D2.3
Report on use cases and comprehensive vision for connected and automated driving in EU

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1 Executive Summary

Connected and automated driving (CAD) promises dramatic benefits as well as a few hurdles along the way of its implementation. After identifying user expectations and goals as well as reservations and concerns, specific use cases have been described and their benefits and reservations were analysed. Furthermore, the relevance of the use cases regarding the vision of CAD for 2030 was investigated. The use cases that have been chosen cover solutions in a wide range of complexity. Starting with automated valet parking in an enclosed area and connected maintenance, which can even be operated without any automation function being necessary, going towards more complex solutions with truck platooning on highways and L3 highway pilot. The later two use cases will be implemented on public roads, however still operating in a less complex environment. Furthermore, truck platooning can also be operated under lower levels of automation (L2), making it a good solution to test and slowly enhance automation functions. The use cases will be completed with shared, automated taxis representing the most complex implementation of automated driving in urban areas. This use case displays the complete realisation of the vision of CAD in 2030.

Starting with the use cases and taking into account user expectations and concerns, a comprehensive vision of CAD in 2030 is formed, representing specific solutions to realise a safe, connected, energy efficient, fluent, accessible and seamless mobility in 2030. This vision will serve as basis for the development of a comprehensive European roadmap for CAD in WP 5.

2 Introduction

Connected and automated driving (CAD) promises dramatic benefits as well as a few hurdles along the way of its implementation. For a gradual implementation of CAD certain use cases have to be realised along the way to increase the visibility of CAD and to convince users step by step of the advantages and benefits of CAD and reduce prevalent scepticism. This report will describe a carefully selected number of use cases describing different steps of the implementation of CAD towards a fully automated transport system, starting with automated valet parking, which will be one of the early-stage use cases due to the use of CAD in an enclosed area. Automated valet parking and connected maintenance illustrate use cases that can possibly be implemented on a shorter time scale, since CAD is either realised in an enclosed area or only the connectivity part is important for the implementation for automated valet parking and connected maintenance, respectively. With truck platooning on highways and one step further L3 automation on highways the automation will implemented on public roads. However, the highway scenario still operates in one of the less complex environments. The last use case in the line "shared, automated taxis (Mobility as a service)" highlights CAD in its greatest complexity, taking into account behavioural changes towards disruptive mobility concepts.
Combining the outcomes generated by analysing the user expectations, reservations and requirements (D2.1) and the use cases established in the co-creation workshop, a vision for automated and connected driving in EU for 2030 from the perspective of users and other relevant stakeholders is formed and will serve as basis for the European roadmap development process.

3 Use case

3.1 Automated valet parking

Description

Automated valet parking is similarly to conventional valet parking a service to get your car parked. This means the driver is leaving the automated and connected vehicle at a certain drop-off point at a public or private parking lot/garage. From there the vehicle drives fully autonomous to its parking position with the help of sensors and cameras implemented in the infrastructure as well as in the vehicle. There are different ways to implement automated valet parking. The control of the vehicle could be done primarily with the technic built into the parking garage. The sensors monitor the drive ways and the environment and communicate with the vehicle to operate it, while the technic in the vehicle translates the orders into movement. On the other hand the parking manoeuvre could be mainly supported by the sensors of the vehicle itself, which can already be used to assist the parking process in private garages.
To pick-up the car, the costumer simply has to get back to the pick-up point, "telling" the vehicle return either via a system installed on-site or via a special smart phone app with which also the payment can be done.
There will be different related applications available on the market, such as an integrated navigation system or a special smart phone app identifying free parking spots near the travel destination or e.g. robotic parking, meaning the cars will be moved around the parking garage either via lifts or via robots.

Benefits

- Retrieval time can be less than the combined driving/parking/walking time in conventional ramped parking structures
- Fuel saving & reduced emissions
- Increased user comfort, since there is no need to walk through the parking area and search for the exit as well as remember where the car was parked
- The user can keep the key and does not have to hand it to a stranger (conventional valet parking)
- More efficient land use, due to smaller parking spots and no need for sidewalks for passengers
- Familiarisation with automated driving in an enclosed area

Reservations

- Data security and privacy
- Contractual and legal issues
- High initial infrastructure investments & construction costs
- Concern about break down and uncertainties about operating and maintenance costs
- Not recommended for high peak hour volume facilities
- User acceptance is not high enough, because people don't want to give up control of the vehicle

Business examples

- Bosch and Daimler realised automated valet parking in the parking garage of the Mercedes-Benz museum in Stuttgart (Germany)[1].
- BMW is experimenting with automated valet parking technology in the i3 and hopes to get this technology on the market by the end of this decade[2].

Relevance to accomplish the vision

- Early stage application of CAD in an enclosed area
- Near-term implementation because it is low speed and operates off the public road
- Good practice example to illustrate the advantages of CAD to the users & the general public

3.2 (Predictive,) connected maintenance

Description

(Predictive,) connected maintenance describes a service provided by the collection and real time processing of data within the vehicle to monitor the health state of certain vehicle components. Therefore, the vehicles are equipped with sensors at different components to monitor the system's condition. Those sensors in combination with the IoT technology stack collect and analyse the fitness and running conditions of different parts of the car, and send this data to a centralised system. The data received from these connected cars, can be analysed further and if any service is needed, a service request can be raised and either communicated to the vehicle owner or to the maintenance service provider directly. Furthermore, the system can generate emergency alerts[3].
The predictive aspect of the maintenance work describes a service in which the data collected from the sensors will in combination with predictive analytics enable long-term services offering entire solutions where maintenance, repair and customer support follow the costumers along the life of the product.
Another related service would be the over-air software update to keep the software up to date in a world where software is continuously improving.

Benefits

- Increased driver safety, since long-term monitoring of components and systems ensures systems functionality.

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[1] https://www.mercedes-benz.com/de/mercedes-benz/innovation/avp-bosch-und-daimler-zeigen-fahrerloses-parken-im-realen-verkehr/, accessed in August 2017.

[2] http://bigthink.com/ideafeed/bmw-experimenting-with-self-parking-auto-technology, accessed in August 2017.

[3] Dhal & Solanki. An IoT Based Predictive Connected Car Maintenance Approach. *International Journal of Interactive Multimedia and Artificial Intelligence*, Vol. 4, no. 3 (2017).

- Real time alerts of possible component failure
- Detection of defects at an early stage
- Reduction of service and maintenance costs
- Target advertisements for monetisation of data received from connected cars (e.g. offering service discounts for cars which need to be serviced etc.)
- Improved customer satisfaction

Reservations

- Concerns regarding data security and data privacy in general and towards insurances
- Innovation for workshops might lack behind connected maintenance
- Lack of synergy between IT and vehicle development teams
- Low user acceptance

Business examples

- Tesla's over-the-air fix can be conducted as an "over the air" software update and doesn't require owners to bring their cars to the dealer[4].
- Daimler launched with Mercedes PRO connect a new service offering connectivity solutions such as maintenance management, vehicle supervision, fleet communication, eco monitor & coach as well as safety monitor & coach[5].
- Connit develops connected maintenance of electric charging stations[6].
- BMW uses big data analytics for predictive car maintenance to detect defects at the earliest stage[7].

Relevance to accomplish the vision

- Increased safety of road vehicle fleets by the help of long-term-monitoring and early stage detection of failures and its maintenance
- Increased customer satisfaction
- Early stage application of connectivity in the automotive sector can be used as good practice example to convince users of advantage of connected vehicles

3.3 Truck platooning on highways

Description

Truck platooning on highways describes a solution that allows trucks to connect with a piloting truck via connectivity technologies (sensors, cameras). Hereby, the piloting truck is controlled by a human driver, while the driver of the platoons can use their time differently with e.g. planning other journeys, organising waybills or communicating with logistic hubs. Vehicle-to-vehicle (V2V) communication is fundamental for platooning systems, enabling vehicles to follow closer, due to reduced reaction

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[4] https://www.wired.com/insights/2014/02/teslas-air-fix-best-example-yet-internet-things/, accessed in July 2017.

[5] http://media.daimler.com/marsMediaSite/en/instance/ko/Mercedes-PRO-New-brand-Mercedes-Benz-Vans-systematically-enhances-its-service-offers.xhtml?oid=13687623, accessed in August 2017.

[6] http://www.connit.com/en/connit-pioneer-in-industrial-iot/, accessed in June 2017.

[7] https://www.v3.co.uk/v3-uk/news/2407083/big-data-analytics-driving-predictive-car-maintenance-at-bmw, accessed in July 2017.

(braking) time[8]. This not only reduces the aerodynamic drag, resulting in fuel savings, but also allows for greater highway utilisation, thereby helping to reduce traffic congestion.
The term “vehicle platooning,” in its broadest sense, uses radar and V2V communications to form and maintain a close-headway formation between at least two in-lane vehicles, controlling the vehicles both longitudinally and laterally at highway speeds, implying at least Level 2 automation. Near term versions of platooning only control the longitudinal movement of the vehicle with radar-based adaptive cruise control (ACC) systems and adding V2V communications, while maintaining a safe gap with the vehicle in front. Drivers in both vehicles remain responsible for steering, implying Level 1 automation. These are referred to generally as cooperative adaptive cruise control (CACC) and in the truck industry the term “Driver assistive truck platooning” has been put forth[9][10].
With an increasing relevance of truck platooning, different business models related to platooning service providers will be evolving to e.g. support ad hoc formations of platoons.

Benefits

- No external infrastructure is needed
- Increase in safety
- More energy efficient operations due to fuel savings, caused by close-headway formation
- Greater highway utilisation, causing less traffic congestion
- Emission reduction
- Driver of the platoon can use driving time efficiently for other tasks

Reservations

- Passing other cars or being passed by other vehicles can be difficult due to the length of the platoon
- Cyber security concerns
- Loss of jobs
- Lack of standardisation and interoperability
- Technology and service constraints
- Reliability constraints
- Legal, regulatory and insurance restrictions

Business examples

- Volvo demonstrates truck platooning in California[11].
- Scania tests truck platooning in the Netherlands[12].
- Semi-automated trucks completed first cross-border journey in as a platoon, supported by DAF, Daimler, Iveco, MAN, Scania and Volvo[13].

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[8] “White Paper: Automated Driving and Platooning Issues and Opportunities”, ATA Technology and Maintenance Council Future Truck Program; Automated Driving and Platooning Task Force (2015).

[9] “Truck Platooning driving the Future of Transportation”, TNO (2015).

[10] “Platooning towards sustainable road freight transport – the benefits, drawbacks and future outlook”, Sia Partners (2016).

[11] https://www.volvotrucks.us/news-and-stories/press-releases/2017/march/volvo-trucks-successfully-demonstrates-on-highway-truck-platooning-in-california/, accessed in June 2017.

[12] http://www.itsinternational.com/categories/location-based-systems/news/scania-tests-truck-platooning/, accessed in July 2017.

[13] https://www.theguardian.com/technology/2016/apr/07/convoy-self-driving-trucks-completes-first-european-cross-border-trip, accessed in August 2017.

Relevance to accomplish the vision

- With truck platooning, automation and communication technology can be tested and advanced without building road-side infrastructure
- Bridge-technology on the way to fully automated fleets

3.4 L3 highway pilot

Description

Level 3 automation is defined as conditional automation in the new SAE international standard J3016[14]. This means the system takes over the steering, acceleration and deceleration as well as the monitoring of the driving environment. The human driver is responsible in a fall-back situation and when requested by the system. In the standard driving scenario, this can also be described as feet-off, hands-off, eyes-off scenario.

Due to the less-complex environment of highways, level 3 automation enables drivers to let their car take over driving tasks for highway driving only (conditional automation), including lane changes as well as (de-)/ac-celeration. Nowadays, advanced driver assistance systems (ADAS), such as distance keeping and cruise control, already show a small step towards L3 automation on highways. To perceive all surrounding objects and to localise itself in the environment, sensors are the key technology, which need to be combined with a computing part. In order to perceive its surrounding, e.g. detect hidden objects and act accordingly, several sensor sources are aggregated via sensor fusion (more technical details can be found in D 3.2). Furthermore, special software as well as communication and connectivity technology needs to be added for a safe working L3 automated vehicle.

For the special use case of L3 highway pilots, the automated driving mode is enabled once being on the highway, whilst it will be disabled before exiting the highway. Specific applications are listed below:

- Traffic jam chauffeur (autonomous driving at speeds up to 50-70 km/h)
- Highway chauffeur (with overtaking)
- Merging into heavy traffic
- Construction zone support
- Combined automated & safety functions

Benefits

- Increased safety, especially with increasing number of cars with L3 automation on highways is
- Increased traffic flow, especially with increasing number of cars with L3 automation on highways
- Increased fuel efficiency; reduction of emissions
- Time can be effectively used for tasks apart from driving
- Increased user comfort and satisfaction

Reservations

- Mixed traffic can interfere with the traffic flow and also reduce safety at the beginning of the implementation
- Increase of individual traffic

[14] SAE international, automated driving - Levels of driving automation are defined in new SAE international standard J306.

- Lack of cyber security
- Classification of society
- Overreliance
- Misuse
- Loss of skills
- Reduced situation awareness
- User acceptance is not high enough, because people don't want to give up control of the vehicle

Business examples

- Tesla launched a self-driving program, which they call "Autopilot", with which L2 automation and L3 automation at low speed is possible. Tesla cars being produced now all have self-driving hardware integrated[15].
- Toyota developed "Highway teammate", a new automated driving test vehicle to drive autonomous on highways. Toyota is aiming to launch products based on Highway Teammate by around 2020[16].
- Audi aims to launch its A8 with L3 autonomy 2018, debuting with a traffic jam pilot[17].
- With the „Highway pilot" of Mercedes L3 automated driving is implemented on highways[18].

Relevance to accomplish the vision

- Increasing user acceptance of automated driving in an environment where automation can be seen as most useful from user perspective
- Embrace automation for mass-application at lower infrastructural costs compared to introduction of L3 automation in cities
- Embrace competition of OEMs and therewith accelerate innovations regarding automated driving
- Step by step adaption of legal frameworks from low (highway) to high (city) complexity automation

3.5 Shared, automated taxis (Mobility as a service)

Description

Shared, connected and automated taxis can either be used as a shuttle/bus service, picking passengers up at defined times e.g. to integrate this service in the public transport system or it can be operated on demand as a conventional taxi service. For the shared on demand taxi solution, the taxi picks up other users on the way considering matching route/destinations, which are analysed by specific algorithms in real time. Automated taxis are most promising in the context of mobility as a service in urban and suburban areas and in combination with the public transportation system.

Benefits

- Higher occupancy rate for one vehicle, compared to the conventional use of taxis (one person with one destination at a time)
- Shared taxis can be more cost-efficient for users and providers
- Automated (driverless) taxis can be cost-efficient as well as energy-efficient

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[15] https://www.tesla.com/blog/all-tesla-cars-being-produced-now-have-full-self-driving-hardware, accessed in June 2017.

[16] http://www.toyota-global.com/innovation/automated_driving/, accessed in August 2017.

[17] http://mashable.com/2016/08/26/autonomous-car-timeline-and-tech/#0JeR1uIc9EqV. accessed in July 2017.

[18] https://www.daimler.com/innovation/autonomes-fahren/special/technologie-lkw.html, accessed in June 2017-

- First & last mile solution in combination with public transport
- Fuels savings
- Increased road safety

Reservations

- Interference with mixed traffic
- Cost-intensive infrastructure investments
- Low user acceptance
- Legal & ethical concerns
- Driver awareness and technical insufficiency: if the automated mode stops abruptly in a difficult situation, it is not sure whether the driver can overtake the control in a second

Business examples

- Uber tests fully autonomous taxis in Arizona, Pittsburgh and San Francisco[19].
- Bosch and Daimler cooperate in the field on automated driving and want to release the first robo taxis on German roads in 2018. A broad market launch is planned for 2020[20].
- Waymo (Google's self-diving vehicles) reach already 3 million self-driven miles with test locations in Mountain View (California), Austin (Texas), Kirkland (Washington) and Metro Phoenix (Arizona)[21].
- NuTonomy and Lyft are launching a self-driving ride hailing service in Boston[22].
- NuTonomy launched world's first self-driving taxis in Singapore[23].

Relevance to accomplish the vision

- Ultimate prospect of implementation of automated driving
- Enhances the seamless mobility experience
- Ultimate realisation of the vision

4 Comprehensive vision for CAD

Starting with the use cases described above, a comprehensive vision for connected and automated driving in Europe was developed. During the workshop "European vision & strategies for connected and automated driving" different stakeholders have been involved to form the vision for CAD in 2030 by finding answers to the question "Which feature in view of user expectations will connected and automated driving provide in 2030?". The vision includes general expectations as well as specific applications, which can be divided into four different categories concerning passenger transport, goods delivery, infrastructure and mobility on demand. Furthermore, the solutions of the vision are classified regarding the environment they will be implemented in such as urban, suburban, rural,

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[19] http://spectrum.ieee.org/cars-that-think/transportation/self-driving/uber-could-be-first-to-test-completely-driverless-cars-in-public, accessed in June 2017.

[20] http://t3n.de/news/bosch-autonom-fahrende-taxis-2018-836556/, accessed in July 2017.

[21] https://waymo.com/ontheroad/, accessed in June 2017.

[22] https://techcrunch.com/2017/06/06/lyft-and-nutonomy-partner-to-bring-first-self-driving-lyft-service-to-boston/, accessed in August 2017.

[23] https://techcrunch.com/2016/08/24/mit-spinout-nutonomy-just-beat-uber-to-launch-the-worlds-first-self-driving-taxi/, accessed in May 2017.

interurban and international. These different areas can also be differentiated by different level of complexity, starting with a highly complex environment in urban areas gradually decreasing to a comparably low complexity in interurban areas.

In general, stakeholders foresee safe and secure mobility in 2030 due to higher automation of passenger as well as delivery vehicles. Additionally, seamless, intermodal as well as shared, automated mobility will play a major role in 2030, which will be complemented by new services provided by big data and connectivity, automated delivery functions as well as solutions regarding the first and the last mile problem.

Hereby, the vision generally aims for more efficient use of time, which can be realised by automated driving in general since the driving time can be used for additional tasks besides the conventional driving. Furthermore, time savings related to less congestion due to better traffic flow and e.g. less search traffic for parking spots are another aspect of the vision. This also goes hand in hand with energy savings due to less fuel consumption. Accessibility, especially for elderly and disabled people, is of significant importance for the mobility in 2030 as well as the recovery of public spaces such as areas for pedestrians and cyclists.

Those general aspects of the vision for CAD in 2030 have to be supported by specific ideas and concrete use cases to convert the vision into reality. The use cases described above cover a wide range of applications from solutions that are realisable short-term to solutions that will be more interesting in the longer run.

Automated valet parking displays a use case that can be implemented on a shorter time scale since the automated driving takes place in an enclosed area in which only automated vehicles move. Therefore, the complexity of this scenario is rather low making it an early implementation. With this, the general public slowly experiences the advantage of automated driving on a small scale, which might increase the overall user acceptance of automated driving also with respect to other use cases. Besides, automated parking can lead to more efficient land use, since less parking space is needed.

A second near term application is (predictive), connected maintenance. This use case describes the ability of sensors in combination with the necessary software in the vehicle to communicate the request for maintenance or to send a real time alert of possible component failure. Since this solution can be realised independent of any automation aspect of the vehicle a wide near-term implementation is likely. This will increase the driver and road safety, since long-term monitoring of components and systems ensures the systems functionality. Furthermore, the customer satisfaction will probably be improved, resulting in an increase in user acceptance regarding new services and vehicle features related to connectivity.

Getting closer towards fully automated driving, truck platooning on highways is an intermedium step to accomplish the vision for CAD in 2030. Hereby, the first truck will be steered by a human driver in a conventional way and the later trucks will follow the head truck, being connected via V2V communication. This use case is a bridge-technology on the way to fully automated fleets, since no external infrastructure is needed. However, automation and communication technologies can be tested and advanced in a less complex environment. Furthermore, truck platooning can increase road safety, reduce emissions, operate more efficiently and increase the traffic flow. Besides, truck drivers can use the gained time for other tasks such as planning of next trips.

Higher interest from a passenger perspective will be attracted with L3 highway pilots. Nowadays, advanced driver assistance systems already attract a broad customer range increasing the user comfort significantly especially on highways. This will be enhanced with the L3 automation on highways, including applications such as traffic jam and highway chauffeur as well as construction zone support and combined automated & safety functions. This leads on the one hand to an increase in safety as well as an increase in traffic flow and fuel efficiency and on the other hand to an increase of user comfort and satisfaction. This use case is already a big step towards a fully automated transport system. It increases the user acceptance of automated driving in an environment where automation can be seen as most useful from a user perspective. Furthermore, it embraces automation for mass-application at lower infrastructural costs in a less complex environment compared to the introduction of L3 automation in cities, and still pushes towards the adaption of legal frameworks regarding CAD, beginning with lower complexity automation on highways.

The final step towards the implementation of fully automated vehicles is shared and automated taxis as flagship of the future vision of mobility as a service. Hereby, taxis will be driven autonomous with high occupancy rate if possible. Therefore, this concept will be cost-effective for users as well as providers due to the sharing aspect, but also due to fuel savings. Shared, automated taxis will also be an excellent solution for the first & last mile when combined with public transport. This solution will enhance the seamless mobility experience as well as the accessibility for all and with this illustrates the full realisation of the vision for CAD in a highly complex environment.

Having the described use cases in mind the vision for CAD in 2030 can be derived. As described above the timeframe of implementation of certain use cases strongly depends on the complexity of the environment. Therefore, the vision (which is visualised in D2.4) will include a dimension concerning the different environments the solution is related to, namely urban, suburban, rural, interurban and international. Furthermore, the solutions are categorised into passenger transport, goods delivery, infrastructure and mobility on demand.

Within the next years not only changes related to technology developments but also changes of user behaviour shifting from a society with mostly private car ownership to a sharing society have been taken place. With this mobility on demand as well as mobility as a service in combination with public transportation systems will gain more and more importance. Therefore, the vision of CAD in 2030 includes shuttles on demand with access for all, especially in areas with less good public transport options such as suburban and rural areas. Automatic dislocation of vehicles on demand as well as proactive user pickups preferably embedded in public transport all lead to increased user satisfaction and comfort, as well as increased accessibility of mobility solutions for all. Furthermore, with less privately owned vehicles, we would expect less congestion, less emission and an enhanced traffic flow. The solutions mentioned above will be most applicable in urban, suburban and rural areas. In cities, robo taxis for shared automated rides will be an attractive solution, where public transport is not sufficient. Furthermore, modularly designed shuttles can be easily converted from offices to meeting rooms or even ambulances, depending on the specific need and therefore increase the efficient time use while being on the road. And finally automated valet parking as already describes above will one of the early solutions regarding automated driving in an enclosed area, mainly being implemented in urban and suburban areas, where there is a need for efficient land use.

The vision of CAD in 2030 from a passenger point of view includes the use of augmented, virtual and mixed reality to increase the personal comfort and personalisation of private as well as public vehicles. Furthermore, universally designed vehicles and services should give access to (individual) mobility for all, especially elderly and disabled people. This solution is closely related to busses and shuttles on demand with access for all. Both solutions aim for a wide accessibility of mobility for all. Those solutions are widely comprehensive and can be found in the whole spectrum of different environments. Furthermore, automated, light vehicles represent a solution that addresses synergies between automation and electrification aiming for energy efficient, environmental friendly alternatives for privately owned passenger vehicles, also including other advantages of automated driving such as the possibility to use the driving time for tasks besides the actual driving.

An efficient combination of passenger and goods delivery transport can be realised with the integration of both in one vehicle e.g. a tour bus could also transport additional goods such as packages. L3 automation on highways can also be beneficial for passenger transport as well as goods transport. As described above in detail, this solution leads to an increased user comfort as well as an increase in road safety and energy efficiency. Furthermore, platooning of trucks, coaches or passenger cars is foreseen in the mobility future and can meet the goals concerning fuel savings, efficient use of time, less congestions as well as increase in road safety. Further goods delivery specific solutions are delivery carriers with follow me function in urban and suburban areas, e.g. helping elderly people to "carry" their groceries home. Last mile delivery robots with automated depot as well as logistic hubs are both playing a major role for the future mobility vision in urban, suburban as well as rural areas. These solutions in combination with truck platooning illustrate a comprehensive picture of the vision for CAD regarding good delivery. The goods are transported via platooning and/or integrated in passenger transport over longer distances to logistic hubs. The last mile from there will then be managed by delivery robots. Personal goods delivery such as delivery of groceries can be either done by delivery robots e.g. from the supermarket or by personalised delivery carriers with a follow me function. This can overall lead to fuel savings, increase in traffic flow and an increase in user/customer comfort and satisfaction.

Beside passenger and goods transport in specific, the vision also addresses general infrastructure aspects that have to be included in the future mobility portfolio to achieve a safe, energy efficient mobility with less congestion and interoperability even for cross-border scenarios. Hereby, bilateral connection between cars and pedestrians/cyclists will increase road safety, especially in urban, suburban and rural areas. This solution has synergies with a connected traffic system preferring vulnerable road users for safety reasons as well as reducing CO_2 emissions. Traceable and transparent mobility situations, meaning investigations on traffic jams, traffic light cycles, etc. via decentralised sensor fusion can help to monitor, adapt to and increase the traffic flow. In interurban and international mobility scenarios, (underground) road trains on fast lanes can have positive effects on the traffic flow. Especially in the early years of automated driving a separation of automated and conventional vehicles can significantly increase road safety and the traffic flow since mixed traffic situation will be avoided.

All the above mentioned solutions that are included in the vision for CAD in 2030 greatly contribute to the seamless function of CAD and therefore to its large-scale implementation. In this system, mobility is predominantly door to door and on demand. Mobility is delivered through a combination of self-driving, shared vehicles, with high-quality public transit as the backbone. All this is enabled through the use of smart software platforms that manage multimodal traffic flows and deliver mobility as a service. Another crucial point concerning all aspects of technologies needed for CAD is standardisation especially in view of interurban and international mobility.

The visualisation of the vision has been done in the deliverable D2.4 and is submitted separately to the EC.

A vision also always goes hand in hand with concerns and reservations. One concern regarding CAD in 2030 is e.g. that automated driving leads to more individual traffic in the short term, counteracting against advantages such as increased traffic flow as well as less congestion and emissions and therefore "cannibalising" public transport. Furthermore, a classification of the society is feared. On the one hand only wealthy people might be able to afford an automated vehicle and/or use new mobility services; on the other hand the fear concerns the betterment of luxury cars in traffic situations (e.g. preferential rights at traffic lights). Another important aspect is privacy in general and data privacy and cyber security in specific. Hereby, passengers might be concerned to not have their private moments in a taxi or in their own car. Furthermore, increasing collection, usage and storage of (personal) data can lead to violation of data privacy. Lack of cyber security could furthermore result in hacker attacks e.g. in the worst case hacker could take over the control of the vehicle. Finally, fully connected and automated driving only works due to the interplay of different technologies and new hardware and software developed for the future mobility. Those new technologies and especially new software aspects, including e.g. deep learning, could be prone to malfunction and failure.

5 Conclusion

In this report use cases with all levels of complexity have been identified and the benefits, reservation and relevance regarding the vision of CAD in 2030 have been described. The following use cases were chosen due to the different complexities of the environments that the use cases take place and therefore also the different timeframes of implementation, starting with automated valet parking and connected maintenance, going towards truck platooning on highways and L3 highway pilot and completing with shared, automated taxis in urban areas.

All those use cases contribute to the vision of CAD in 2030 by aiming for a safe, connected, energy efficient, fluent, accessible and seamless mobility in 2030. The vision is further complemented with solutions concerning mobility on demand, passenger transport, goods delivery and infrastructure, being categorise into areas (environments) of different degrees of complexity.

Besides all hopes and expectations towards the future mobility in 2030, there are also some concerns and reservations present. Hereby, the classification of the society is feared as well as the so to say "cannibalisation" of the public transport. Furthermore, data privacy and cyber security as well as malfunctions and failure have a high importance when it comes to the vision of CAD in 2030.