection and storage?

The regulation about data privacy and protection (applicable in Europe by 2018 May) and the forthcoming technical regulation (UN ECE R79) are still to be applied. Most actors would like to get access to any kind of collected data but a clear regulation still has to be stated.

Beside this, the question of personal data protection is a societal issue that oppose two options: Collecting data is an unstoppable tendency and that we all have to live with it. The second opinion contains that the collection of data is stoppable and it also has to be stopped or at least controlled (cf. Max Schrems struggle against Facebook for example). These opinions might also collide regarding data collection.

- **Ethical issues**

Even though CAD vehicles go through an extensive testing process and will therefore be generally safer, it cannot be excluded that those vehicles will be involved in accidents. Thus, it will be expected from the vehicle itself to select a path with the lowest damage or collision probability. This could raise ethical problems regarding the question how priorities in avoiding obstacles will have to be decided if requested by the circumstances.

Ethics have a significant role when examining data privacy. As underlined previously, CAV will be connected with infrastructure, receiving and sending huge amounts of data. What kind of data and for which institutions will those be collected, owned, and shared, what is their purpose, how long can the data be stored are some of ethical issues to be taken into consideration. These problems apply to the user/driver sitting in the vehicle but also to other road actors (e.g. pedestrians, bikers, etc.) filmed with cameras which are installed in vehicles or are part of the infrastructure. This kind of ethical issues could very much affect the acceptance of CAD if not adequately addressed.

- **Reduction of emission**

On the one hand, the diffusion of automated vehicles and traffic management optimization systems are expected to determine a reduction in fuel consumption and a significant increase in infrastructure capacity, thus reducing emissions and congestion. Environmental benefits are also expected from automated systems regulating both acceleration and braking as well as route choice.

On the other hand, an overall increase in private transport demand is likely to be spurred by the availability of the new automated transport technologies, therefore environmental gains could be counter balanced by increased demand for road transport.

- **The Client Value**

The biggest reservation after all is the client value. It is currently unknown whether or not the different use cases will have a value for the customer and whether or not they are be willing to pay for an CAD system. There are studies showing that some users will adopt CAD systems, for certain a priori safe use cases (easy parking, congestion) but not for all and the degree of willingness to pay will directly depend on the confidence users will allow to systems. Demonstration of performance, reliability, security and safety will have to be robust, shared and accessible to public.

Moreover, it is still unknown whether the systems will please the general public than early adopters or technology lovers.

On the other hand, willingness to pay more will also depend on the real service offered by the CAD application. If the service is only offered partially for special occasions and use cases expectation for free time, comfort and side activities might not be met. Real-life experiments and pilots are needed to identify customer demands and supply real-life AD systems.

6.3.2 Combination of goals and reservations. Matrix of interdependencies

Figure 5 shows the matrix of interdependencies between all these goals, expectations, challenges and reservations.

The horizontal axis depicts a continuous line between reservations and expectations from the user perspective. We picked up a few of them in the above chapters. Similarly, the vertical axis is also a continuous line, but from the society perspective, from challenges at the bottom to the goals at the top.

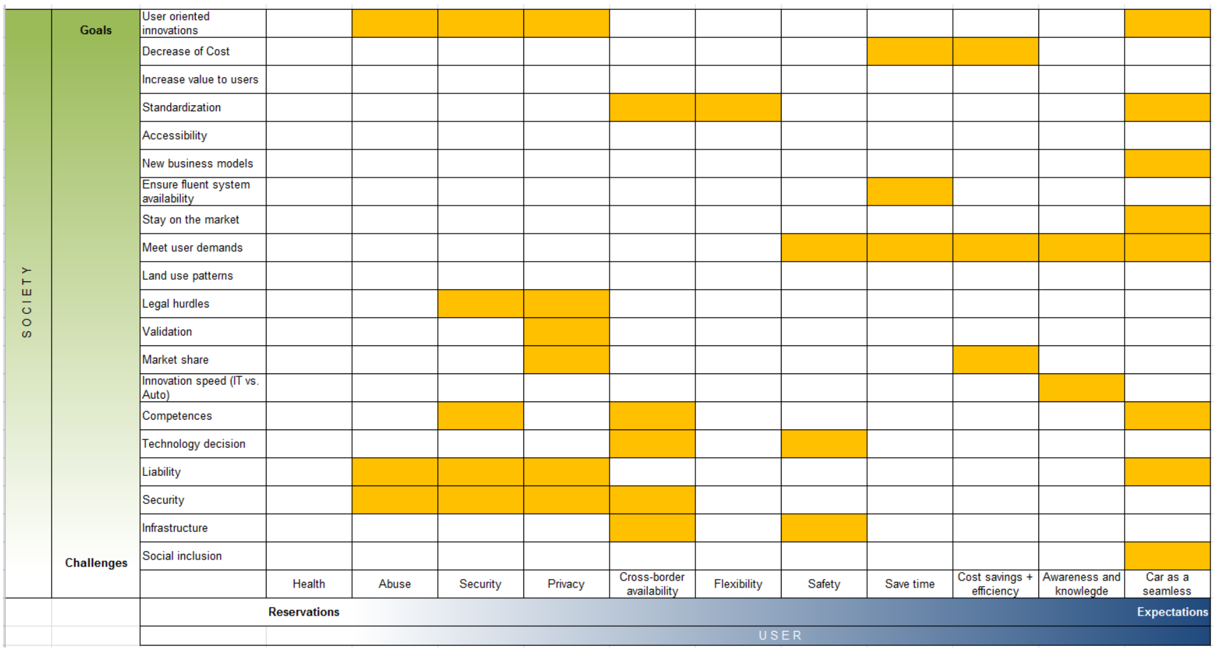

Figure 5. Matrix of interdependencies

There are of course many interactions between all items in this matrix. We chose to retain the main ones, highlighted by yellow cells. Beware, this matrix does not show how society gives answers to users' viewpoints; it shows how personal and collective viewpoints are correlated. For example, data privacy concerns expressed by users are also a general challenge for the society, needs competencies that should be available in the society and of course is also a legal issue. Another example is the demand for safety expressed by users. It is correlated with the challenge to build connected infrastructure, reliable technology and to the necessity to fulfil this need for CAD to be a success accepted by end-users.

7 Conclusion. How should hurdles be overcome?

In the previous chapters, expectations and reservations towards the extensive implementation of CAD were analysed.

Those issues represent important challenges that have to be addressed so that Connected and Automated Vehicles represent a great value for consumers and society. The following paragraph describes future activities to solve concerns of the different actors.

Further technological progress in smart systems for automated driving is desirable. This particularly applies to technologies enabling higher degrees of automated driving (e.g. SAE Levels > 2) like sensors and sensor fusion for environmental and driver monitoring, components meeting legal requirements, subsystems providing redundancy, functional safety, and reliability, and the concepts for smart integration into vehicle architectures as well as reliable and secure data communication. Eventually this progress shall lead to more affordable automated vehicles. Particularly for more revolutionary scenarios of highly automated driving in cities and fully autonomous driving, even better connectivity of vehicles and their integration into the Internet of Things, actions will be required

Technical progress on sensors and algorithms should also go along with efficient integration into infrastructure. It is actually recognised that sensors must properly read the infrastructure. Obvious and trivial considerations concern clear road markings and visible vertical road signs, which facilitate their recognition by automotive sensors but compatible infrastructure can go much further: recognition of road works, of road toll, of surface quality, etc. CAD will work even better if the improvements in sensors are accompanied with a compatible infrastructure.

Vehicles and their sensors and cameras will have to go above and beyond simple detection and be able to pick up on different forms of communication to deal with future interactions between connected and automated vehicles and vulnerable road users in safe and acceptable ways.

A vital hurdle that needs to be overcome is an appropriate legal framework for both testing and use of higher degree automated driving in Europe. Firstly, this concerns the fast adoption of the modified Vienna Convention into national practice which would enable European countries to keep up with competing regions worldwide. Secondly, legal issues and regulations, as e.g. liability in case of accidents, and data security and privacy are of the highest priority. Thirdly, ethical issues of decision making by machines have to be considered.

Significant effort is required to create new concepts and test systems for validation of complex CAD systems in simulated environments. In fact, relevant safety critical situations have to be tested as quickly as possible. Also Field Operational Tests represent a crucial testing method.

The dissemination of best practices both for technical and HMI aspects for the implementation of automated driving is highly recommendable for demonstrating its societal, economic and ecological benefits.

In the future, training could play a role in alleviating the long-term impact of automation on the degradation of driving skills. In the aviation industry, pilot skills are monitored and periodic custom trainings are provided to ensure skill retention or improvement. This is a good hint for driving automation. May be it could be useful to pass from the current system, in which training is essentially provided before obtaining a license, to a system where training is viewed as an on-going or at least periodical obligation for the driver. One option is to rely on simulator training. Another idea is to make on-going training part of the HMI.

Further research is needed in impact assessment to better quantify, e.g., the impact on traffic safety, or effective fuel consumption and emissions reductions provided by different automated and connected systems.

Costs are for the customer equally as important as for the vehicle manufacturer. Beside already mentioned technical standards that an automated vehicle has to include, the product still has to be affordable in the end.

Great attention has to be given to HMI design in order to help the traveller (at the same time driver and passenger) to have a safe and smooth interaction in all the automated driving phases. This very careful HMI User-Centred Design, based on users' needs, expectations, expertise, cognitive and physical abilities, preferences, habits also in consumer, working and personal domains will improve CAV acceptability, diminishing risk of users' rejection and will allow a seamless user experience.

New business models are also a very important factor and have been explored within WP 3 in the SCOUT project.

To conclude, expectations by different actors are high. Both users' and stakeholders' expectations are a mix of more reasonable and more imaginary ones due to the fact that sometimes those actors are aware of what CAD are and what CAD can do and sometimes not, going far beyond what CAD can offer in the short-term and even mid-term. Beside more safety, more free-time, more mobility, less emissions, less land space, incidence on insurance costs, etc.. CAD can also have relevant impacts on economy with new entrants, new challenges and more competition in the automotive domain.
The biggest challenges are the technological ones, in fact technology must perform better than the human driver and this is not a simple task, because human are fallible but at the same time performant.
Moreover an important challenge is represented by the CAV HMI design too so to be able to allow a nice User Experience, thanks to the high usability, acceptability and hedonistic involvement. This attention on HMI aspects will enhance even more drivers and vulnerable road users' safety too.

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