D4.6

Automation-ready Action Plan for each road authority

Version: 1.0
Date: 25.05.20
Authors: Rupprecht Consult, city of Gothenburg, city of Helmond, Milton Keynes City Council and city of Stuttgart

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201-2

Document Control Page

Title	D4.6 Automation-ready Action Plan for each road authority
Creator	Rupprecht Consult - Forschung & Beratung GmbH
Editors	Daniel Franco, Wolfgang Backhaus, Jakob Rupprecht
Brief Description	
Publisher	
Contributors	Mikael Ivari, Frank van den Bosch, Brian Matthews, Susanne Scherz, Carla Heckel, Daniel Franco
Type (Deliverable/Milestone)	Deliverable
Format	
Creation date	21.04.2020
Version number	1.0
Version date	25.05.2020
Last modified by	Daniel Franco
Rights	
Audience	☐ Internal ☒ Public ☐ Restricted, access granted to: EU Commission
Action requested	☐ To be revised by Partners involved in the preparation of the Deliverable ☐ For approval of the WP Manager ☐ For approval of the Internal Reviewer (if required) ☐ For approval of the Project Co-ordinator
Deadline for approval	29.04.2020

Version	Date	Modified by	Comments
1.0	14.04.2020	Daniel Franco	Draft with inputs from all cities
2.0	29.04.2020	Daniel Franco	Integrating first round of review
3.0	25.05.2020	Daniel Franco	Final version, including 2nd round of revision by partners.

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1 Introduction

1.1 Automation-ready road authorities

CoEXist understands that automation-ready transport and infrastructure planning in cities are a key precondition for fulfilling the promises of connected and automated vehicles (CAVs). To ensure a positive roll out of CAVs and its alignment with local policy goals, authorities will have to play a key role and should take the lead with proactive planning approaches. This begins with planning, as early as possible, how the introduction of CAVs should unfold, to minimise the potential negative impacts and more importantly make the most of the opportunity to influence the paradigm shift into a more sustainable urban mobility vision.

The promises of Cooperative Connected and Automated Mobility (CCAM) to improve traffic and space efficiency, enhance safety and improve mobility for all, will only be fulfilled when local authorities have the capability to shape the deployment of CAVs to their needs. Without it, CCAM could certainly worsen the urban mobility problems that local authorities are currently facing.

There is a clear need for considering CAVs in local policy discussions and planning processes (e.g. SUMP), but its purpose should not be misunderstood as endorsing the disruptive technologies surrounding CCAM and their impacts, but rather empowering the local authorities to critically review the anticipated technological changes and shape the future according to their expectations.

This is defined in the CoEXist project as 'automation-readiness'[1], i.e. the capability of making structured and informed decisions about the comprehensive deployment of CAVs in a mixed road environment, and it requires:

- A clear awareness of the technology underpinning CAVs, the different functional uses and business models for CCAM and a high-level understanding of the impacts different deployment scenarios can have on traffic, quality of life and stakeholders involved in local transport planning.
- The institutional capacity to plan for a future with CCAM by using tools that accurately represent CAV behaviour in order to identify the impacts of different deployment scenarios.
- A strategic approach in planning a wide range of measures that will ensure a deployment of CCAM, which supports higher level mobility goals, which can be achieved by following the SUMP concept and its principles.

1.2 CoEXist's Automation-ready Action Plans

The ambition of CoEXist is that the research results and analysis achieved throughout the project, including the practical application of CoEXist tools on the selected use cases (see D4.2 and D4.3), should influence the transport and infrastructure planning in road authorities and steer their progress towards automation-readiness. In this way, the project aims to strengthen the capacities of local

[1] CoEXist (2018) Automation-ready framework. Preliminary version.

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authorities, partners and cities in general benefiting from the project's results, to make informed decisions about the deployment of CCAM.

Therefore, each CoEXist road authority has developed a concrete 'Automation-ready Action Plan', providing detailed guidance on their specific processes and steps that should be taken to conduct automation-ready transport and infrastructure planning.

These Automation-ready Action Plans include an analysis of the local legal framework and policy context for each city, as well as a description of the strategy definition, vision and objectives for CCAM deployment, considering the risks identified and expected impacts. Besides, each city has reflected on the results from their automation-ready forum (D4.4) and the results from the use case impact assessment (D4.3).

Building upon this basis, CoEXist road authorities have performed a self-assessment of their current level of automation-readiness, analysing their progress and challenges for each aspect of mobility and for each phase of the automation-ready framework, and defined a set of measures and activities going forward.

In this way, the action plans provide a comprehensive overview of their paths towards automation-readiness, including previous experiences and successful approaches, and future strategy based on CoEXist's results and lessons learnt.

This document presents the 'Automation-ready Action Plans' developed by each CoEXist partner city, namely: Gothenburg (Section 2), Helmond (Section 3), Milton Keynes (Section 4) and Stuttgart (Section 5). Finally, general conclusions and lessons are derived (Section 6).

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2 Automation-ready Action Plan – Gothenburg

2.1 Introduction

2.1.1 Goal of the Action Plan

On the 23rd of April 2020, the Urban Transport Committee of the city of Gothenburg approved of the "Strategic plan for traffic innovation within the areas of electrification, digitalization and automation for the period of 2020-2023".

Figure 1 The Strategic plan for traffic innovation within the areas of electrification, digitalization and automation for the period of 2020-2023

The plan has two major purposes. The first purpose is to support traffic innovation that delivers value for residents, visitors and businesses in the City of Gothenburg. The second purpose is to ensure that the City of Gothenburg will be a leading actor when it comes to supporting the development in the areas of electrification, digitalization and automation. The plan also outlines basic principles for

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how the Urban Transport Administration shall address innovation, including specific actions to focus on in the time period of 2020-2023.

The plan applies to all activities where the Urban Transport Committee is responsible. In addition, a strategic co-operation between administrations and public companies within the city further strengthens the ambitions of the plan. The following administrations and companies work closely together to support traffic and mobility innovations in the city:

- The City Hall Administration
- The Urban Transport Administration
- Business Region Gothenburg
- The Urban Real Estate Administration
- The Urban Planning Administration
- Gothenburg Energy Company
- Gothenburg City Leasing Company
- The Urban Environmental Administration
- The Urban Water and Sewage Administration
- Renova
- Gothenburg City Parking Company
- Älvstranden Real Estate Development Company
- Göteborg & CO

This CoEXist Action Plan reflects upon Gothenburg's Strategic Plan and the projects conclusions, to describe the city's roadmap towards automation-readiness and lessons learnt from the process.

2.1.2 Scope and target audience

Gothenburg is the core and growth engine of the Gothenburg region which inhabits 1.1 million people. The city has a strategic location on the west coast of Sweden in between the capital cities Oslo and Copenhagen. With a population of 550,000 it is Sweden's second largest city.

Even though the city is growing, financial outlooks foresights that financing city services will be more challenging in the future. To provide efficient mobility, and at the same time reach ambitions as an attractive city, calls for new transport and mobility solutions. Clean air, low noise levels, safe and secure mobility are key components in reaching the ambitions.

At the same time technological development is fast pacing, not least within the automotive sector. Electrification, digitalization and automation will enable new solutions for providing sustainable mobility and transports. It is important that innovation projects where the city is involved has a holistic approach to traffic innovation. The strategic plan includes guidelines for expected project outcomes to support choosing the right projects to get involved.

Desired outcomes are those that will:

- make traffic in the city more efficient
- be economically sound to deploy and operate
- increase energy efficiency
- are fossil free (or even carbon neutral)

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- reduce emissions
- increase traffic safety
- increase space efficiency
- affordable
- support cohesion of the city

The Urban Transport Administration believes innovation will enable better services to the public not using more funding.

Sweden is the innovation leader of EU and the Gothenburg Region is amongst the highest ranked regions in the Regional Innovation Scoreboard, rated as a Leader +.

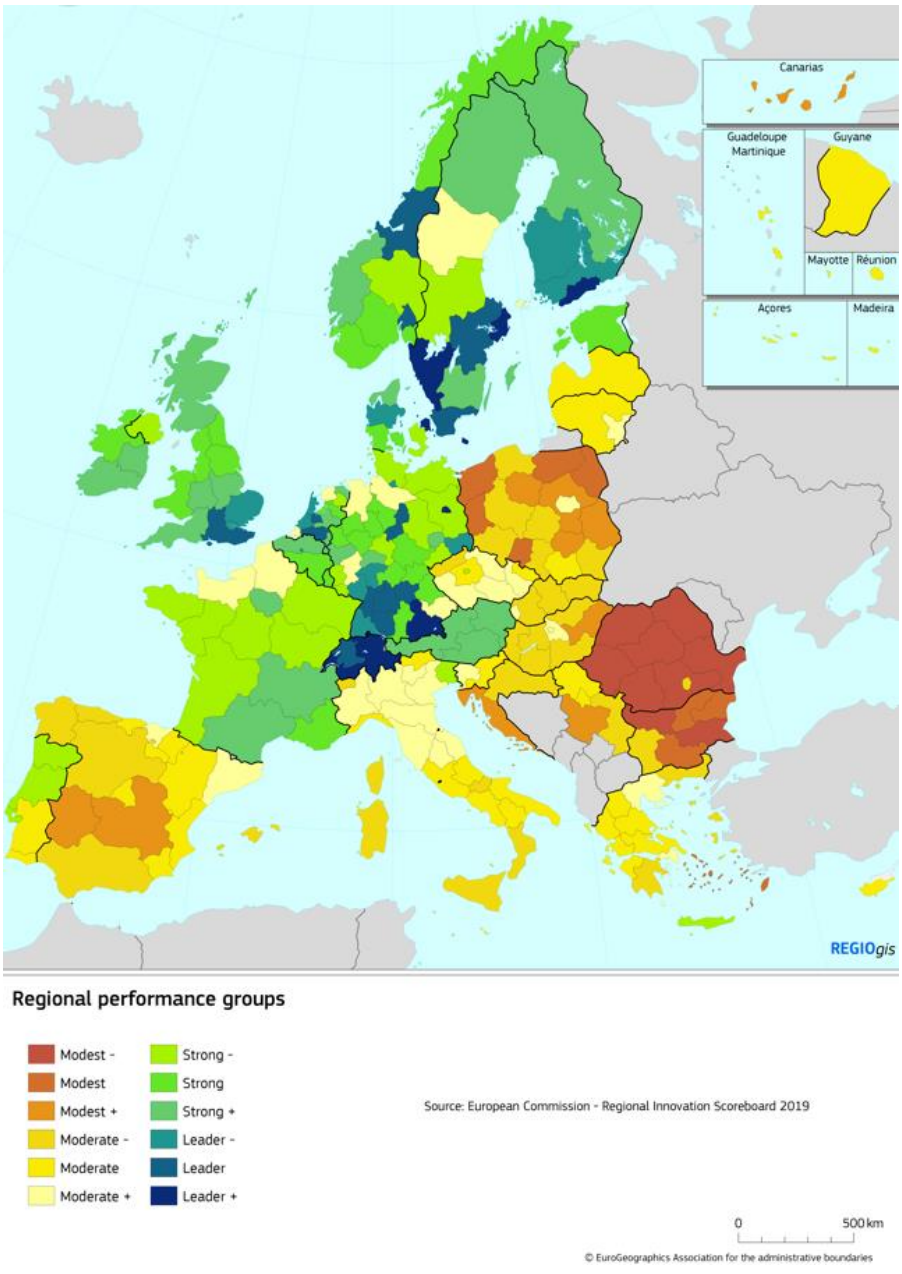

Figure 2 The Gothenburg Region ranks as Leader + in the Regional Innovation Scoreboard

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The Gothenburg region is home to a variety of strong business clusters, including major automotive companies such as AB VOLVO, Volvo Cars, CEVT and Geely as well as innovative start-ups. The city of Gothenburg, the academy and the industry have a long tradition of innovating together, developing a strong collaborative innovation capacity. This makes Gothenburg an attractive testbed for developing and implementing new mobility and transport services.

When preparing for large-scale deployment of innovative solutions, it is important to have an understanding of the time-perspective. Putting innovation into practice usually takes time. The strategic innovation plan focuses on activities for the coming four years that will prepare for future deployments.

The plan contains measures, projects, co-operations and other activities that will support the Urban Transport Administration to become a leading actor within innovation. Actions taken will be prioritized in the regular budget process of the administration and will thus have an impact of the expected outcome.

2.2 Transport policy and planning context in Gothenburg.

2.2.1 Legal and normative framework

At the moment, Sweden has no separate legislation permitting regular use of Automated Vehicles. However, already in 2015, the national government initiated a 2-year public investigation in order to assess the needs for a separate legislation. Halfway into the investigation, the appointed investigator, Mr. Jonas Bjelfvenstam, published a preliminary report, “On the road to automation – testing[2]”, suggesting new regulations to enable CAV-testing in Sweden. The Swedish government then initiated a public hearing. The city of Gothenburg responded positively.

As a result, a regulation for allowing tests on public roads was in place in June 2017. The regulation states that it is the Swedish Transport Agency that issues permit for testing[3]. Road authorities, including cities, may object testing but have no veto to hinder issuing a permit.

The city of Gothenburg wants to support testing activities and has taken part in the investigations as well as developed internal processes to support the legislation.

[2] https://www.regeringen.se/contentassets/ffa493ce047a4f37ae3b74508616cab4/vagen-till-sjalvkorande-fordon-forsoksverksamhet-sou-2016_28.pdf (English summary available)
[3] https://www.transportstyrelsen.se/sv/vagtrafik/Fordon/forsoksverksamhet/sjalvkorande-fordon/ (Swedish only)

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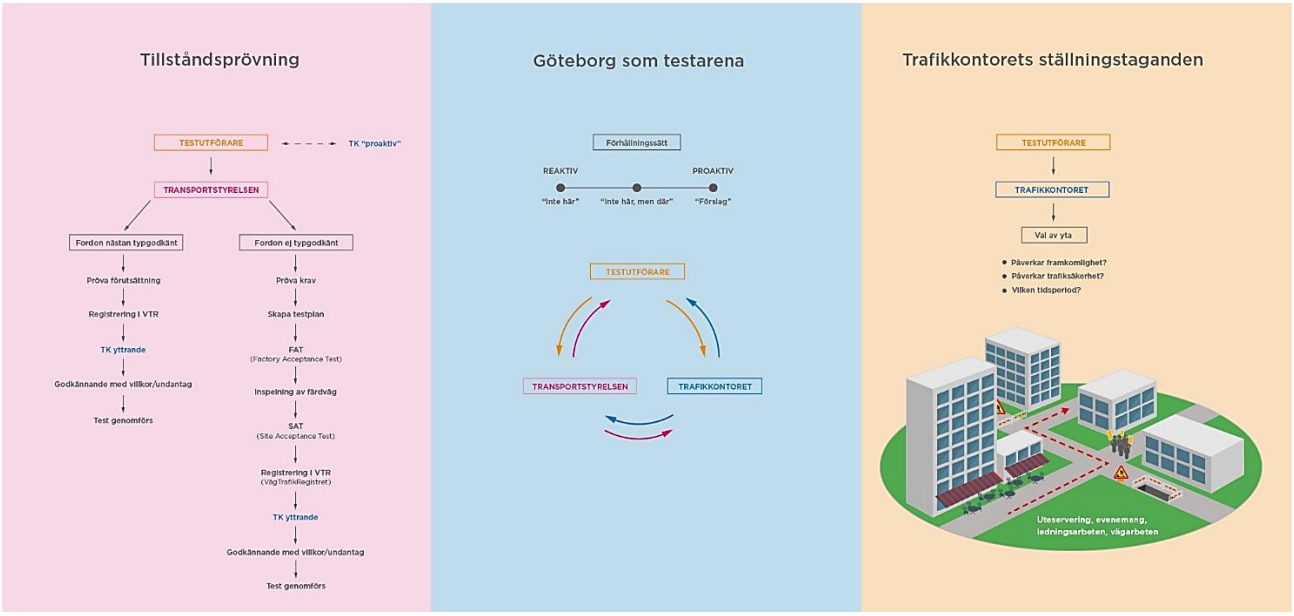

Figure 3 An overview of how the Urban Transport Administration facilitates testing with CAVs

The Urban Transport Administration has a pro-active approach to testing and open for early dialogues with organizations that are in progress of testing in Gothenburg. One important aspect is to find suitable routes where the status of the road can be ensured for the given test period. This means that there are no known planned road works, events or other permittable use of public space that might be in conflict with CAV-testing.

In March 2018 the full public investigation, "On the road to automation - introduction[4]", was published and handed over to the minister of Infrastructure, Mr. Tomas Eneroth. It was a very comprehensive report comprising almost 1000 pages excluding appendices.

In the summary of the report, the public investigator stated:

> One difficulty regarding this work has involved developing a regulation for a phenomenon that is not yet available on the market, namely fully automated vehicles capable of replacing the driver. The committee has attempted to suggest solutions that provide enhanced opportunities for testing and introducing advanced automated functions in vehicles in the short term, as well as certain fully automated vehicles. However, these solutions can primarily be used even when a broader introduction becomes possible.

[4] http://www.sou.gov.se/fordon/ (English summary available)

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The report also included new suggested legislation. One example was the introduction of a new defined vehicle class, the class 2 automated road machine. The suggestion was to allow class 2 automated road machines to operate on roads or cycle paths without a test permit at speeds not exceeding 20 km/h and on footpaths at walking speed. In addition, new road signs were also suggested in order for road authorities to regulate CAVs.

Figure 2 **Mandatory lane or carriageway for automated vehicles**

Proposal for a new road sign for automated vehicles. For other vehicles, such as buses or tractors, can be used.

Source: Self-produced sign

Figure 3 **Mandatory lane or carriageway for automated class II road machines**

Proposal for a new road sign for automated class II road machines.

Source: Self-produced sign

Figure 4 New suggested road signs to enable road authorities to regulate CAVs

Other major topics addressed in the report were:

- Updated regulation to allow for more advanced testing.
- Introduction of new definitions for automated vehicles
- New suggested legislation, including a new definition of “the driver” to allow one driver to control several vehicles
- New crime definitions suggested to handle the introduction of CAVs
- Suggested new traffic regulations to allow road authorities to regulate CAVs
- New instructions to the Swedish Transport Agency to update and mandate geo-localized traffic regulations in order to support gradual introduction of CAVs

The government initiated a public hearing in 2018, but there have been no major initiatives since then.

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2.2.2 Policy goals and planning context

Gothenburg has just entered a phase of major transformation as the city will increase its population from 550,000 to 700,000 within the next 20 years. The bulk of that growth will take place in the most central parts of the city, the so-called River City. This area is located along both sides of the river that cuts through the city.

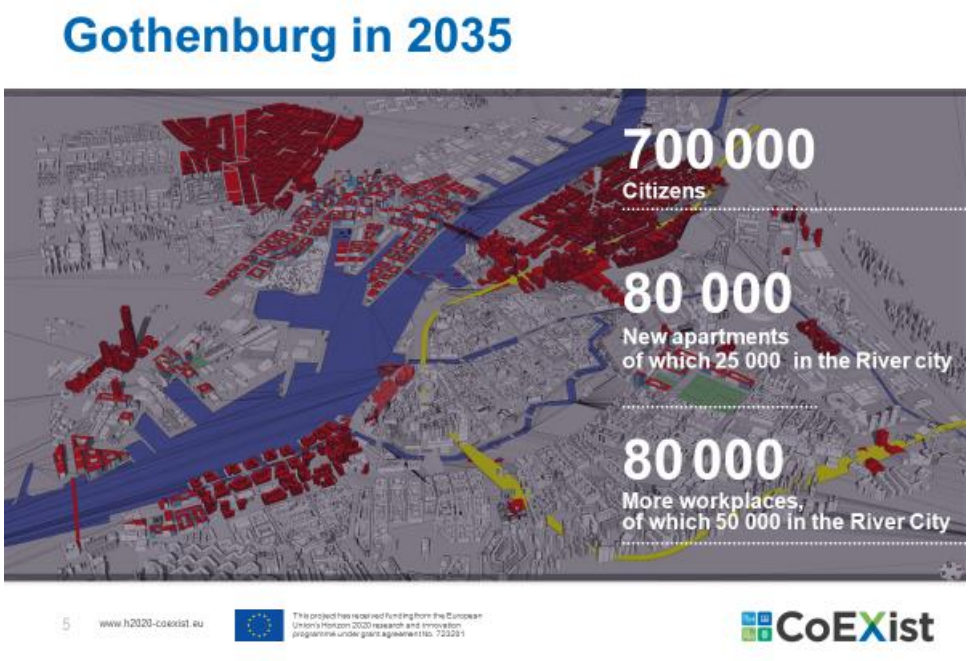

Figure 5 Expansion plans for the central parts of the City of Gothenburg. Areas under development are shown in red. The yellow areas indicate the new train tunnel under construction that will convert the central railway station from a cul-de-sac to a through station.

Here 25,000 new apartments will be built, and 50,000 new jobs added to the same area. This extreme densification will obviously put a tremendous load on the future transportation system. In 2012 the city council adopted the River City Vision[5] that sets a firm direction for the future development. One important strategy for implementing the River City Vision is to allow areas now under development to become living labs for development of innovative transportation and mobility solutions, always with a strong focus on sustainability.

[5] https://stadsutveckling.goteborg.se/siteassets/alla-bilder/rivercity_vision_eng_web-2.pdf (English)

For mobility, the Urban Transport Committee adopted "Traffic strategy for a close-knit city[6]" in 2015.

The transport strategy sets objectives in three areas, where the correct planning and investment focus in the transport and traffic sector are most important for Gothenburg's achievement of its stated objectives for quality of life, competitiveness and sustainable development.

The three areas are travel, urban space and transport of goods. The transport strategy's three main objectives are derived from the comprehensive plan's thirteen strategic questions for Gothenburg's development, where every question has an objective and a strategy.

Four of these strategic questions have been identified as most relevant and guiding for the direction of future transport planning. From these, three objectives for the transport strategy have been formulated:

- An easily accessible regional center
- Attractive urban space and a vibrant urban life
- Scandinavia's Logistics Centre

The strategies have been drawn up with consideration given to the challenges for an ecologically, socially and economically sustainable development.

Main objectives for travel: An easily accessible regional center, where it is easy to reach key places and functions irrespective of means of travel and other conditions. The transport strategy will create the conditions for an attractive, efficient and sustainable transport system that supports urban development and makes inhabitants, visitors and activities perceive Gothenburg as easily accessible.

Main objectives for the urban space: Attractive urban space and a vibrant urban life, where people want to live, work, shop, study and meet. The transport strategy will contribute to making the urban environment so attractive that the city's competitiveness increases, and many want to become established here. The transport strategy will also contribute to making people feel safe and secure, and to making time spent in the city feel beneficial.

Main objectives for transport of goods: As the logistics center of Scandinavia, Gothenburg has a competitive logistics and industry sector, and encourages the development of existing and new industries that create jobs. The transport strategy will contribute to robust transports of goods to and from the port, other logistics operations and industry, while at the same time reducing negative effects on the local and global environment.

[6] https://goteborg.se/wps/wcm/connect/6c603463-f0b8-4fc9-9cd4-c1e934b41969/Trafikstrategi_eng_140821_web.pdf?MOD=AJPERES (English)

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The transport strategy also stresses the use of innovation for implementation.

Four principles for how to implement the transport strategy:

P1 Begin with investments that facilitate travel within, through or around the inner city.

P2 Ensure that accessibility is maintained while the close-knit city is being realised.

P3 Support innovation and the introduction of new solutions, and allow Gothenburg to be a testing ground.

P4 Make use of the potential in a meaningful dialogue with businesses and inhabitants.

Figure 6 Four principles for how to implement the transport strategy

For travel there are three key strategies:

- Strengthening the potential to travel to, from and between the city core and key destinations
- Increasing access to neighborhood services, retail, meeting places and other everyday functions
- Making more efficient use of roads and streets

The overall mobility goals for 2035 suggest a strong modal shift.

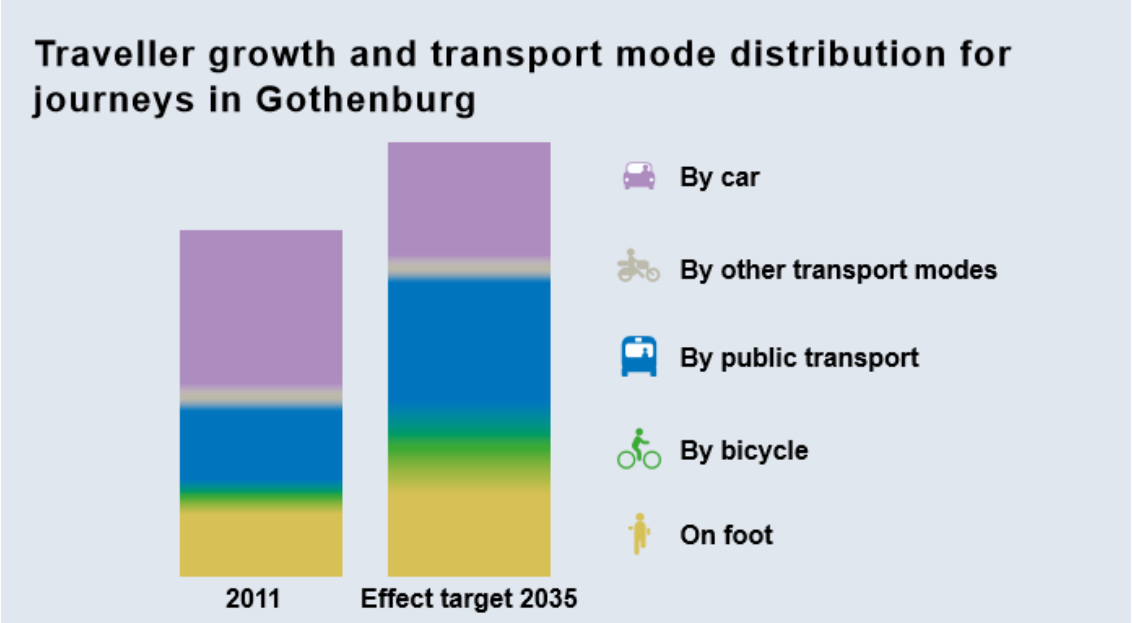

Figure 6 Effect target 2035 for traveller growth and transport mode distribution for journeys in Gothenburg.

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2.3 Potential impact of automation in Gothenburg

2.3.1 Vision and targets

Already in 2015 leading politicians stated that “The city of Gothenburg wants to lead the way in realizing the potential of automated vehicles”. Implementing traffic innovations is one of the strategies in “Vision River City”, adopted by the city council in 2012 as well as in the “Transport Strategy for a close-knit city” adopted by the Urban Transport Committee in 2015.

When the city decided to co-create the Drive Me research program together with Volvo Car Corporation, Chalmers University, the National Road Administration and the Swedish Transport Agency, three major potential benefits were identified. The first was how the technology could enable new mobility solutions and benefit citizens, including providing access to people that today have less mobility options. The second was how CAVs could help mitigating challenges such as congestion, traffic safety, air pollution and carbon dioxide. The third potential benefit was how the use of AVs could impact city planning and street design, contributing to a more attractive city.

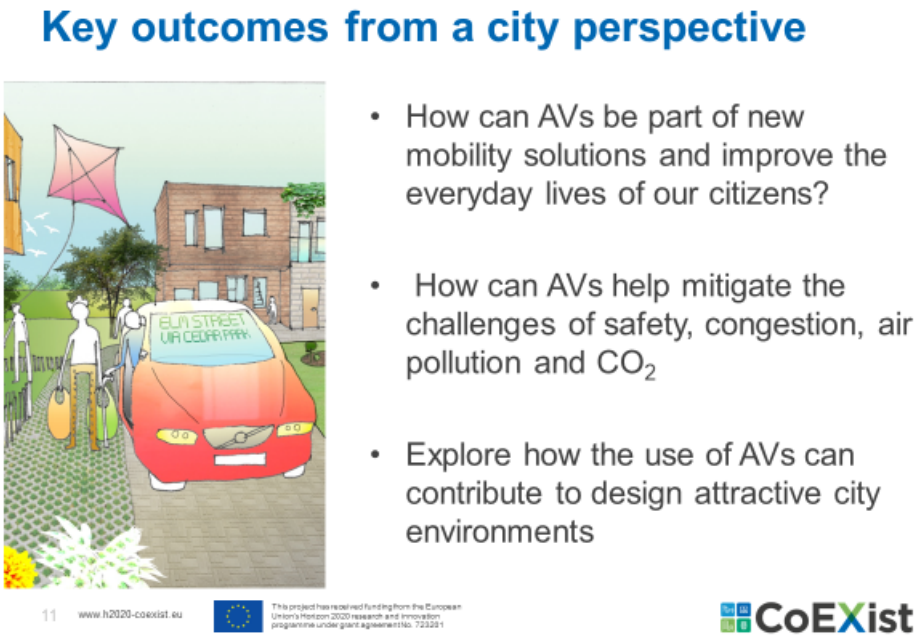

Figure 7 Expected key outcomes from a city perspective as stated in the Drive Me research program

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for the period of 2020-2023". The plan further strengthens the ambition of the city to lead the way in realizing the potential of technological development to support city objectives.

The Urban Transport Administration has also initiated several projects to assess the potential impacts of Maas-services based on CAV-functionality. Results from a scenario-based study using a newly developed multi-modal transport model, including bicyclists, are expected later this year (2020). The city, together with industrial partners, is also preparing for piloting CAV-based Maas services in the years to come.

2.3.2 Risks and uncertainties

Even though the rapid technological development, it is still to a large extent unclear what will be the impacts of an increasingly automated transportation system. The city of Gothenburg has facilitated tests with cars, trucks, buses and service vehicles but CAVs are still a scarce phenomenon. In the recent months a couple of vehicle manufacturers have publicly expressed their plans to put vehicles with self-driving functionalities on the market in 2022.

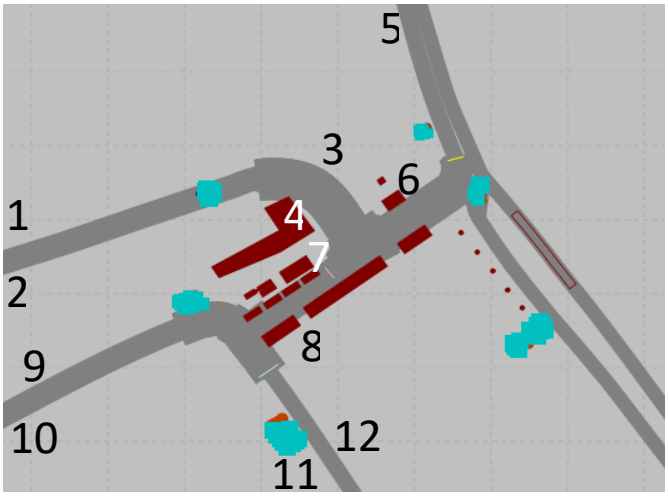
Hence, it is important to have an adaptive approach to the increasingly automated transportation system. This is also the approach in the Strategic Plan for Traffic Innovations.

The large degree of uncertainties is also important to recognize when deciding on major infrastructure investments.

2.3.3 Use case impact assessment and lessons learned

2.3.3.1 Use case 1: Shared space

A microscopic PTV Vissim model of a shared space with large pedestrian volumes in the city centre of Gothenburg is used to investigate the effects of introducing an automated last mile service. The service consists of automated minibuses. These pass through the shared space and do not have any stops for boarding or alighting within the studies area. As a possible measure to improve traffic performance for the motorized traffic without delaying pedestrians, channelization of pedestrian flows using pedestrian crossings is evaluated.



Vehicle travel time increases through the shared space area.
The simulations indicate a negative impact on traffic performance for all three stages. However, since this is partly due to speed limit compliance this may be positive for safety. Delay for cars and minibuses increases substantially when automated vehicles are introduced since they are very cautious when interacting with pedestrians, but when the CAVs get more advanced their negative impact on traffic performance is reduced. Double walking speed is often seen as a minimum for a

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last mile service to be attractive. The simulations indicate that the minibuses will have an average speed lower than this threshold through the shared space due to delays resulting from interactions with pedestrians. However, minibus trips will not only go through shared space areas which will result in an average trip speed above double walking speed.

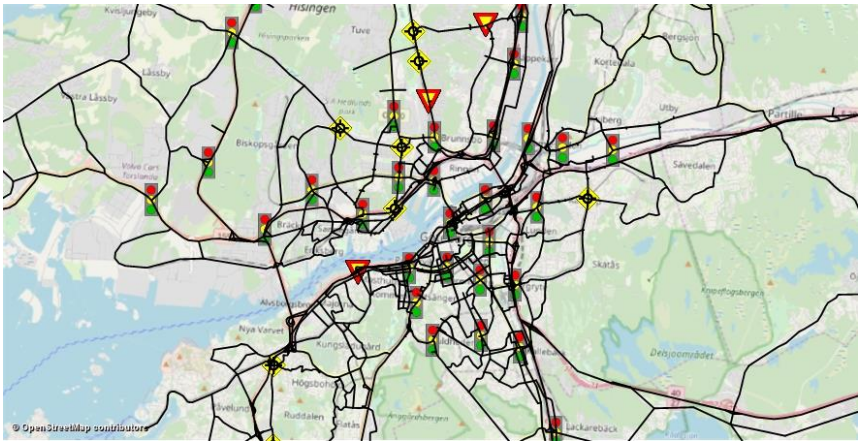
Traffic performance for pedestrians is unaffected by the introduction of automated vehicles
Both automated and conventional vehicles give way to pedestrians and the additional safety distance kept by automated vehicles does not affect the pedestrian traffic; the pedestrians were already mostly unaffected by the vehicle traffic.

Channelizing pedestrian flows leads to breakdown of vehicle traffic
The proposed measure fails drastically. Long queues of vehicles are formed behind automated vehicles waiting at the pedestrian crossings unable to get past the continuous flow of pedestrians formed by the channelization; vehicle traffic breaks down completely.

Design recommendations
The findings described above suggest that the current design works well from a pedestrian perspective but not so well from a vehicle traffic performance perspective when automated vehicles are introduced. Channelization do not solve the problem. Rather, the results indicate that it may be beneficial for vehicle traffic performance to spread out pedestrian flows crossing the road over a larger area rather than channelizing the flows to pedestrian crossings.

2.3.3.2 Use case 2: Accessibility during long-term construction works

A PTV Visum model over the Greater Gothenburg was used to investigate how accessibility during long-term construction works is affected by the introduction of automated vehicles. The study area includes the metropolitan area of Gothenburg and its surrounding suburban and rural areas. The figure on the right shows an overview of the coded network and the centre of study area.



Transition from negative to positive impacts of AVs during the established stage
The modelling results show a minor increase in car travel times and slightly larger increase in car delays during the Introductory stage. This negative impact on traffic performance switches to positive (decrease in car travel time and delay) in the Established stage. In the Prevalent stage, a rather substantial positive impact on car travel times and delays are observed. At the meanwhile, large variations in travel time and delay are estimated in the Established stage which can be attributed to transition from mainly cautious to more advanced AVs and with a large uncertainty regarding the mixture of AV types.

Positive impact in Established and Prevalent stages from redesigning from a one-way three lane tunnel tube into a two-way AV-only tunnel tube (measure 1)

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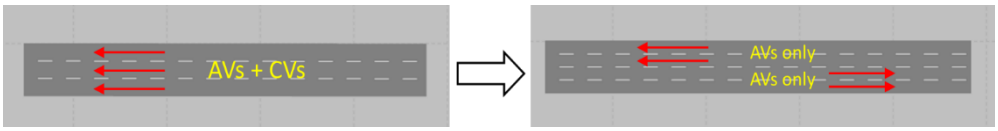
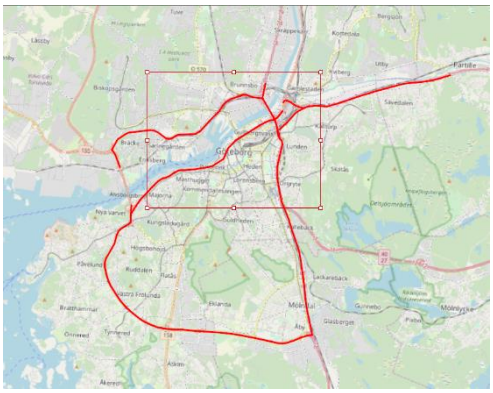
The redesign leads to a marginal increase in car travel times and delays in the Introductory stage



but a slight decrease in travel time and delay in the Established stage and somewhat larger effects in the Prevalent stage. CVs have a shorter travel time and delays compared to the case without this measure. in the Established and Prevalent stages. This is due to route shift of AVs from alternative routes to the tunnel, which free capacity on alternative routes.



No positive impacts in all three stages from reserving a bus and AV lane on the motorway network (measure 2)
This measure leads to a marginal increase in car travel times and delays in the introductory stage but no increase or decrease in the Established and Prevalent stages. Travel times on bus lanes decrease in Introductory stage but increase in Established and Prevalent stages.

Design recommendations
The findings described above suggest that a slight increase in delays and congestion levels on the urban core networks in the Introductory stage, especially on motorways. In the Established and Prevalent stages, delays and congestion levels have a moderate decrease. Reserving a bottleneck link that increases the capacity for AVs has in general a positive impact on traffic performance in the Established and Prevalent stages when AV share is high. However, only reserving a lane on the major motorway network that does not increase overall capacity but just redistributes capacity to AVs does not lead to any positive impacts on traffic performance. In the Introductory stage, buses gain from a shorter travel times and delays while cars lose from this measure. In the Established and Prevalent stages, there is no gain or loss for either buses or cars.

2.4 Stakeholder engagement: Automation-ready Forum in Gothenburg

2.4.1 Objectives and scope of the event

The Automation-ready forum in the city of Gothenburg was arranged at Lindholmen Science Park on the 11th September 2019 as a full seminar day on the topic of societal development and automated transports. It was jointly organized by CoExist, City of Gothenburg and Drive Sweden.

Drive Sweden is one of 17 national strategic innovation programs supported by The Swedish Innovation Agency, the Swedish Energy Agency and the National Research Council for Sustainable Development. Strategic innovation programs is an instrument established by the Swedish government to address complex societal challenges where there is a huge potential to develop sustainable solutions – requiring cooperation among several stakeholders to succeed.

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It's not all about driverless vehicles. This is a completely new approach to mobility. We are on the threshold of a radical shift, and it's happening fast. In just a few years the world will change. We will see entirely new mobility business models enabling sustainable cities.

Figure 8 Drive Sweden vision of future mobility.

Drive Sweden was launched in 2015, with the city of Gothenburg as one of the first members, as a cross-functional platform that drives the development towards sustainable mobility solutions for people and goods. Together, the partners of Drive Sweden, develop and demonstrate efficient, connected and automated transport systems that are sustainable, safe and accessible for all. Today there are some 100 partners from different sectors including Technology companies, Telecom, Vehicle manufacturers, Consultancy companies, Maas companies, Research institutes as well as Public authorities.

Figure 9 Drive Sweden partners.

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One of the core questions raised at the seminar was how cities can plan for a future where connected and automatic vehicles, CAVs, constitute a natural and integrated part of the urban transport system.

The main objective of the forum was to raise awareness of CAVs amongst stakeholders such as national, regional and local authorities as well as other urban mobility stakeholders. The full seminar day was also part of launching the Society Planning thematic pillar of Drive Sweden.

The seminar was organized in two parts:

10:00h – 12:00h

- **Welcome and introduction** – Moderator: Suzanne Andersson, City of Gothenburg
- **Collaboration for the development of the future transport system** – Sofie Vennersten, Program manager Drive Sweden
- **Future scenarios for self-propelled vehicles in Sweden** – Erik Almlöf, KTH
- **Development of future human-centred mobility** – Vaike Fors, University of Halmstad
- **A future with self-driving vehicles in Gothenburg - a basis for an in-depth overview plan for central Gothenburg** – Anna Svensson & Monica Wincentson, City of Gothenburg
- **Structure plan Kista - autonomous vehicles and automatic transport systems in physics planning** – Lukas Ljungqvist, City of Stockholm
- **CoEXist - How do you plan to get the automated transport system of the family time? Introduction to this afternoon's workshop** – Mikael Ivari, City of Gothenburg
- **Panel discussion -** moderator and today's speakers

13:00h – 16:00h

1. **Workshop: How can cities become "automation-ready"?**
   Although technological developments are rapidly increasing, there are great uncertainties about how urban and traffic planning will be affected in the future. That is why CoEXist has developed an Automation-Ready Framework to help cities build their own ability to plan for a future with an increasing number of automated vehicles. At the workshop, a draft framework will be presented and subsequently worked on in group exercises.

In the morning session there were final presentations from a couple of projects co-financed by Drive Sweden. The Gothenburg City Planning Authority was one of the organizations on stage. The urban planners Anna Svensson and Monica Wincentson presented the results of a project where the interaction between autonomous vehicles and sustainable, long-term urban planning has been examined.

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Figure 10 An illustration from Comprehensive planning for CAVs in central Gothenburg 2050.

The results are useful input in the current work with the new comprehensive plan for central Gothenburg. But the ambition to add the CAV-dimension into the planning process is still much of a travel into the unknown. Many questions still have rather vague answers. Can Gothenburg and other cities for instance count on that a CAV-revolution in the streets lead to a more substantial decrease in the need of parking spaces?

Mikael Ivari, from the Urban Transport Administration in Gothenburg, concluded the presentations by introducing CoEXist objectives and activities, including the Automation-Ready Framework concept.

Figure 11 Mikael Ivari presenting the CoExist project.

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As wrap up of the morning, the presenters were invited back on stage to participate in a panel discussing topics such as “how can the technological development support today´s mobility challenges in the cities?” and “how do we ensure an inclusive introduction of CAVs?”.

Then the afternoon session was completely devoted to a workshop of the Automation Ready Framework developed by the CoExist project. The workshop was structured around the five different mobility aspects in the framework. The idea was to support discussions and generate ideas of what actions or measures a city could or should initiate in order to be able to plan for the advent of CAVs. As an introduction Mikael Ivari presented the Framework concept illustrating it with examples from Gothenburg, including a self-assessment of Gothenburg’s Automation Readiness.

2.4.2 Analysis and lessons learned

There was a large interest for the seminar. When planning and preparing for the seminar a maximum of 100 participants were expected. However, invitations were sent out in June and the seminar was fully booked already before summer vacations started. Since the capacity of the room at the venue was only 100 persons, the organizers had to reject a couple of dozens of potential participants. Despite this the participants still represented a broad array of different types of organizations ranging from national, regional and local authorities, industry, academia, research institutes, insurance companies and other urban transport stakeholders. Of the 100 persons attending, some 40 persons stayed the full day and thus participated in the afternoon workshop.

The workshop focused on the mobility aspects of the Automation Ready Framework – policy, infrastructure, planning, capacity building and traffic management Several potential actions and measures were ideated by the participants but also a lot of discussion points, both recommendations and question marks.

The city of Gothenburg was involved with development of CAVs already in 2013 due to the Drive Me project initiated by Volvo Cars. It was early on very clear that there was a strong need for policy development in order to facilitate CAV testing and in the long run to allow for automated driving systems. In 2017 testing of CAVs in public roads was allowed in Sweden. The city of Gothenburg has worked closely with the Swedish Transport Agency to support this and has also developed internal processes to facilitate CAV testing in Gothenburg. At present the city has facilitated tests with cars, trucks, buses and service vehicles. There is also a Policy Lab initiative hosted by Drive Sweden where the city as well as several of the attendees of the workshop are partners.

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Policy

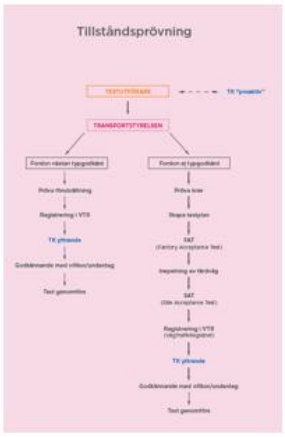

Figure 12 Examples of initiatives and measures from Gothenburg related to the Policy aspect.

At the workshop, the **policy** discussions were hosted by a legal expert, the former head secretary of the Swedish National Investigation “On the road to automation”. The investigation that also included proposals that later resulted in legal support for CAV testing in Sweden. The discussions ranged from balancing individual needs with societal objectives to pricing and procurement models.

When summarizing the top 4 most relevant discussion points in group discussions were:

1. The need for cooperation. Not everyone can do everything, but everyone can do something. We can learn from each other.
2. The need for national coordination, taking into account different needs of different cities.
3. Focus on end user needs rather than current behaviour.
4. Who is responsible for developing an automated city? What are the roles of authorities, public transportations providers, citizens, developers, etc.?

When it comes to **infrastructure**, the city has focused on developing digital rather than physical infrastructure. One reason for this is that new digital services, such as C-ITS services, can be deployed in a near future taking advantage of the increasing number of connected vehicles. Digital services are also relatively easy to scale, and the functionality can expand according to the needs and capabilities of the automated systems.

Lessons learnt from CAV testing and the CoExist case studies suggest that some technical solutions clearly would benefit from physical infrastructure support. However, improving the physical infrastructure in a large part of the road network is much longer process than expanding digital services.

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(Physical) and Digital Infrastructure

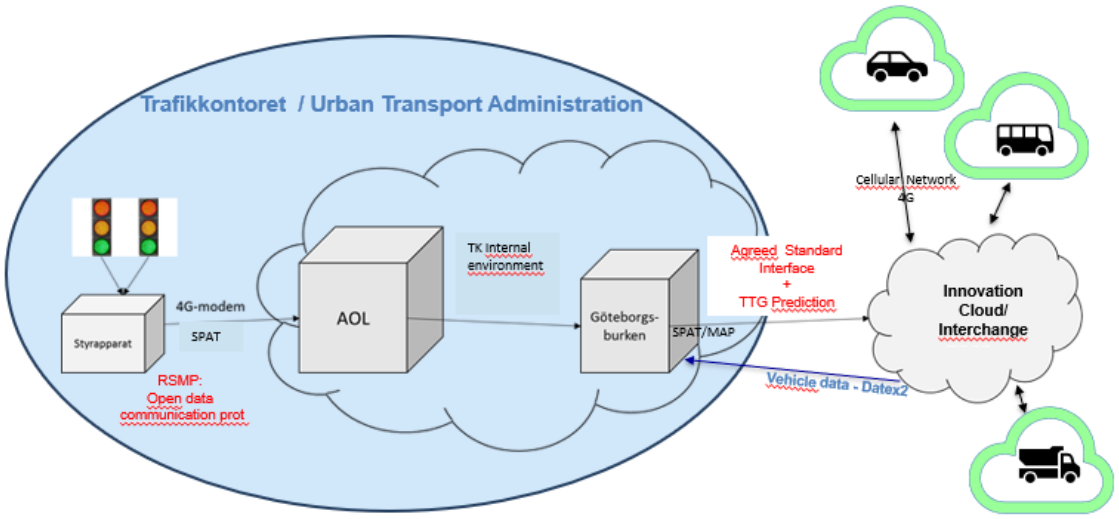

Figure 13 Example of pilot system architecture for providing C-ITS services such as Time To Green in Gothenburg.

The discussions related to infrastructure involved representatives from government, vehicle manufacturers, road authorities and consultants. One topic addressed was the need for cyber security as well as traffic safety. The interaction between the vehicle and infrastructure was another topic. Different companies use different development strategies, i.e. whether operation of the vehicles rely on the physical infrastructure or not. When summarizing, the top discussion points were:

1. Focus on needs rather than technological development. Cities should reflect on their strategies and visions. Infrastructure planning should take advantage of CAV development to reach goals.
2. Test beds are important to get a better understanding of possibilities and limitations with CAVs. Cities should facilitate demonstrations.
3. Cities should exchange information to get an overall better awareness. Organizations such as POLIS and Drive Sweden are valuable networking platforms.

The discussion about infrastructure also resulted in several tangible actions and measures that could be implemented. Geofencing, digitizing traffic regulations, connecting traffic signals, parking management, CAV-lanes and speed zone management were some of the suggested planning and implementation measures.

In order to plan you have to have the right tools and the right knowledge. Projects like CoExist are important initiatives to help enhance planning capabilities, developing tools and methods that support planning for CAVs. The user perspective is of uttermost importance for a public authority. This is why the city of Gothenburg also has engaged in the AHA (A Human Approach) project that involves and engages with the public. Based on people's everyday lives, future mobility services are prototyped and evaluated. The city has also started to assess long term impacts of new mobility services using multi-modal traffic models to analyse future Mobility-as-a service scenarios.

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The **planning** discussions was hosted by the project manager for the new comprehensive plan for the city of Gothenburg. A lot of the discussions involved different aspects of what makes a city liveable. What can we learn from history? What is considered liveable today and what will define liveability in the future?

When summarizing the top discussion-points were:

1. Define the vision. What do we want to achieve?
2. Cities should engage in demonstrations to support planning measures. What works and what does not work within the local context. Living labs to are useful to explore and to co-create solutions.
3. Recognize the different time perspectives of implementation. It is important to have an adaptive/iterative approach.

The discussion about planning also resulted in several tangible actions and measures that could be implemented. Test beds, living labs, scenario-based planning and parking management were some of the suggested planning measures.

The discussions of **capacity building** were facilitated by experienced open-innovation managers and involved participants from industry, academy and public authorities. The need for defining roles and responsibilities was one important discussion topic. This is something that the city is already exploring in several C-ITS projects involving national authorities and linking to European harmonization initiatives. There is a common understanding that the future transport system will be fuelled by data. The major uncertainty is how the eco system supporting data exchange will look like. A common vision is considered important even though actors supposedly have different objectives.

The top discussion points were:

1. It is important to define a common vision. What does it take to achieve it?
2. Implement a holistic workflow. Learn from the industry and implement cross-functional teams to improve innovation in public sector.
3. Develop a transformation model that supports a modular approach.

The **traffic management** discussion included participants from several vehicle manufacturers and Maas companies as well as research institutes and consultancy companies. A lot of focus was put into the need for test beds and the need for a connected infrastructure. Services need to be harmonized on a European level and should support multi-modal travel. The top discussion points were:

1. What infrastructure needs to be connected? Where should a city start to deploy in order to facilitate a gradual introduction of CAVs?
2. Cities should offer access to infrastructure for testing purposes.
3. Cities should share data that enables multi-modal travel.

The workshop was very successful, and a lot of the participants expressed their appreciation afterwards. It was also a successful launch of the new Society Planning thematic pillar of Drive Sweden. In addition to the valuable inputs from the workshop, it was a great dissemination

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opportunity for the CoExist project, reaching 100 dedicated professionals from industry, academy and public authorities.

One of the main takeaways from the workshop was that continued and deepened cooperation between different actors is essential to support a sustainable development of CAVs. The everyday lives of our citizens must be the driving force in this development, not technology or individual behavior. To support this, a clear and inclusive political vision need to be formulated. The workshop also gave valuable input for near term initiatives and measures. As an example, the city has continued the user-centric approach in a follow-up project to AHA. This time with the aim to evaluate the prototyped mobility solutions in so-called living labs.

2.5 Roadmap towards Automation-readiness in Gothenburg

Since there are so many uncertainties related to CAVs, the city of Gothenburg has adopted an adaptive approach to automation-readiness. There is no general roadmap towards automation-readiness in place but instead a Strategic Plan for Traffic Innovation.

In some specific areas related to the introduction of CAVs there are roadmaps in place. Connected traffic signals and related C-ITS services is one example of an area where the Urban Transport Administration has developed a roadmap.

2.5.1 Self-assessment of current situation

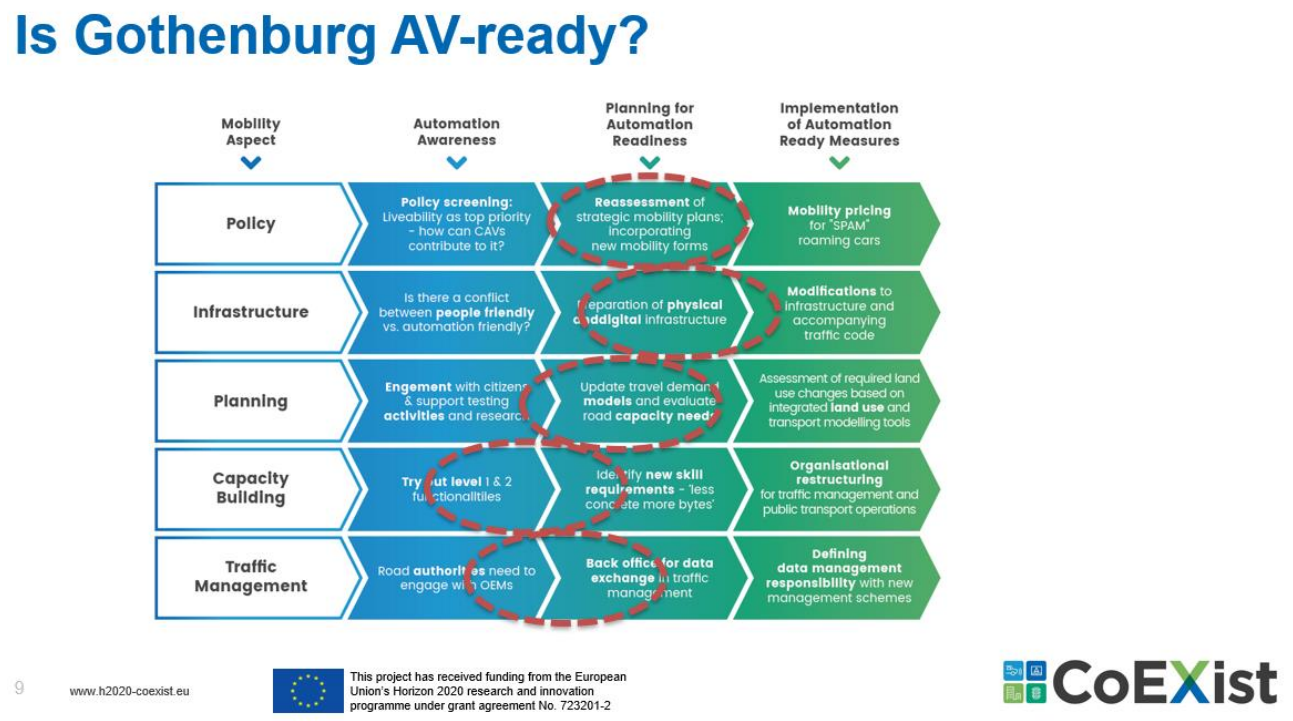

Figure 14 Self-assessment of Gothenburg's Automation Readiness using the Automation Ready Framework concept.

The city of Gothenburg has been involved in activities related to CAVs since 2013. That was when Volvo Car Corporation introduced the technology and the potential benefits of deployment to the City, the National road administration and the Swedish transport agency. This has resulted in several actions taken and a lot of experiences gained in the last seven years.

When it comes to POLICY aspects the city has been involved in several initiatives over the years. Developing internal processes for facilitating CAV testing and a preparing a strategic plan for traffic innovation are just a few examples.

For the INFRASTRUCTURE aspect the city is preparing for implementing day 1 and 1,5 services using the Connecting Europe Facility funded project Nordic Way 2 as a platform for piloting services.

PLANNING is an area where the city has been involved in a number of projects to gain experiences and to introduce the concept of CAVs into traditional ways of planning. Projects range from user-centric projects such as AHA to Comprehensive planning using CAVs.

Exploring roles and responsibilities is an integral part of CAPACITY BUILDING. It is important to for the city to align with initiatives taken on a national as well as a European level. Identifying the need for new competences is also important. This is of course pushed by the increasing digitalization of the transportation system.

Many agree that data will fuel the future transport system and future TRAFFIC MANAGEMENT. Still it is an open question what the eco-system for data exchange will look like. The city engages in knowledge sharing in projects and platforms to gain valuable experience for future deployments.

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2.5.2 Automation awareness creation

Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Comprehensive planning with CAVs	Exploring potential impacts of CAVs when planning for central parts of Gothenburg.	Urban Planning Administration	Create awareness of CAVs amongst planners and architects	Completed	Drive Sweden
Eldsjäl	Assessing impacts of Maas in Gothenburg	Urban Transport Administration/Public Transport Authority/ et al	Increase knowledge of impacts from mobility services	2020-2021	Drive Sweden
AHA 2	Involving the public in creating next generation of mobility services	Halmstad University/Urban Transport Administration/ Volvo Cars/et al	Improve everyday lives of citizens	2019-2021	Drive Sweden
CREATE	An open digital twin to support data driven simulation	Rise/ Urban Transport Administration/Volvo Cars/ et al	Increase knowledge of impacts from mobility services	2020-	Not approved yet

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2.5.3 Planning automation-readiness

Measure	Description of Measure	Responsibility	Relation to **Automation**-ready vision	Time of implementation	Funding Source
Facilitate CAV testing in Gothenburg	Develop Aligning roles and responsibilities with Swedish Transport Agency.	Urban Transport Administration	Increase knowledge. Support a sustainable development of CAVs and future services	ongoing	Internal
SPAT/MAP services	Exploring roles and developing interfaces in cooperation with industry, national authorities and Roads.	Urban Transport Administration, Industry, National Road Administration	Increase knowledge for future large-scale deployment	-2025	Drive Sweden, CEF
Assessing platforms for ITS-services and data exchange	Establishing and assessing different setups in different types of projects	Urban Transport Administration	Services and digital regulations will support deployment of CAVs	-2022	Drive Sweden, CEF
Policy Lab	Assessing and improving CAV testing pre-conditions	Rise/AB Volvo/Einride/ Urban Transport Administration	Services and digital regulations will support deployment of CAVs	2019-2020	Vinnova

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2.5.4 Automation-ready measure implementation

Measure	Description of Measure	Responsibility	Relation to **Automation**-ready vision	Time of implementation	Funding Source
Connect Traffic signals	Enabling cellular communication when upgrading signal controllers	Urban Transport Administration	Prerequisite for providing services	ongoing	internal
Implementation of SPAT/MAP services	Setting up SPAT/MAP subscription services	Urban Transport Administration	Facilitate CAV-deployment. Enhance performance of	2025-	CEF

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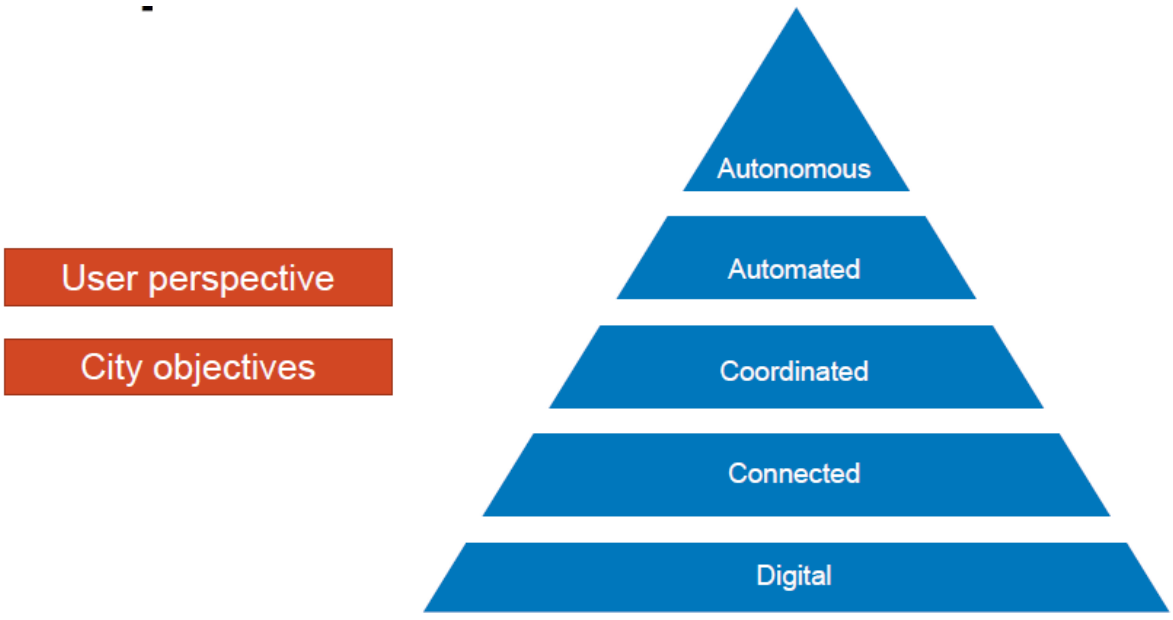
2.6 Conclusions and outlook

Even though the technological development is fast pacing, it is still quite unclear how and in what ways the gradual introduction of CAVs will impact the transportation system. The concept of ODDs (Operational Design Domains) for CAVs was introduced a couple of years ago and now, in analogue, the concept of ISAD (Infrastructure classification Scheme for Automated Driving) is under development to classify road infrastructure automation-readiness[7]. Still there are few, if any, demonstrations that showcase the interaction between ODDs and ISADs. The concepts should still be considered as work in progress. However, it is obvious that data exchange between vehicles and infrastructure will be important in order to facilitate a smooth introduction of CAVs. In the future it might also be necessary to develop new regulatory approaches to ensure expected benefits such as traffic efficiency and traffic safety. New efficient regulations will be digital and use authorized communication systems.

Hence, it is important to have an adaptive approach to the increasingly automated transportation system. Mikael Ivari, of the Urban Transport Administration, has put forward the following strategic approach:



To facilitate communications, the vehicles as well as selected infrastructure must be connected. In addition, the infrastructure, including traffic regulations, must be digitized. Reviewing and enhancing existing workflows so that what happens “on the street” also happens in the digital twin will be important to facilitate the data supply chain that is needed for providing new services that will support CAVs as well as conventional vehicles. Investments in “digitizing” workflows, digitizing infrastructure and enabling connectivity are necessary building-blocks in order to develop new services and support a safe and efficient introduction of CAVs. In the long-term authorities might want to facilitate a coordinated traffic system which in turn will support more advanced CAVs and eventually fully autonomous solutions.

[7] INFRAMIX (2019). D.5.4 Infrastructure Classification Scheme.

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3 Automation-ready Action Plan – Helmond

3.1 Introduction

3.1.1 Goal of the Action Plan

The goal of this action plan is to describe and explain the strategic for the introduction of CAVs in the city of Helmond. This plan can be used by the traffic department of the city of Helmond to determine the actions they have to take to implement the introduction of CAV's in the city's policy but it can also be used by other authorities to see which actions Helmond took or planned to take to help them also to prepare for the introduction of CAV's

3.1.2 Scope and target audience

This document is mainly for internal purposes of the traffic department of the city of Helmond. it describes how Helmond came that far as it is now, by relating it to the former Strategy Plans (Helmond Mobiel 2005-2015 and Helmond Verbonden 2016-2025) and give some advice and recommendations to improve their existing and future policies.

Figure 15: The two traffic policy papers 'Helmond Mobiel' and 'Helmond Verbonden"

In Helmond Mobiel, the policy was mainly focused on optimizing the use of existing infrastructure, while Helmond Verbonden elaborates on it by focus on technology driven urban traffic solutions (CITS) and active support of smart mobility pilots and showcases.

Helmond believes in the principle of learning by doing and is convinced that innovative developments can be taken one step further by actually testing them together with the business community and educational institutions. Helmond also believes AV's are an innovative development which could contribute to (traffic) policy goals.

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3.2 Transport policy and planning context in Helmond

3.2.1 Legal and normative framework

Gaining practical experience with intelligent technologies, such as CAV's, is permitted on public roads in the Netherlands. New regulations came into force on 1 July 2015 whereby it is now legal under certain conditions which have to be approved by RDW to take Connected automated vehicle systems out on the public roads. RDW is the Netherlands Vehicle Authority in the mobility chain. RDW has developed extensive expertise through its years of experience in executing its statutory and assigned tasks. Tasks in the area of the licensing of vehicles and vehicle parts, supervision and enforcement, registration, information provision and issuing documents. The regulations have been elaborated over the past years so if test will take place on public roads each test must go through a procedure (as shown below) at the RDW.

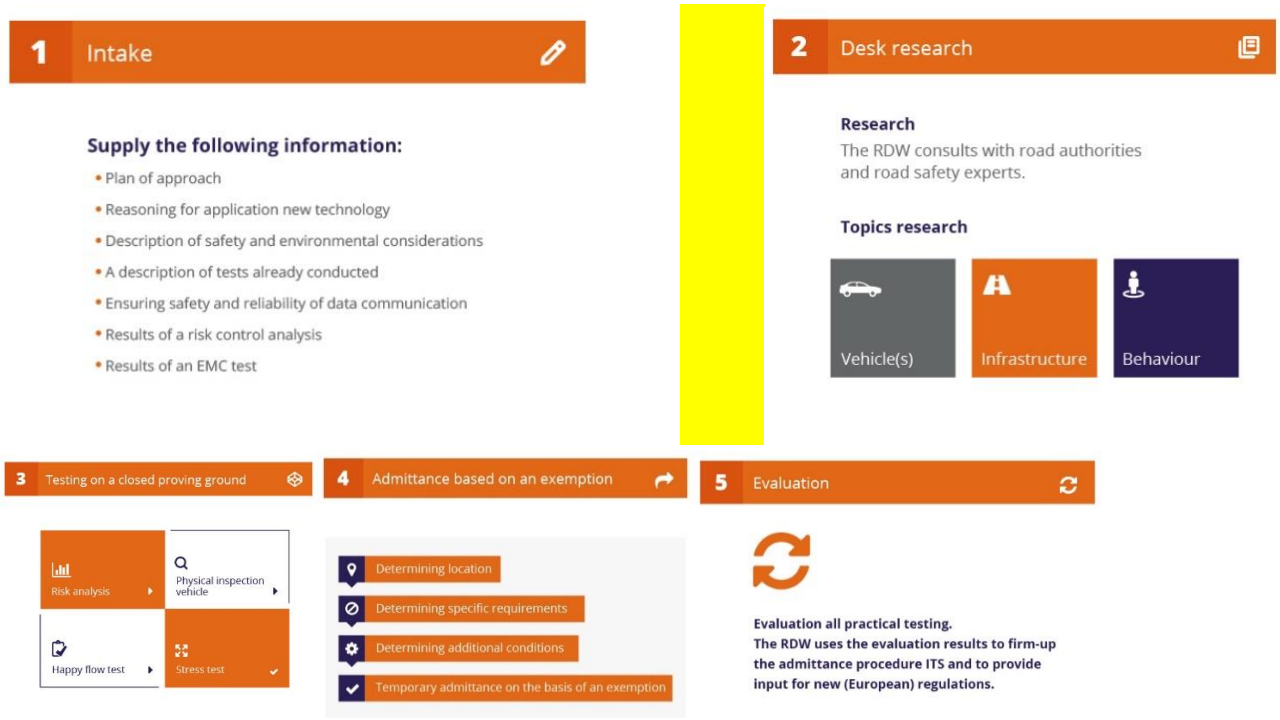

Figure 16: The method admittance procedure by RDW (source www.rdw.nl)

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3.2.2 Policy goals and planning context in Helmond

Helmond is a medium sized city in the south of the Netherlands, with a current population of around 90,000 inhabitants. Helmond is part of the Brainport area, one of the three most important economic areas in the country. Innovation is the key-word here and for Helmond the focus lies on innovation on the fields of automotive and mobility.

Helmond is home to the Automotive Campus, where over 35 companies work on innovative mobility solutions. With the Automotive Campus, Helmond presents itself as a knowledge and innovation centre for mobility solutions and as “City of Smart Mobility”.

Though a relatively small city, Helmond receives international recognition for its ambitious goals and the realisation of innovative mobility solutions in the city. The Brainport region hosted the Intelligent Transport Systems ITS Europe 2019 Congress in June 2019, where the active role of Helmond as a Living Lab for ITS was showcased.

Current policy and planning strategy started when Helmond saw major traffic problems due to the growth of mobility in early 2000. Various studies had been started to find out how the city could overcome those traffic problems. These studies resulted in different solution directions: the expansion of physical road infrastructure or a totally different approach, namely choosing to manage traffic. Dynamic traffic management was on the rise in that period. The growth of mobility was difficult to facilitate and new infrastructure often led to an even greater growth of mobility.

The mere expansion of physical infrastructure would have entailed enormous costs and would not solve all traffic problems. Helmond had about 60 traffic control installations at its disposal, and so 60 potential traffic managers. Therefore, at this time it was decided to invest in traffic management.

When traffic management was also embraced nationally, almost all traffic control installations in Helmond were converted to network control installations, partly with the help of subsidy programmes from the State and the Province. This was the first major step Helmond had taken. By realising the network controls, the traffic problems did not occur in the city and accessibility was guaranteed in recent years.

3.2.2.1 City of Smart Mobility

The leading role in dynamic traffic management has given Helmond the name "City of Smart Mobility". The municipal traffic policy is based on a smart approach to mobility, moreover Helmond has an important economic ambition with Smart Mobility. The automotive industry, which in the past was also located in Helmond, was revived. This is visible in recent years, in the (inter)national driving role that this top technology region fulfils in the automotive field. As a result, the municipality has a driving role in the expansion of the home base, the Automotive Campus in Helmond. With its mobility policy, the municipality is making an extra contribution to smart mobility by profiling itself as a testing ground or “living lab” for new mobility techniques and solutions. This will give many of the innovative mobility developments their first application in Helmond and will enable important experiences to be gained.

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3.2.2.2 Living Lab projects

Helmond has made a deliberate choice to actively land smart mobility pilots and showcases. The city believes in the principle of learning by doing and is convinced that innovative developments can be taken one step further by actually testing them together with the business community and educational institutions. Helmond is participating in a several projects with AV's or AV-functionalities not only in CoEXist but also in others such as Maven, Autopilot, Fabulos.

Figure 17: Helmond as a Living Lab

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3.3 Potential impact of automation in Helmond

3.3.1 Vision and targets

Following on from the previous policy memoranda (Helmond Mobiel and Helmond Verbonden), more policy is being developed for the city and the city centre of Helmond in which automated vehicles cars do not play an explicit role, but can contribute to reach the goals. In the latest vision on Accessibility and Parking in the centre of Helmond a scenario was chosen find solution for mobility issues which is somewhere between “technlogy-driven” and “car-free and green”.

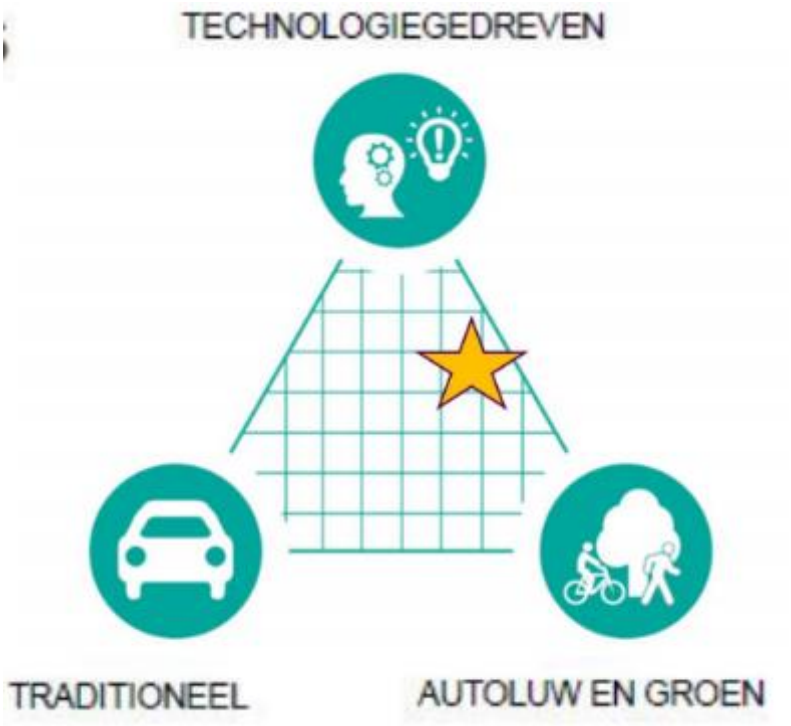

Figure 18: Helmond as a Living Lab

Car-free and green scenario can be described as:

"The mobility structure in and around the centre is such designed to maximise helped to strengthen spatial quality for example with green and new buildings. The urban traffic is dominated by walking and cycling"

Technology-driven scenario can be described as:

“Based on technology and data be sustainable and efficient solutions for mobility and parking created such that physical interventions to a minimum can be limited, account taking into account the social trends of "sharing" instead of 'to own'

In a solution were both scenarios have to be taken in account. Automation or Automated Vehicles could contribute and it’s worth to investigate and to see if experiences obtained in projects and tests (demo’s) can be implemented in to reach the goals.

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3.3.2 Risks and uncertainties

In spite of the rapid technological development, it is still to a large extent unclear what will be the impacts of an increasingly automated transportation system. Hence, it is important to have an adaptive approach to the increasingly automated transportation system. That's why Helmond believes in the principle of learning by doing, in being a living lab and participating in projects to gain knowledge and experience. By participating in projects and being part of developments as a city, you can also have influence in the development and pick out quick wins which could have the most benefit for your city policy.

3.3.3 Use case impact assessment and lessons learned

3.3.3.1 Use case 3: Signalised intersection including pedestrians and cyclists

A microscopic Vissim model was used to investigate the traffic performance impact of the introduction of automated vehicles on the traffic at a signalised intersection with an advanced control algorithm at one of the main arterials in Helmond.

Longer travel time, especially for CAVs

Due to the full speed limit compliance of the automated vehicles, these experience significantly longer travel times. The speed compliant CAVs also reduce the possibility of speeding for the conventional vehicles, increasing their average travel time. This effect increases with the penetration rate of CAVs, but is partly counteracted by decreased delay at the intersection as the CAVs get more advanced.

The advanced adaptive traffic signal control adapts to the partly automated traffic, redistributing green time between motorized traffic and active modes

The saturation flow is lowered by the presence of cautious AVs and increased by the presence of advanced AVs since the former claim more space and the later less. The advanced traffic signal control algorithm reacts to the changes in saturation flow (or some effect of them), by redistributing green time from and to the active modes, respectively. That is, in the introductory stage green time is reduced for bicycles and pedestrians to keep the vehicle flow up, while it is increased in the prevalent stage. This adaption leads to increased delay and travel time for active modes in the introductory stage, while decreased delay and travel time in the prevalent stage.

Design recommendations

When advanced adaptive traffic signal control algorithms are used, care should be taken to ensure that the introduction of automated vehicles does not lead to an unwanted redistribution of green time from active modes, especially in the introductory stage.

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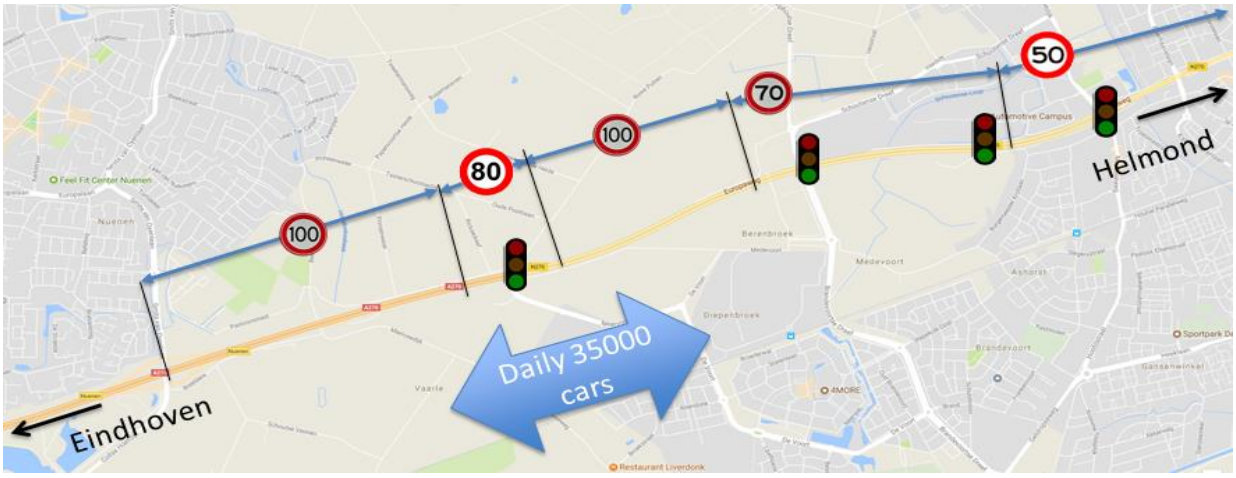
3.3.3.2 Use case 4: Transition from interurban highway to arterial

A microscopic Vissim model was used to investigate the traffic performance impact of the introduction of automated vehicles at the transition from highway to arterial outside Helmond.



CAV speed compliance leads to increased travel time both for CAVs and CVs

The full speed compliance of automated vehicles reduces speeding among the conventional vehicles and leads to longer travel times for all vehicles except for very high penetration rates of advanced CAVs.

Large discrepancy in delay between automated and conventional vehicles

Since the desired speed of CAVs is close to the speed limit they are hardly delayed at all away from intersections while many of the conventional vehicles have desired speeds significantly above the speed limit and are thus delayed significantly by slow-moving CAVs.

Platooning leads to a slight improvement overall for motorized traffic and significant improvement for active modes

Allowing CAVs to form ad-hoc platoons, either in any lane or only in the rightmost, slightly improves travel time and delay for motorized traffic. Platooning leads to increased saturation flow at intersections, but due to the adaptive signal controls green time is redistributed to active modes who receives the benefits of the increased intersection capacity. The difference between allowing platooning in any lane or only in the rightmost is small.

Design recommendations

Facilitating platoon formation at intersections can be a way of improving the conditions for active modes without reducing the throughput of motorized traffic.

3.4 Stakeholder engagement: Automation-ready Forum in Helmond

3.4.1 Objectives and scope of the event

By organising the Automation-ready forum in Helmond it is intended that all internal stakeholders of the municipality of Helmond, from policymakers to implementers, see the possibilities or impossibilities of self-driving vehicles, so they can set the objectives and measures for the future.

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Being a city of Smart Mobility and a living lab, the city of Helmond participates in several (AV)-projects. By participating in such projects, we as a city enrich our knowledge and stay up to date when it comes to new developments. Also, a city can anticipate and even influence developments on AV's or Smart Mobility. The city of Helmond believes these new developments bring changes to meet other city policies goals such as more accessibility, less pollution etc.

By organizing this Automation-ready Forum, first, local and internal stakeholders will be informed about these AV-related projects that take place or have taken place in Helmond. But more relevant, after this session local stakeholders will be informed about the ins and outs of the AV-related projects running in Helmond. The projects which will informed about are:

- MAVEN focuses on the cooperation between individual automated vehicles and an intelligent infrastructure specifically at signalized intersections and signalized corridors.
- AUTOPILOT brings together relevant knowledge and technology from the automotive and the Internet of Things value chains in order to develop Internet of Things-architectures and platforms which will bring Automated Driving towards a new dimension
- CoEXist develops "Automation-ready" transport models and road infrastructure for the coexistence of automated and conventional vehicles.
- FABULOS delivers a systemic proof-of-concept on autonomous last mile public transport as part of the urban areas' existing transport system, based on use of autonomous self-driving minibuses for transporting people.
- ISA (Intelligent Speed Adaptation) deployment initiatives, as a quick win for road safety in the transition phase towards fully connected and automated vehicles

Attendees of the Forum were informed by short project presentations by project participants of these projects. After this presentation the participants are better informed about the state of affairs and afterwards a discussion can take place about how to proceed.

Figure 19: Impression of the Automation Ready Forum in Helmond

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3.4.2 Analysis and lessons learned

Forum members were asked to identify and analyse key aspects that Helmond should arrange or take into account, in its efforts towards automation-readiness. The main conclusions are summarised below.

Revised expectations
Expectations are somewhat subdued. Development and introduction will be less rapid than forecasted a few years ago. Outlook has thus been revised, understanding that limitations on CCAM deployment are highly probable (e.g., to specific sections or dedicated roads).

Involve a larger audience
Helmond can involve a larger audience, such as councillors (they have to make money available to implement or run projects), students, other governments, companies. Create more visibility in the city.

Quick wins
Helmond should participate in projects which can (quickly) contribute in city policy goals on road safety and mobility, such as ISA, last mile solutions, social inclusion measures.

Figure 20: A quick win for Helmond on road safety is ISA

Organization
The organization must be in order, the expertise (gathered last years) and experts must be preserved. Continue to cooperate internationally and having a good network.

Attract business to Helmond
Being a smart city and involved in many projects is also works as a magnet that causes companies to establish themselves on Automotive Campus in Helmond. So, it is not only to contribute on traffic goals but also economic and employment goals were met.

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Figure 21: The development of the Automotive Campus

3.5 Roadmap towards automation-readiness in Helmond

3.5.1 Self-assessment of current situation

In the automation-ready framework (D1.1)[8] a scheme was set up with a 3-phase distinction. The different stages do not correspond to a linear chronological process, as different cities may be in a different phase depending on local circumstances. The phases can be overlapping, parallel and interlinked. The automation-ready framework aims to reduce uncertainty as cities go through each of the phases. Cities can use this scheme to do a self-assessment to see their current state and it can be used to investigate on which mobility aspect there is a gap or which mobility aspect needs attention or focus on.

[8] CoEXist: Deliverable 1.1 (2018). Automation-ready framework. www.h2020-coexist.eu/wp-content/uploads/2018/12/D1.1-Automation-Ready-Framework-Preliminary-version-1.pdf

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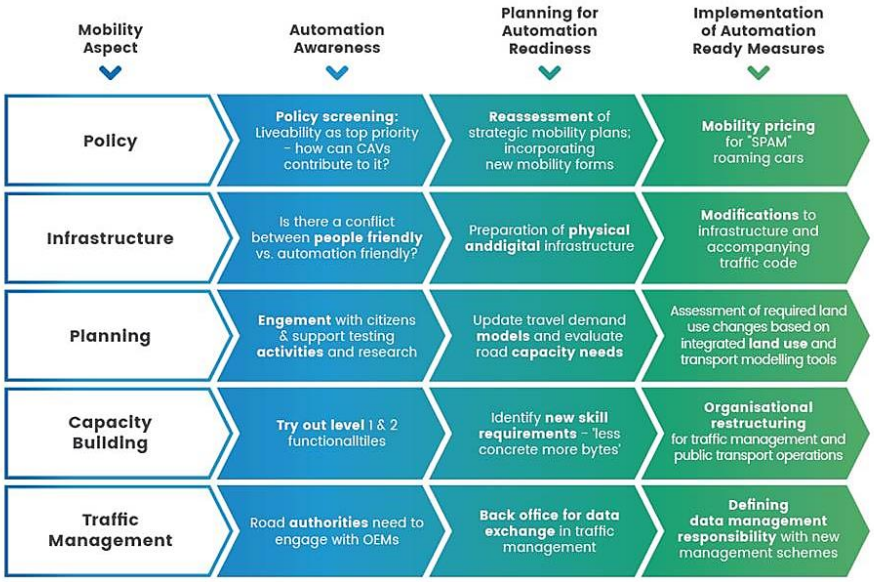


Figure 22: Self-Assessment model from the Automation Ready Framework

On every mobility-aspect, an assessment was made through discussion with participants. Results are described in detail in deliverable 4.4 and a short summary on every mobility aspect is listed below. The analysis covers Helmond's strategy, experience and planned actions, for each phase of the automation-ready framework and mobility aspect.

Automation Awareness

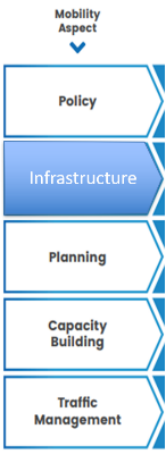
Participation in European projects and being Living Lab

Planning for Automating Readiness

Helmond believes in ISA to be a great benefit for road safety and focus on it as a quick win.

Implementation of Automation Ready Measures

Still it's unknown what AV's require to drive (in cities) so it's difficult to set measures now. Yet, investments on C-ITS capabilities and traffic management, allow the city to prepare for CCAM, whilst gaining further benefits (e.g., ISA, traffic control and optimisation)



Automation Awareness

Helmond is one of the leading cities in implementing the I-VRI (traffic lights which are able to communicate) in the Netherlands.

Planning for Automating Readiness

Planning activities towards hybrid communication for traffic lights (G5 and 4G/ wifi and cellular).

Implementation of Automation Ready Measures

Implementation of I-VRI, enabling sending messages V2I and I2V

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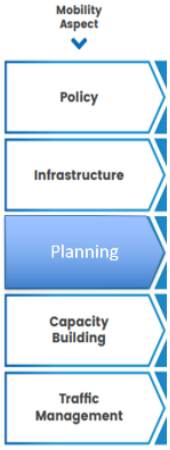


Automation Awareness
Participating in European projects with AV's and being a living lab for experiences

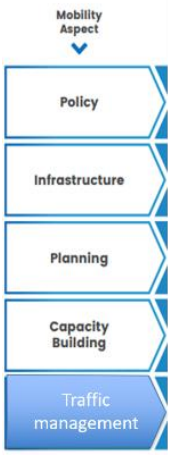
Planning for Automating Readiness
The vision of the city of Helmond that CCAM can contribute in traffic improvement and sustainability and therefore trying to implement useful outcomes of projects and tests but also be the host of developments in this branch of industry with the Automotive Campus.

Implementation of Automation Ready Measures
Helmond has been proactive in making the most of opportunities to implement quick-win measures within projects, identifying no-regret actions that support current improvements and enhance the cites readiness for CCAM

Automation Awareness
Participating in projects with mainly employees of the traffic department. There is a lot of experience and knowledge gathered the last years

Planning for Automating Readiness
Steering cross-sectorial cooperation and communication is key to optimise efforts and synergies towards Helmond's policy goals. The Automation-ready Forum enabled such collaborative approach and constitutes a priority for the city going forward.

Implementation of Automation Ready Measures
Experience should be wider spread among politicians and other departments.



Automation Awareness
Lack of standardisation, harmonisation but also lack of clarity about which information automated vehicles need make it difficult to optimise, store and make accessible which data

Planning for Automating Readiness
Helmond is starting a new program this year "De Digitale Stad" (the digital city). A change to get and to provide more data regarding to traffic and CAV's

Implementation of Automation Ready Measures
The implementation of I-VRI's, where vehicles can communicate with traffic lights

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3.6 Conclusions and outlook

Participating in the project CoExist (but also other projects related to Automated Vehicles) has brought a lot of knowledge and experience to the city of Helmond, which can be used by adopting new policies or taking new measures in the city.

Through its proactive City Lab approach towards Smart Mobility, Helmond has already taken important steps to prepare for CAV's (see chapter 5.1 or the deliverable 4.4). Still, through the analysis of CoEXist's impact assessment results and policy discussions within the projects, recommendations have been identified to further improve the city's strategy. These key findings are summarised below:

Quick wins/learning by doing
Helmond's strategy during the last years, has proved effective, not only from a mobility perspective, but also economically, by attracting business to the city (e.g., to the Automotive Campus). It is important to maintain this approach, to ensure a continuous enhancement of mobility and the economy.

Larger Audience
The European ITS congress in Brainport (Eindhoven/Helmond) held in 2019, was good to show Europe but also the citizens (Public Day) what important developments took place in the city. In coming projects, it's useful to involve more and more citizens and politicians to experience what these new technologies could bring them. A good start is the intended automotive week in 2021, which will be held on the Automotive Campus where again the latest state of the art technologies and developments will be shown to the public.

Organization
Being a city of Smart Mobility and participating in projects with all these new technologies ask for a good and adequate organization that can handle all issues. Not only enough people but also experts are needed. There must also be a clear direction and focus, because the mobility spectrum is so large and broad that it is impossible for a relatively small municipality, such as Helmond, to put in an infinite effort. Cooperation and coordination with other authorities is of key relevance to achieve joint goals through knowledge exchange and harmonisation of needs and strategies.

Avoid focus on only AV
Due to also the revised expectations, it is necessary to focus not on only AV's. Sometimes too many opportunities are attributed to new developments too quickly. So, it's necessary to test and learn and implement useful outcome. Mobility is predicted to change due to new technologies very fast the coming years. So, it's necessary not to focus on one part of the innovative-mobility spectrum. It's not only automation but also new transport modes as MaaS, car-sharing, shuttles, peds and so on.

AVs no, CAVs yes
Through CoEXist's results and other research, Helmond understands that AVs need to be connected to other vehicles and the traffic management system in order to contribute to a more sustainable mobility system. For this reason, the earlier investments of the city in C-ITS, such as the intelligent traffic lights, will not become obsolete, but on the contrary, are a sound base for future introduction of automated vehicles in the city of Helmond. This has proven a strategic no-regret measure.

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4 Automation-ready Action Plan – Milton Keynes

4.1 Introduction

4.1.1 Goal of the Action Plan

The goal of the Action Plans is to give guidance on the steps the highway authorities should take to develop and conduct automation-ready transport and infrastructure planning. To do so, this plan includes an analysis of the current situation, learn lessons from actions taken so far, and define targets and potential measures to further advance towards automation-ready transport planning. This action plan is aimed at responding to Milton Keynes particular needs and priorities, following a bottom-up approach.

4.1.2 Scope and target audience

The primary target audience are the professional officers and decision makers in local planning and highway working within local authorities. Whilst the expectation the key individuals will be associated with the planning, transport and highway departments, the reach of this report did consider related professional disciplines such as urban design, social care/mobility, economic and business development and legal regulatory functions.

The report is delivered in a broad non-technical format so that the content is suitable for a broad non expert audience.

4.2 Transport policy and planning context in Milton Keynes

Local Government in the UK

Milton Keynes is a unitary authority in the south east midlands of England. A unitary authority is a type of local authority that has a single tier of governance and is responsible for all local government functions within its area. Unitary authorities are relatively new format of local government structure, previously there had been a majority of local authorities that were two tiers, with the upper tier dealing with strategic planning of highways and planning, whereas, smaller district tier dealt with operational issues.

Many large towns and cities and smaller counties benefit from being unitary, where the scale means that it is efficient to have one body responsible for all functions. Unitary authorities are therefore responsible for: education, **highways**, **transport planning, passenger transport**, social care, housing, libraries, leisure and recreation, environmental health, waste collection, waste disposal, planning applications, **strategic and local planning** and local taxation collection. Citizen can benefit from having a single point of contact for all services.

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UK National Government

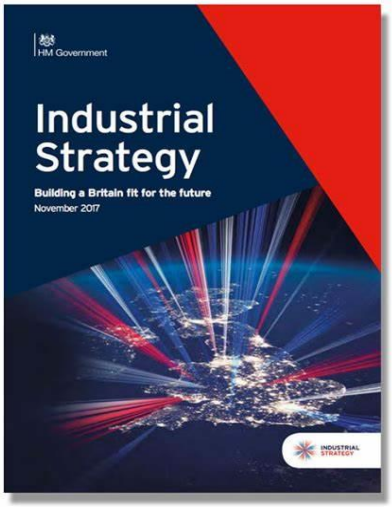
Above the unitary level, strategic co-ordination of transport is the primary responsibility of a national Government department. This Department for Transport (DfT) set overall national policy and guidance, and takes specific responsibility for Rail, Aviation and Maritime. National Government Agencies take specific responsibility for Strategic Highways, and most relevant to CAM, Vehicle licencing, standards and regulation.

4.2.1 Legal and normative framework

UK legislation, as it relates to highways and transport, is typically contained within various Highway Acts - The current Highway Act (1980) is prevalent. Within these acts, some powers are devolved to Local Highway Authorities to enact, with some scope via local instrument such as traffic regulation, orders and bylaws to specific address local issues – particularly around parking and how some vehicle access and use highways (e.g. vehicle restrictions and speed limits). Local orders however cannot overturn primary legislation within the overarching Highways Act.

Some existing Highways Act date as far back as 1835. These acts were initially introduced to manage Horse drawn (Hackney) carriages! With the step change in how mobility is provided and potentially used without a driver, there has been a recognition that the legal framework required to support and regulate the use of this technology is urgently required. A new legislative programme is currently underway to deliver a Modern Transport Bill which will consider the needs of autonomous vehicle operation from specifically a legal and regulatory perspective. Given recent political issues around exiting the European Union, parliamentary time to enact the bill has been limited, However the UK government recognising the importance and urgency has taken a practical and pragmatic approach to creating a technical, legal and regulatory framework around which CAV technology can be developed and deployed without the need to wait for the full Act of Parliament.

Part of this approach has recently seen government develop closer cross departmental working, recognising transport has direct relationships to key priority areas. This has manifested in the creation of cross departmental approaches to reducing carbon and developing new business opportunities, So, DfT working with the Department for Business Energy and Industrial Strategy-BEIS) have created two specific functions - the Office for Low Emission Vehicles (OLEV) and the Centre for Connected and Autonomous Vehicles (CCAV). These functions are hosted, created in 2015/16, within DfT under the new section tasked with delivering 'Future Mobility. This is now supported via a specific new senior Government Minister with the Future of Mobility portfolio.



National Government developed a key strategy document in 2017 - its industrial strategy. The strategy focussed on key themes – or grand challenges, and relevant to this area was the challenge of the Future of mobility. The strategy recognised that the development of CAV technology is a strength within the UK and that effort should be placed on exploiting this strength via support from Government. With CCAV leading, the UK has and continues

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to prioritise investment in research and development into CAV technology and solution. Managed by the UK Innovation body (Innovate UK) the UK government has invested around £200m along with £200m matched funding from industry to initiate a full portfolio of test and trial programmes designed to catapult the technology into mainstream industrial output for the UK.

Regulation and Trialling

To enable the deployment of live trials and testing, the UK government created a legal and regulatory framework to allow public trialling of CAVs. The initial framework, Pathway to Driverless cars was published in 2015 and updated in 2018. Alongside this framework came a first tranche of live projects to demonstrate CAVS in public areas, with the projects designed to evaluate the potential of the technology to deliver improved transport and mobility opportunities for citizens and business. The first project was LUTZ pathfinder (2015) – this deployed the first public trial in the UK of self-driving vehicles (SDV) on shared surfaces (in Milton Keynes). This project was closely followed in 2016 by three major projects (3-year programmes) in London, Bristol and Milton Keynes. The Milton Keynes demonstration was perhaps the largest and most complex involving 16 organisations and two forms in SDV integrating journeys and vehicle capabilities (connected and autonomous).

The CAV programme in the UK now includes over 150 projects that cover all aspect of the technology from large public trial s to small very specific research areas.

To build on the UK capability and accelerate CAV technology to practical deployment, UK government created a capability to facilitate, manage and promote and promote commercial real-world testing of CAVs and supporting technology via a national scale testbed. Zenzic (formally Meridian) was established in 2018 to develop partnerships between industry collaborators, OEM and local areas to allow testing and evaluation of vehicle on open networks. The testbed area created include the West midlands, London Greenwich Gateway, Oxford/Culham and Cranfield-Millbrook-Milton Keynes triangle. The purpose of the testbed is two-fold – accelerate real world practical deployments and develop a commercial capability to develop UK capability and attract inward investment into the UK.

4.2.2 Policy goals and planning context

Local Context – Why CAVS in Milton Keynes?

Milton Keynes is one of the fastest growing areas in the country seeking to deliver game changing growth and innovation which will lead to an expected level of population growth from 268,000 to c.400,000 people by 2050. To support this Milton Keynes, like every other local authority responsible for planning and transport, is required by statute to deliver a range of strategic plans to set out its objectives and proposals for planning and transport. For transport, this has taken the form of a Local Transport Plan (LTP). Initially the LTP set out the strategy to deliver transport and highway objectives over a 5-year period, and typically included costed delivery plans. The UK is in its fourth cycle of LTPs with a recent change now allowing local authorities to set longer timeframes for planning. For Milton Keynes this has meant our LTP4 is now called our Mobility Strategy for Milton Keynes. This Mobility Strategy, adopted in 2018 is now the reference point for how the town wishes to maintain, improve and develop its transport system up to 2036. It also shows how Milton Keynes wishes to begin investing in the short term in the development of the town's long term future transport system

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to 2050 to deliver the vision for transport set out in MK Futures 2050 (the councils long term development planning strategy) to ensure connectivity to new national and local infrastructure.

Figure 23: Passenger Pod Operating in Central Milton Keynes

One of the key guiding principles for the design and operation of the city has been the requirement for 'ease of movement' for all its citizens and visitors. This principle, seen as key to ensuring continued social and economic development of the city. The hypothesis for CAVS is that they support this by:

- Reducing congestion
  Can CAVs operate with reduced road space and with enhanced capabilities operate without the in-built highway design that are needed to address human reaction times
- Improving safety
  Will vehicle capabilities reduce the incidence of collisions due to faster comprehensive sensing and reaction times from the vehicle technology?
- Increase mobility options for those who cannot use 'driven' vehicle
  Will self-driving capabilities allow section of communities who cannot (for whatever reason) or do not want to drive. Will supporting mobility operations without the cost of a driver and operating efficiencies (trough connectivity) reduce the cost of transport.
- Improving productivity
  Will addressing all the points above mean time is saved and efficiencies can be delivered.

Figure 24: Fully Autonomous M1 Saloon car deployed in Milton Keynes

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To summarise the Milton Keynes Mobility strategy addresses the following transport challenges for

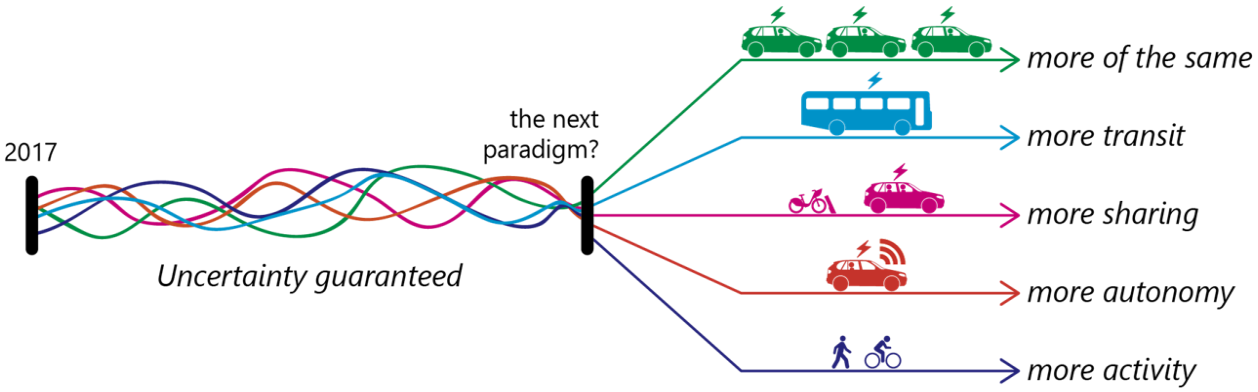
Transport challenges for Milton Keynes:

- MK potential to grow from 268,000 to c 400,000 people by 2050,
- Additional 31,000 homes beyond the forecasts in current plans, mostly at the outer areas of the city resulting in further traffic growth to access
- Growth is an expectation for Milton Keynes meaning the current 16% net inward commuting is likely to increase bringing further pressure on the transport system.
- Mobility to the city a high priority for businesses and local residents and visitors.
- Milton Keynes' ambition is to lead the way in transport innovation
- Reliable journey times for all modes of transport are needed for Milton Keynes to remain competitive.

City Ambition

To accommodate this growth in travel demand, the city needs to:

- Stabilise average journey times and ensure they remain competitive while promoting the development of smart shared sustainable mobility for all;
- Provide a fully integrated and accessible public transport system - "Mobility as a Service" (MaaS)
- Develop and promote a 'First Last Mile' culture for future technologies such as autonomous and connected vehicles and sustainable connectivity
- Ensure transport infrastructure is configured to enable the city's future development and growth in travel demand to be accommodated based on the council's 'First Last Mile' Strategy.



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4.3 Potential impact of automation in Milton Keynes

4.3.1 Vision and targets

Milton Keynes – Transport Vision

> *Like all cities Milton Keynes is a city in transition, a city faced by unprecedented change brought about by the pressures of rapid growth, environmental issues and accelerated advancements in IT and digital technologies, some are liking this to a third age revolution.*
>
> *At the heart of this is the need for a healthy liveable city that is resilient to climate change and where peoples' ability to move around the city is maximised; A city which moves towards low carbon solutions that deliver improved air quality, uncongested roads and a mobility network accessible to all.*
>
> *Advancements in transport technology, IT vehicle technology and innovative transport systems provide Milton Keynes the potential for a radical low carbon solution. Electric vehicles, connected and autonomous vehicles, the driverless cars and new service systems, whether demand responsive transport (DRT) systems or personalised rapid transit (PRT) systems will be appropriate for delivering sustainable travel in a suburban area like Milton Keynes?*

To deliver the vision the council proactively established a small professional staff unit (2015) within the authority to explore the potential opportunities of connected and autonomous vehicles. This team was set up in 2015, with the remit to:

- Work with industry and technology partners to develop and investigate potential innovative mobility solutions
- Create a testbed (Urban laboratory) within Milton Keynes to undertake live practical trials and demonstrations of new technology applied to city challenges.
- Engage with citizens and stakeholders to evaluate attitudes to the technology and seek input into future system design
- Set the scope of trials and demonstrations to report against council objectives.

Three aims were set for the explorations of the programme;

1. What were the potential operational benefits of the new mobility options?
2. What, if any was the business case?
3. What was the public attitude to the technology?

To illustrate this, the following project have been developed and deployed in the period 2015 to 2020 to respond to the above questions.

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Project	Element	Scope	Outcomes
LUTZ Pathfinder	Public Operation	To operate a SDV on shared public space	First UK trial of technology on open public areas Evaluated public response in small area Demonstrated the technology worked as planned
UK Autodrive	Headroom Study	To create a city scale microsimulation model to illustrate benefits (or not) of 100% of fully capable CAVS operating on city network	Suggested capacity could increase by 15% - 20%.
	LSATS Business Case	Undertook an economic business case to evaluate the potential mode share that could be achieved within a city centre environment with a fleet of SDV pods	Suggested that a viable business case could be delivered based on highly capable vehicle being deployed at scale.
	Scalability Study	Assessment of the development of technology at affordable prices, e.g. could the technology be deployed within vehicles that was comparable with existing tech solutions	Illustrated that cost and cost and capability of sensor pact would be viable within a relatively short period
	LSATs Trial	Deployment of vehicle fleet in public area mimicking	Tested public opinion and acceptance
	Public Attitude Study	To gauge local national and international public attitudes	Measured wide ranging public opinion and concluded that ‘views’ either way have not hardened
	M1 Trial	Various live demonstrations of connected and autonomous vehicles (level 4) on open roads	Confirmed technology works in public arena and no adverse response from other road users
SWARM	LSATS Trial	Advanced demonstration of ‘swarming’ pods	Illustrated further PODS acceptance and improved

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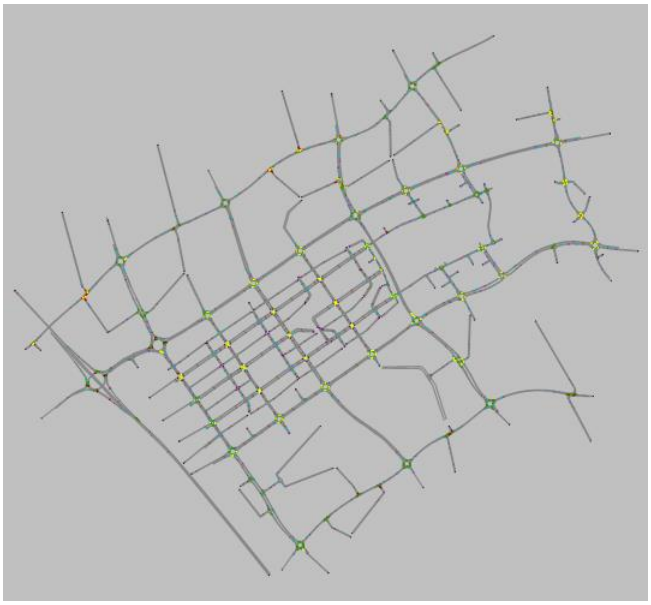
			technology to enhance business case
Starship Robots	Commercial trials	Small delivery autonomous delivery robots using shared footways as commercial delivery service	Illustrated strong public acceptance when valid use is demonstrated.
Human Drive	AV demonstration	Long distance demonstration of AV with research into human interaction with SDV	Should advanced use of technology on long journey using variety of roads.

4.3.2 Risks and uncertainties

4.3.3 Use case impact assessment and lessons learned

4.3.3.1 Use case 5: Waiting and drop-off areas for passengers

A very large microscopic model of The Central Milton Keynes area and its immediate surroundings was implemented in Vissim to investigate the effects of restricting access to the city centre for cars and instead provide vehicle intercept areas at the perimeter of the city centre for transfer to other modes.



Introduction of CAVs first significantly worsen and then significantly improve traffic performance

The cautious AVs in the introductory stage cause significant delay, likely at the many roundabouts of the city. On the other hand, in the prevalent stage advanced AVs significantly improve the traffic performance and decrease travel time even though they comply fully to the speed limits.

Introduction of pickup and drop-off areas reduce in-car travel time significantly

The introduction of high capacity pickup and drop-off areas at the perimeter of the city centre significantly reduces in-car travel time. However, part of the reduced travel time is replaced by travel between the origin/destination in the city centre and pickup and drop-of areas, which is not included in the model.

Car parks at the city perimeter increase in-car travel time due to their limited inflow capacity

If the pickup and drop-off areas are replaced by car parks the result is instead an increase in travel time and delay due to queue formation from the car park entrances. However, if it is possible to add a third lane on the links towards the car parks there are even larger positive effects than from the pickup and drop-off areas.

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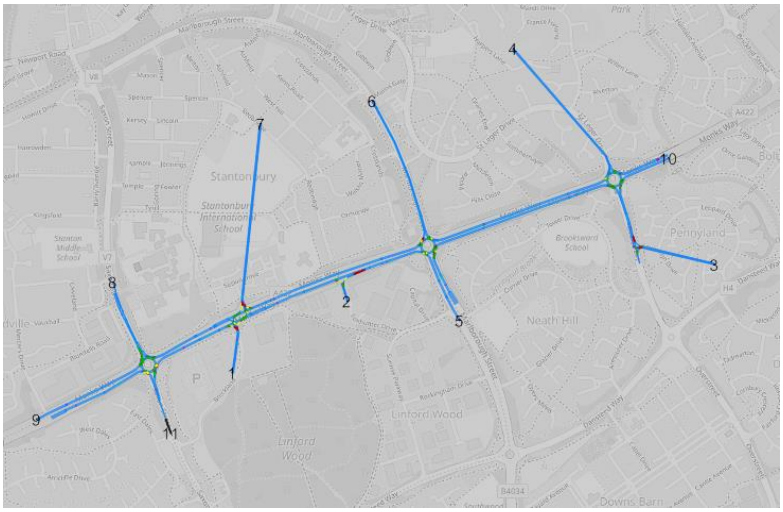
Design recommendations

Vehicle intercept locations at the city center perimeter can lead to significant traffic performance improvement, provided that their capacity is sufficient to handle the incoming traffic and that there exists a well-functioning transit system within the city center.

4.3.3.2 Use case 6: Roundabouts

A microscopic Vissim model of the H3 Monks Way outside of the Milton Keynes city centre was used to investigate the traffic performance impact of automated vehicles on an arterial with roundabouts.



Large increase in travel time and delay for the introductory stage

The cautious CAVs in the introductory stage have trouble entering roundabouts due to their large required gaps, leading to queue buildup behind them and large delays for both automated and conventional vehicles. For a future demand of 120% of todays the system seems to be close to breakdown in the introductory stage with very large delays. However, the traffic conditions improve as soon as the simple AVs are replaced by intermediate and there are large improvements as most of the traffic is advanced AVs.

Adding traffic control based on V2V communication at roundabouts amplify the effects

Implementing a specific V2V based control system for CAVs at roundabouts increases the effects; the traffic conditions deteriorate even more in the introductory stage with several hundred percent increase in delay, and the benefits in the established and prevalent stages are also amplified.

Adding a third lane would dramatically improve traffic performance if possible

If CAVs are able to drive much more precise than human drivers, it could be possible to reduce the lane width to two thirds of the present width and thus include three lanes in each direction. The simulations indicate that this would dramatically increase traffic performance, but it would require a fully automated vehicle fleet.

Design recommendations

The evaluated V2V-based control system should not be implemented until the CAVs present in the system is sufficiently advanced, corresponding to the established stage used in the evaluation. The city should continue to investigate further solutions to improve the capacity at roundabouts for cautious CAVs to be prepared if the CAV development and deployment result in a scenario similar to the introductory stage investigated in CoEXist.

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4.4 Stakeholder engagement: Automation-ready Forum in Milton Keynes

4.4.1 Objectives and scope of the event

One of the key guiding principles for the design and operation of the city has been the requirement for 'ease of movement' for all its citizens and visitors. This principle, seen as key to ensure continued social and economic development of the city. As the city continues to grow and pressure on its transport networks intensifies, the council has embarked on a detailed exploration of the use of Connected and Autonomous Vehicles (CAVs).

Throughout the trials and demonstrations, the council has prioritised working with its citizens to understand their needs, views and concerns. Without support from its citizens, particularly those who may feel most threatened or impacted by the new technology then its successful deployment runs the risk of being delayed or stopped. It is therefore the primary focus of the Milton Keynes approach to managing the introduction and transition to Self-Driving Vehicles (SDV) within the city is to understand and respond to all citizen's issues.

Figure 25: Autonomous robot in operation in sub urban Milton Keynes

Three events were undertaken, using two different formats designed to maximise meaningful engagement and interaction with the two very different target audiences.

Event 1 – November 2018 and March 2019 Older Peoples Forum

With support from Milton Keynes Community Action team, a series of discussion was held with a mixed group of 32 elderly and disabled Milton Keynes citizens. Of these, 9 were affiliated to groups representing disability issues such as the local Centre for Integrated Living, RNIB, Bucks Vision, Hard of Hearing Support Group, Disability Advisory Group and Senior Voice at Age UK. Their mobility issues included things like strokes, asthma, visual impairment, hearing impairment, Parkinson's, Cerebral Palsy and amputees. Twenty of those people, including 2 representatives from RDM / Aurrigo, then attended a storytelling workshop to develop their response to the demonstrations. The workshop focused on developing a narrative based on a 'quest' which sought to unpick people's feelings, before, during and after their trial journey.

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Figure 26: Passenger Pod being assessed by Guide dos for the blind association

The format of the sessions was

1. An introduction to the technology, its capability, its deployment in Milton Keynes, and how and why the city was considering the technology. This presentation and discussion were led by Milton Keynes council's co-exist lead and support staff.
2. The group then met with a professional facilitator who was able to engage in a non- technical way to understand the 'feelings' of the group after the information was given. There was no presence from MKC or technologists at this session
3. The group was then introduced to an actual SDV (a POD operating in MK) Supported by the POD operators all the group were given a demonstration and ride in a SDV. They were accompanied by the facilitator, who then led a discussion about the experience, capturing the feedback in a series of 'stories' using the 'words' of the participants.
4. A follow up session was held with MKC/ Co-Exist representatives to hear views and discuss recommendation that emerged from the group.
5. A standalone report was produced by Community Action MK on the event and its findings.

Figure 27: Pod being trialled by older group representative

Event 2 - June 2019 – Schools' forum

As part of MKC engagement programme with schools in Milton Keynes a session was arranged with around 250 school children drawn from secondary schools in the area. The students, aged between

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14 – 16 were brought together to hear about developments in mobility which could be adopted within Milton Keynes. Most were aware of the SDV demonstration being undertaken in the city.

Following the introduction, a group of around 30 students were asked to participate in a specific session.

1. The selected students were asked at the start of the session to complete a short survey about their views on SDV. The survey form is attached as an appendix. At this point the students had not received any other information about SDV
2. Following completion of the survey, a short presentation was given on the potential benefits and challenges of SDV. Further information was then given via the information boards (included in annex).
3. Following the information sharing session, a facilitated discussion was held for around 30 mins, views being recorded, and questions answered.
4. Finally, the survey was repeated in order to establish if views following the information sharing and discussion had changed.

Results of this are presented later in this report

Event 3 September 2019 – MK Youth Parliament

Figure 281: Milton Keynes Youth Parliament

Milton Keynes has established a youth parliament. This parliament is elected every 2 years by young people across the Milton Keynes area. Election is open to 11 – 18 year olds. The parliament is made up of 36 members.

As representatives of the wider young community, this group was approached to participate in a forum to discuss SDV. The session held was undertaken in the same way as the schools' event. The group tended to include slightly older young people, approaching the age when independent mobility is a greater issue, and to some a challenge.

The results from this session are included in the results section and are compared to the results from the parallel session with the schools' event.

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4.4.2 Analysis and lessons learned

Survey Approach

Two very different approaches were taken to engage with what in essence were two distinct groups of people. It is not uncommon for public authorities to tailor its approach to maximise meaningful input into consultation. Cities perhaps need to think about how they approach its communities and develop appropriate engagement strategies that facilitate meaningful input which provides the insights required and also give confidence to the stakeholder that views are being considered seriously.

The approach also wanted to ensure that the audience didn't feel as if 'minds were made up' and that the sessions tried to give a balance of views on SDV. This worked very well with the engagement with the older group, with an independent facilitator managing the engagement/events, and there was a good mix of discussions and activity that included input from experts and separate sessions where there was no outside involvement from people associated with the technology. This developed a level of trust and the ability of the participants to express their views without any 'pressure' from external experts.

To a similar degree, the engagement with the younger groups were managed in a way that a balanced (non-biased) approach was taken designed to share and receive information. At no point in the discussions did it become evident that one view prevailed over another. In a sense this reinforced view from the major surveys undertaken in the UK Autodrive project that minds were yet to be made up and that this gave the opportunity for the promoters of the new technology to understand the positive and negative aspect that were expressed and respond to this, so that the technology could be developed to respond to stakeholder needs.

In terms of a survey approach it can be concluded that it worked in terms of securing views of the groups and this was achieved by two different approaches

Results

The outputs of the events are illustrated and discussed in the previous section.

When comparing these outputs with other work and engagement, in particular the UK Autodrive project and indeed several other surveys from the US and far-east, the feeling is that there is a level of consistency in views developing, namely

The technology is found to be perhaps exciting and threatening in equal measures, but these views are limited to around 25% of respondents (polarised)

For the majority, minds have not been made up.

For the target groups in this research, there seems to be a slightly more positive outlook for the technology, and with some information, delivered in a non-biased structured way, can lead to slightly greater positive opinion being formed.

The groups chosen as part of this project have been seen by some commentators as 'a threat' to the development of the technologies, without meeting the needs of older and younger generations,

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the technology may be delayed or engineered in such a way that it is less effective and not realise some of the benefit around increasing mobility opportunities for all.

Conclusions.

The engagement programme and events have achieved the following

- Without a comprehensive understanding of the needs and views of all local stakeholders it will be more difficult for local and national decision makers to embrace new technology that is fundamentally disruptive to current transport system and may indeed have short term negative impact until the technology matures.
- That bespoke methods can be adopted to engage with key stakeholder groups, and by using effective communication techniques, meaningful outputs can be achieved.
- Combining efforts with other studies and works in the area of interest can bring efficiencies and broaden knowledge.

It is up to the local area to determine the areas of interest and design specific engagement activities to meet the needs of the local area or specific outputs.

4.5 Roadmap towards Automation-readiness in Milton Keynes

4.5.1 Self-assessment of current situation

4.5.1.1 Policy

Milton Keynes has developed a new mobility strategy where CAVS are placed at the forefront of the plan. The policy has developed through a relatively long period of engagement with the technology, an appreciation of its potential and support from a wide range of stakeholder. The council has developed a roadmap to support its ambitions, illustrating what and when the technology will be available.

The council, in its strategic overarching ‘council plan’ actively track progress of key projects and initiative, and within the new plan for MK future 2050, a specific programme has been identified to deliver Smart Shared, Sustainable Mobility with CAV included as a priority. To deliver this, MKC has developed a high level ‘roadmap’ to take an initial view on how the future of mobility may unfold. The key recognition is that we are in a time of great uncertainty on what will develop, and it is the role of this report and work within CoEXist to remove some of this uncertainty.

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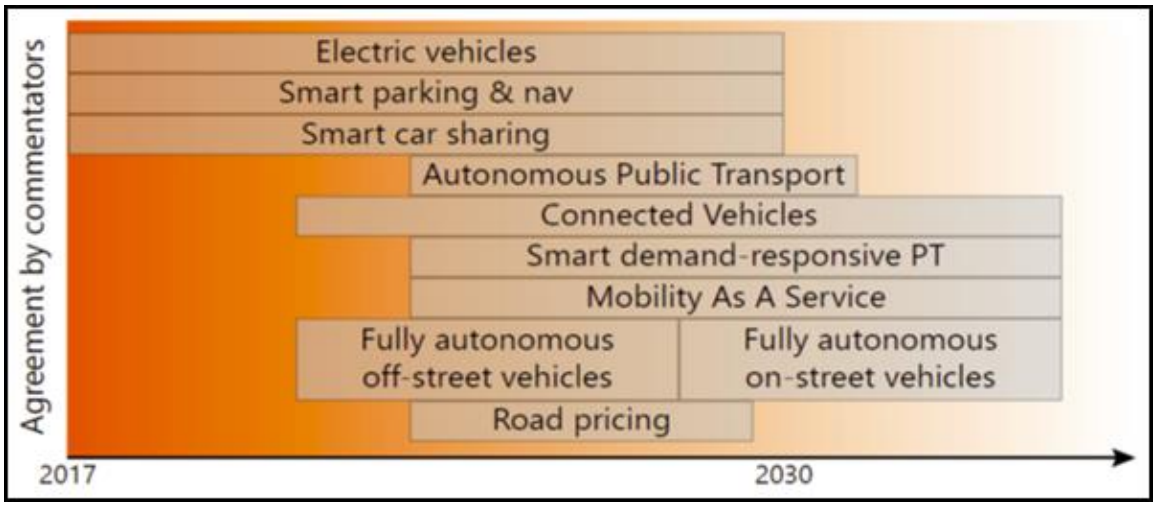

Figure 29: MK – Roadmap to future mobility?

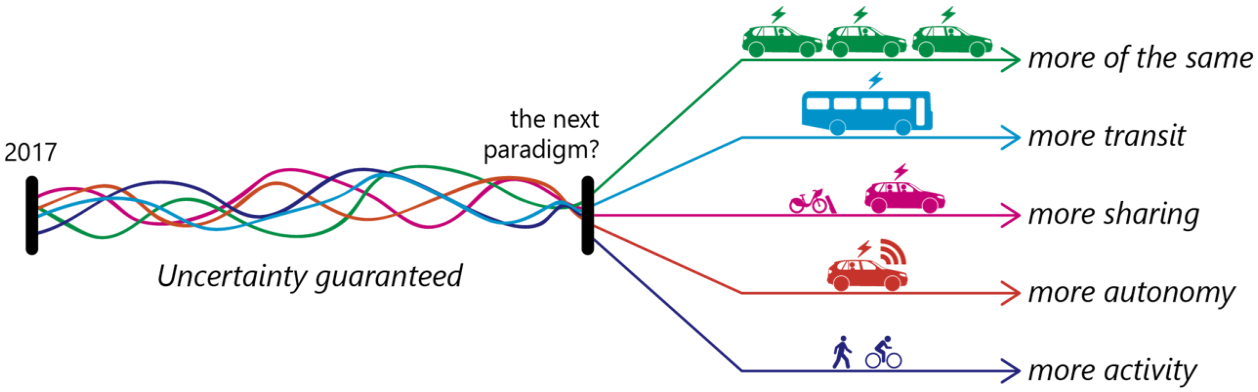

Figure 30: Roadmap Required Outcomes

4.5.1.2 Infrastructure

In specific areas the council has started to develop and deploy infrastructure to support and accelerate CAVS. The council has an investment ongoing to deliver city wide 5G infrastructure and use this with specific use cases to support CAV operation. It is also deploying city scale sensor deployments to support connected vehicle and working with a number of OEM and technology companies exploit connected vehicle outputs to manage the city's operations.

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Figure 31: Local Infrastructure

4.5.1.3 Planning

Significant and targeted work has been undertaken by the council, working with its residents and stakeholders – this is discussed earlier in the report and covered in great detail the supporting report (AV Ready Forum). Supporting work as part of a wider research programme has also looked at issues around highway capacity through a full scale MK wide simulation model and a number of business cases looking at commercial operations of SDV pod fleets, the economics of technology development and security issues, As part of the UK Autodrive project the council with its partners published a series of 'white papers' – position statement on a range of topics relevant to the planning for CAVs. These included topic areas around, Data, Security, Moral issues and infrastructure. These papers can be found at www.ukautodrive.com

Figure 32: Cooperation between OEM in action – Fleet deployed in MK (2016- 2018)

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4.5.1.4 Capacity Building

Limited progress has been made in this area, capacity is limited to a small number of individuals and Milton Keynes is not unique with this issue, in fact it is believed that capacity across most local authorities is not consistent and Milton Keynes may be among just a few authorities that has some capacity.

4.5.1.5 Traffic Management

Milton Keynes has engaged and collaborated with several OEM on a range of CAV related projects and is actively developing and delivering new traffic management capabilities to respond and support CAV operations, A council owned and operated 5G network will be a new capability which will be opened up as a test bed for OEM and tech companies to developed and launch new mobility capabilities – the infrastructure includes a new data exchange linked to the 5G and city wide fibre network. The data exchanged linked to sensors and in future connected vehicle will form a new urban traffic management system for the city.

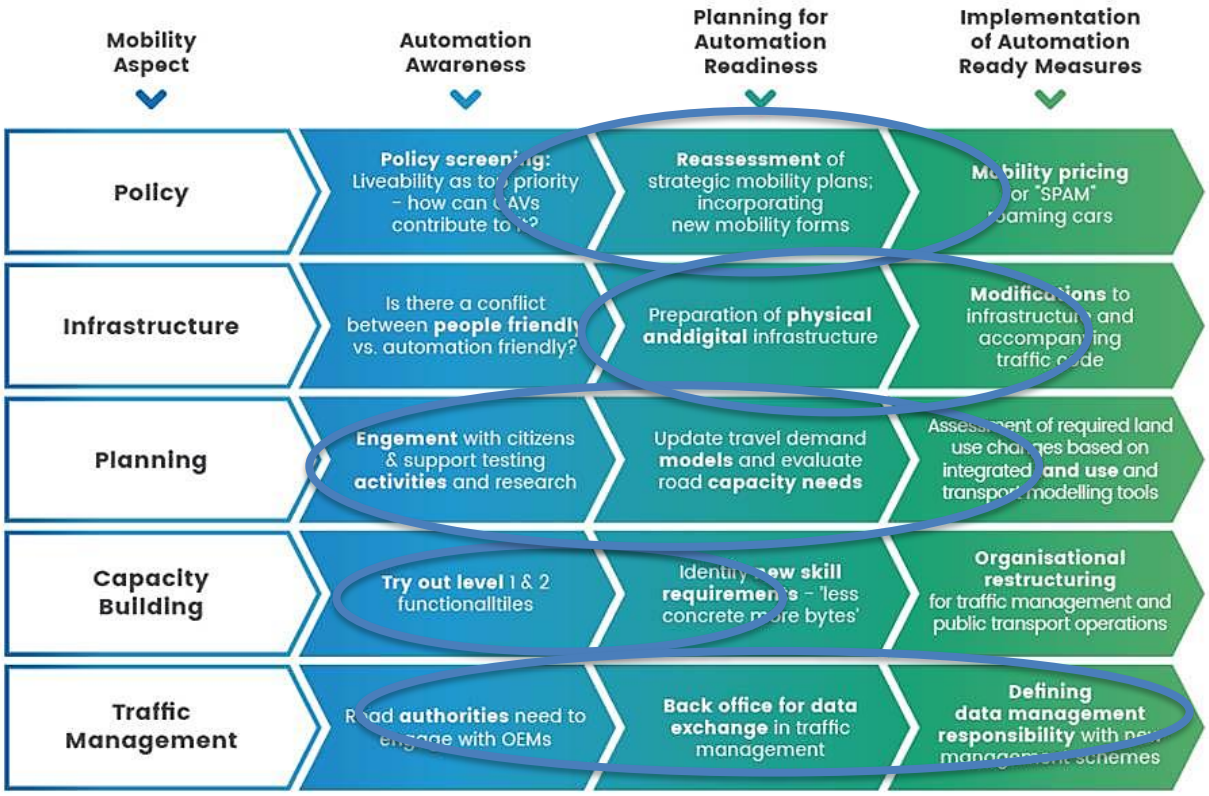

Figure 33: Self-assessment of automation-readiness in Milton Keynes

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4.5.2 Automation awareness creation

Measure	Description of Measure	Responsibility	Relation to AV-ready vision	Time of implementation	Funding Source
Creation of city use cases (create visibility of real technology applied in city)	Demonstration projects Set operating parameter to address city mobility Objective	City Authority	Regulatory Challenges Social Challenges	1 - 5	Joint venture between business and government
Develop Policy / strategic framework	Refresh of SUMP to consider role of CCAM	City Authority	Social Challenges Regulatory Challenges	On=going, but start immediate	City Authority
Training	Develop wider awareness for all levels involved in decision making and planning	City Authority, national Government Academia	Regulatory Challenges, Social Challenges	Immediate and on going	City Authority

4.5.3 Planning automation-readiness

Measure	Description of Measure	Responsibility	Relation to AV-ready vision	Time of implementation	Funding Source
Research programme	Undertake research of technology and how it can be applied in city	City Authority, Research bodies	Regulatory, social Business Challenges	Immediate and on going	Government/ Industry

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4.5.4 Automation-ready measure implementation

Measure	Description of Measure	Responsibility	Relation to AV-ready vision	Time of implementation	Funding Source
Name the measure	Brief description of the measure	Entity / stakeholder responsible (e.g., City administration, road owner)	Addressed objective	Potential timeline: e.g., Year 1-3	If possible and applicable
Transport modelling tool	Creation of assessment tool design to address local questions	City	Transport system, Business Challenge Challenges	Immediate with regular reviews	City/ developers
Traffic Control systems	Introduce/ upgrade traffic control system to enable connected vehicle operation	City	Transport System	3-5 yrs	City, national road authority
Communication system	Linked to traffic control – upgrade comms network to connect to vehicles/ public transport	City, mobile network operators	Transport System	3-5 yrs	City, Business
IoT/Data	Establish data management system - required to assist in comprehensive management of CCAM	City/private sector	Transport System	1- 5yrs	City Business
Creation of CCAM operating zones	Create specific controlled areas to operate cautious CCAM	City/ private areas	Transport Challenges, regulatory	1- 5	City Business

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4.6 Conclusions and outlook

Milton Keynes has been very proactive in developing the United Kingdom's thinking around CCAM, certainly in the early stages of developing the UKs roadmap towards testing of CAVs on open roads. Part of this is down to the innovative culture found within the city authority and part down to the local industrial, business and academic landscape Milton Keynes is the host city for the Transport System Catapult - The national transport innovation centre and within striking distance of leading academic institutions (Oxford, Cambridge, Cranfield and Warwick Universities). Automotive has a strong local heritage - Aston Martin, Red Bull, Nissan and Honda with bases in MK, Millbrook proving ground and Silverstone nearby and links to major OEMS such as Jaguar Land Rover and Ford.

However, whilst the above is an important factor in Milton Keynes being at the forefront of early CAV testing and development, a significant part has also been the city's setting out of clear objectives for the deployment of trials. And this is important for any city looking to deploy CCAM. The technology will only be successful if it supports achieving established mobility/business objectives – the technology needs to be a solution to a problem, not a solution looking for a problem.

Delivering against a clear objective makes public acceptance more straightforward. Even if trials do not work, criticism can be deflected if the efforts are designed in collaboration with local stakeholders to improve things. Milton Keynes learned this with its deployment of passenger pods. They were designed to address a city centre challenge of a last mile problem, A broad understanding and acceptance of the value of this deflected potential criticism, particularly around them taking valuable space from other pavement users. Unfortunately, at the time of the trials the technology was in its infancy meaning the capability was insufficient to deliver a viable service. But this has led to two important findings. Firstly, a clearer understanding of the barriers to operation from the technology – greater emphasis is needed on vehicle to infrastructure to support eservices and secondly the usefulness to mobility impaired users was found to be greater than anticipated - so support for the service returning in the near future is higher

The trials in MK has be crucial in developing out readiness for CCAM. Our current mobility strategy = which includes significant roles for CCAM, was developed after trials and tests. Local people, politicians and professionals were able to see and use the vehicles and be part of the testing. This made the technology real – not theoretical. The importance of seeing and experiencing the services offered should not be underestimated, and whilst there are unlikely to be trials and services in every city for some time there are now sufficient demonstrations in most EU countries which would allow those most interested in preparing for the technology to experience it first hand – it's surprising how users 'accept' the technology after only a few experiences.

So whilst it is recognised that much of the initial hype around the technology has died down – CAVS will not be ubiquitous by 2021 as commentators suggested in 2018 - , the current outlook is that the technology is coming, albeit slower and in phases, and without preparedness for it, cities run the risk of have technology solution imposed on these areas unless cities start to prepare.

Looking very much at these trials to help answer important questions about the practicality and usefulness in the technology supporting the council's mobility objectives.

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5 Automation-ready Action Plan – Stuttgart

5.1 Introduction

5.1.1 Goal of the Action Plan

Worldwide, vehicle-technical, infrastructural, legal and ethical framework conditions for automated driving are being promoted or tested. Even though semi-automated functions such as automatic braking, parking assistants, longitudinal and lateral control or variable speed control have already become standards and are available for many new vehicles, it will still take several years or even decades before highly or fully automated driving (SAE (J3016) levels 4 and 5) will be established in the market.

At present, there are still many questions about “how" CCAM services will be deployed. Nevertheless, it is expected that the market introduction of automated driving will take place gradually, and highly and fully automated vehicles will find their way into the city.

The State Capital Stuttgart shares the position of the German Association of Cities, which states that: “The automated/autonomous or networked driving will noticeably change urban traffic in the medium and long term. The course for automated/autonomous driving is already being set today. Here, active participation by the local authorities is important in order to exploit the opportunities of this technology and minimise the risks"[9].

5.1.2 Scope and target audience

Approximately 2.7 million people live and work in the Stuttgart region, which is Germany's largest exporting metropolis and the No. 1 high tech region in Europe. The capital city of the State of Baden-Württemberg is not only geographically the central region of the state. It also represents the economic, political and cultural hub of Baden-Württemberg and is the headquarters of global players such as Daimler, Bosch, Porsche, Kärcher, but also of numerous hidden champions and small and medium sized enterprises, which play an important role on the world market. The tight and dynamic interaction of the education facilities, research institutions, science and manufacturing sectors make Stuttgart one of the most innovative and dynamic regions in the world. High quality transport systems and intelligent traffic management are therefore existential key factors for the prosperity of the Stuttgart Region.

In this context for the State Capital Stuttgart it is important from various perspectives to deal with automated driving in a timely and strategic manner and to take an active role.

During the CoEXist project and before the City of Stuttgart and its various municipal departments worked on several aspects and projects related to CCAM. After it became clear that the process of market introduction is fraught with many uncertainties, the action plan focuses on the strategy on how the administration accompanies this ongoing process.

[9] Deutscher Städtetag (2018): Nachhaltige Mobilität für alle, Positionspapier

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The following municipal departments and institutions are primarily affected by or are part of the action plan to prepare automation-readiness:

- Department for strategic planning and sustainable mobility,
- Department for public engineering - road construction authority (incl. road construction and infrastructure for traffic management),
- Department for public affairs - road traffic authority (incl. traffic management strategy and operations and traffic regulations),
- Department for urban planning – transport planning,
- Department for business development,
- Public transport authority (SSB).

Furthermore, it should be noted that the process of achieving automation-readiness concerns far-reaching issues of a municipal administration and numerous competencies have to be involved.

5.2 Transport policy and planning context in Stuttgart

5.2.1 Legal and normative framework

The legal basis for automated driving in Germany can be found in the Vienna Convention on Road Traffic (WÜ) and in the Road Traffic Act (StVG) of the Federal Republic of Germany.

The different degrees of automation of driving must be considered in a differentiated way. The levels 1 and 2, e.g. assisted and semi-automated driving, were already permitted in the past, as these levels require - in accordance with legal framework - a driver to be present to drive and control the vehicle.

Levels 3 and 4 initially have not been legally possible in Germany. However, due to progressive technical developments, the Vienna Convention on Road Traffic (WÜ) was amended in 2016 and then the Road Traffic Act (StVG) was adapted in 2017. Since this time, it has also been possible in Germany, under certain technical conditions defined in § 1 StVG, to operate highly and fully automated. These conditions include:

- The vehicle function shall be used as intended.
- The vehicle must be capable of performing the driving task, including longitudinal and lateral guidance.
- The technical equipment of the vehicle must comply with the applicable traffic regulations.
- The automated vehicle function shall be manually overridable and deactivatable by the driver.
- The vehicle must be able to recognise when manual control by the driver is required and indicate this visually, acoustically, tactilely or otherwise with sufficient time reserve.
- The vehicle must inform the driver if it is used contrary to the system description.

Fully autonomous driving according to level 5 is currently not yet permitted.

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When implementing fully automatic driving (level 5), the Passenger Transport Act (PBefG) in the field of public transport must be taken into account. The PBefG regulates basic principles and contains requirements in relation to the operating concept of transport companies; it is the legal basis for the approval of transport services in passenger traffic.

In praxis, the range of passenger transport services has already exceeded the types of transport covered by the PBefG. For upcoming transportation services providers (ride-hailing or ride-pooling) characteristics and rules need to be adapted and clarified in the legal framework, e.g. for flexible modes of public transport, commercial app driving services and platform operators. The coalition agreement of the 19th legislative period of the German Bundestag contains the goal of creating a legal basis for new digital mobility offers. An amendment to the PBefG is discussed.

5.2.2 Policy goals and planning context

The goals and strategies for a sustainable mobility are reflected in specific overall frameworks adopted by the Stuttgart City council. Strategies and measures related to automated driving are highlighted for the following planning frameworks:

Urban Transport Development Concept 2030 (VEK 2030), 2014

The VEK 2030 represents a framework for action on transportation planning until the target horizon 2030. The VEK 2030 takes into account all modes of transport and the main transport policy instruments. Standards for infrastructure are set and aspects are addresses such as road safety, mobility management and traffic management.

The VEK is based on the specifications of various superior plans or legal requirements and elaborates these in detail. With regard to the further development of the State Capital of Stuttgart, the following plans and objectives are directly related to the VEK: regional transport plan, local transport plan, land use plan, clean air and noise action plan, climate protection concept, urban development plan.

Policy goals of future mobility in the 21st century have to be sustainable, especially in view of the need to protect the environment and climate. The goal of reducing the number of cars with polluting engines in the Stuttgart basin by 20% takes this important issue into account. At the same time, it must be ensured that mobility is flexible, resilient, available and affordable for passenger and commercial transport. The intensification of the "city of short distances", which is already being pursued by interior development, is an important component in supporting sustainable mobility.

Guiding principles for all modes of transport adopted by the Stuttgart City Council are:

- Stabilising traffic flow - making car mobility environmentally friendly
- Organising commercial traffic city-compatible
- Expansion of local public transport - increasing attractiveness
- Strengthening cycling - increase its share
- Promoting pedestrians - improving routes and connections

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Action Plan Sustainable Mobility in Stuttgart (2014, 1st update 2017)

The VEK 2030 represents the static part of a mobility plan (with its long-term goals); while the Action Plan can be considered the dynamic part (updated every two years, including concrete measures) (see Figure 16). The VEK 2030 covers together with the "Action Plan Sustainable Mobility in Stuttgart" all elements of a Sustainable Urban Mobility Plan.

Figure 34: Structure of the SUMP Stuttgart (Civitas I 2MOVE2)

The Action Plan is divided into nine fields of action with assigned measures: intermodality and networking, public transport, peak-hour traffic, urban mobility, mobility in the region, motorised individual transport, non-motorised traffic (foot and bicycle traffic), commercial transport, public relations, other measures.

The State Capital Stuttgart gradually implements the innovative projects and measures listed in the action plan and continues to regularly update this action plan in the interests of sustainable mobility. The topic of automation-readiness is related to following measures, which are addressed in the Action Plan:

- Expansion of the traffic monitoring and control for ensuring the efficiency of the road network
- Strengthening data processing and impact analysis in the Integrated Traffic Control Centre (IVLZ)

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- Expansion of traffic control and guidance systems
- Expansion of a road works and incident management system
- Acceleration and stabilisation of public transport for shorter travel times and higher punctuality (e.g. expansion and optimisation of public transport priority at intersections, expansion of the SSB operations control centre and the IVLZ)
- Expansion of traffic information and guidance for optimized route planning for commercial traffic (traffic situation, travel times, road works information)
- Expansion of traffic information for the public

Green City Masterplan Stuttgart (GCP, 2018)

With the Green City Masterplan (GCP), the City of Stuttgart is pursuing the successful approaches of traffic planning and traffic and mobility management for air pollution control. GCP forms an important basis for the implementation of short, medium and long-term measures. It describes the strategies and projects that the City is pursuing to reduce nitrogen dioxide pollution and includes a broad catalogue of measures. The focal points of the GCP include the areas of digitisation, stabilisation of traffic flow, networking of mobility offers and mobility services, strengthening public transport, promotion of walking and cycling, electrification and urban logistics.

Of the various sets of measures, the following in particular are related to autonomous driving:

- Environmentally sensitive traffic management (traffic data collection, management of traffic and environment data, online monitoring and calculation of emission data, strategic traffic management network, real time travel data, digital traffic map, key performance indicators, incident management for public transport control system, traffic information and control system (VIZ), cooperating systems for traffic management, mobility data marketplace, car2x communication, traffic management system, linking of urban traffic control systems with routing and navigation manufacturers, virtual signs)
- Traffic flow optimisation (traffic flow optimisation on the basis of emission critical traffic conditions)
- Increasing attractiveness in public transport (Automation / Digital assistance systems for buses / minibuses, digital assistance systems light rail and automation light rail operation, Pilot project automated bus depot (DiaMANT))

Transport Development Plan (NVEP), 2018

The Transport Development Plan (NVEP) summarises measures for the planning of public transport that still require a (political) discussion when setting priorities or financing. This means that the NVEP can also present and deal with planning approaches or tariff targets which go far beyond the planning horizon of 5 years or when costs have not yet been conclusively determined. In addition, the NVEP also allows the presentation of topics that are closely related to public transport but are not directly relevant to the awarding of transport services.

Since the NVEP deals with perspective developments on a conceptual level, automated driving is seen as the starting point: "*However, it is already clear today that this technology can also have a strong impact on local public transport, especially bus transport. Since driverless vehicles are*

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cheaper to produce, it is likely that smaller vehicles will increasingly be used in public bus transport. This should make it possible to improve the development of peripheral residential areas or special topographical situations where long or steep access routes to bus stops are currently required. Scheduled services in the classical sense will then tend to concentrate on routes that are in high demand and which cannot be sensibly served by small vehicles. Even if the implementation of such options cannot yet be fixed in terms of time, it seems sensible to take this perspective into account already today when formulating development goals."

5.3 Potential impact of automation in Stuttgart

5.3.1 Vision and targets

The municipal units of the State Capital Stuttgart as well as companies such as SSB AG are already confronted with the developments and issues of automated driving in their planning and work processes. Questions and possibilities are accompanied, tested or implemented constructively but critically at the same time. This "learning strategy" makes it possible to gather experience step by step, to identify ground-breaking decisions and thus, as a city, to actively and knowingly accompany this change and - whenever possible - to shape it as a representative of urban society and in the interest of the science and business location.

Central questions and guiding principles towards automation-readiness are:

- There is a need for a discussion and orientation of the City on how automated driving is compatible with urban and social structures. Central questions are how automated driving can and should affect public space, existing and future modes of transport and forms of mobility and thus the mobility behaviour of the urban community and society in the metropolitan region.

- As a business and science location, the City and the Region have a special interest in supporting the resident institutions and companies in their economic sustainability. Cooperation makes it possible to test specific developments and generates answers to questions. The cooperation partners will be strengthened in order to shape the developments of automated driving in a target-oriented manner and with a common understanding.

- The State Capital Stuttgart is interested in exploring and using the advantages of automated driving. Therefore, it is appropriate to test technologies in the sense of a sustainable public transport system at SSB for example. Their use is also worth testing in other areas where vehicle technologies can be used to efficiently fulfil municipal tasks and achieve municipal transport policy goals.

- The modern expansion of data and transport infrastructures as well as traffic management strategies is an essential basis for the future viability of the State Capital Stuttgart. In addition, the existing infrastructures and tools are subject to a continuous renewal process.

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In terms of efficient infrastructure and tool management, the respective existing technological possibilities are evaluated and decisions on their implementation as a Stuttgart standard are understood as a permanent process.

5.3.2 Chances, risks and uncertainties

The following assessment of chances, risks and uncertainties is based on the knowledge gained during the CoEXist project.

In addition, the chances, risks and uncertainties are commented in terms of their temporal relevance (in terms of awareness, planning and implementation) and on action needed by the City of Stuttgart.

5.3.2.1 Road safety

A large proportion of road accidents are due to human error. Already today, assistance systems contribute to increasing road safety. In addition to the in-vehicle safety-enhancing systems in the vehicles, the networking of the vehicle fleet associated with automated driving will also have positive effects on road safety. In this way, danger spots can be registered quickly and furthermore e.g. accesses for emergency services can be improved.

Road safety			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures ✓
Actions by the City of Stuttgart	Authorities may issue statements within the framework of the legislative procedure.		

5.3.2.2 Traffic volume / Modal Split

The interdependencies between automated driving and the development of traffic volumes are complex.

The degree of automation will lead to increased comfort when driving. Travel time could be used for other activities. The perception of travel time will change and might shift to car.

Fully automated vehicles would also reach new target groups (e.g. children, the visually impaired), who were previously dependent on other forms of mobility or their use.

The impacts might take place at the expense of the existing environmentally-friendly transport modes - i.e. public transport, cycling and pedestrian traffic. Further impacts, especial re-suburbanisation, would be misguided consequences and are the subject of various studies.

Depending on the degree of car ownership, the framework conditions for passenger and logistics transport services and the availability of parking spaces, empty runs may occur.

Whether passenger transport services can lead to a reduction in the number of vehicles and vehicle kilometres required is currently being investigated in studies. The idea of always available and cheap, autonomous on-demand services as hailing or pooling systems is especially

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promoted by automotive and IT providers. Based on studies, there are doubts whether these systems will lead to a reduction in car use without a regulatory framework (see chapter 5.3.2.6).

The future volume of vehicles and vehicle kilometres in goods transport will also depend on various framework conditions. These are not yet specified (see chapter 5.3.2.7).

Traffic volume / modal split			
Timeline	Automation Awareness ✓	Planning for Automation Readiness -	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	Pilot projects and studies to be initiated and accompanied. Municipal experts participate in expert committees and prepare statements. In the CoEXist project, this question was investigated within the Stuttgart use case 7 (see chapter 5.3.3).		

5.3.2.3 Traffic flow / capacities

Some studies assume that the introduction of automated vehicles will lead to an optimised traffic flow and thus to an increase in capacity. These studies are usually based on observations of out-of-town situations. Interactions typical for urban conditions, e.g. with pedestrians and cyclists, are not considered.

Whether automated driving in urban areas actually leads to an increase in capacity depends on spatial separation of automated and non-automated vehicles / transport modes and on minimum safety distances to be respected.

Traffic flow / capacities			
Timeline	Automation Awareness ✓	Planning for Automation Readiness -	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	Pilot projects and studies to be initiated and accompanied. Municipal experts participate in expert committees and prepare statements. In the CoEXist project, this question was investigated within the Stuttgart use case 7 (see chapter 5.3.3).		

5.3.2.4 Travel demand management

Parking management strategies are appropriate to regulate traffic circulation. Parking fees in public spaces as well as in private parking garages and underground car parks are used to control travel demand and parking behaviour. The possibility of privileging residents, which is anchored in the road traffic regulations, influences the influx of commuters.

With the implementation of fully automated driving, these instruments are no longer effective, as independence from parking space is achieved. Other planning, monetary or regulatory instruments would have to be discussed. If necessary, the legal framework conditions would have to be created for this.

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Traffic flow regulation			
Timeline	Automation Awareness ✓	Planning for Automation Readiness -	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	At present, awareness of this possible effect should be raised e.g. in expert committees. Studies to be initiated and accompanied.		

5.3.2.5 Public space/road design

5.3.2.5.1 Parking space

Discussions indicate that future automated transportation services could lead to a reduction in the number of vehicles required and thus to a reduction of needed parking space. This vision is closely related to the level of car ownership and the availability and accessibility of parking spaces.

Transportation and logistic services (see chapter 5.3.2.7) as well as private autonomous vehicles also require transfer, boarding and alighting zones, which must be taken into account.

In the future, the planning principles for the design of public space and of mobility / connection hubs may change with the availability of automated vehicles and transportation and logistic services. Appropriate approaches must be thought of in advance, but will be developed and tested successively as the market becomes established and will ultimately change the cityscape. With this process, mission statements, strategies and plans need to be developed in a goal-oriented manner.

5.3.2.5.2 Road design

Based on the assumption that capacity increases will be achieved on roads with undisturbed carriageways, a consistent and structural separation of transport modes on inner-city main roads could be discussed. Such demands would hardly be compatible with the current municipal efforts for a liveable city design.

Public space/road design			
Timeline	Automation Awareness ✓	Planning for Automation Readiness -	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	At present, awareness of this possible effect should be raised e.g. in expert committees.		

5.3.2.6 Public Transport

For public transport, the opportunities and risks of automated driving have to be evaluated in a differentiated way.

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In conurbations such as the State Capital Stuttgart, the means of transport of the environmental alliance (public transport, walking, cycling) have been consistently promoted in recent decades. The aim is to offer society a wide range of services for independent and self-determined mobility.

On the one hand, automated driving offers the opportunity to reduce the operating costs of classic public transport line operation. Especially in times and areas of low demand, an efficient public transport service could thus be made possible.

On the other hand, automated driving can jeopardize public transport services and taxi industry. The critical factors are:

- Change in the modal split in favour of car transport as a result of the increasing attractiveness of automated driving (see chapter 5.3.2.2).
- Falling demand and rising per-capita costs in regulated public transport (scheduled and taxi services) due to inadequate protection against transportation services companies operated under market economy conditions.

The revision of the Passenger Transport Act (PBefG) plays a central role in this context, as it sets the requirements for public service providers to fulfil their responsibility to provide services of general interest and to ensure that public transport is demand-oriented, environmentally - and socially compatible and cost-efficient. The municipal departments of the City of Stuttgart and the SSB are accompanying the revision of the PBefG within the framework of the committee work e.g. at the German Association of Cities and the Association of German Transport Companies (VDV).

Public Transport			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	Pilot projects and studies to be initiated and accompanied. Municipal experts participate in expert committees and prepare statements. In the CoEXist project, this question was investigated within the Stuttgart use case 8 (see chapter 5.3.3).		

5.3.2.7 City logistics / last mile delivery

Automated driving can mean immanent changes for the transport of goods. All modes of transport are affected: rail, road but also water and air.

In urban road traffic, the technical possibilities of autonomous driving are already used successfully today to improve traffic safety.

The technology of platooning will be of minor importance in the local road network.

In particular, the possibilities of automation will be of great importance for increasing the efficiency of city logistics. The possibilities of reorganizing production processes are expected to

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lead to considerable cost reductions. In connection with e-mobility, solutions are seen for the delivery of the last mile in urban areas. The potential is seen for shifting urban goods delivery traffic to less congested periods or in currently restricted areas (e.g. pedestrian zone). With low-noise technologies, transport could even be shifted into the night.

Several key technologies are currently being developed and tested: autonomous delivery vehicles, drones, robotics. Key development steps will be: full automation for unattended delivery, automatic park pilots, delivery right to customer (front door), mobile pick-up stations and courier vehicles. In addition to technological development, the level of networking and cooperation between logistics companies will be decisive in urban conurbations.

The impact of automated driving on urban delivery and thus on traffic volume will depend strongly on economic decisions and regulatory and planning framework conditions. The City of Stuttgart is therefore initiating and participating in various projects, e.g. to test logistics hubs or to collect data.

City logistics / last mile delivery			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	Pilot projects and studies to be initiated and accompanied. Municipal experts participate in expert committees and prepare statements.		

5.3.2.8 Road infrastructure / C-ITS

At present, field trials for automated driving are being conducted worldwide as well as in the Federal Republic of Germany at various locations and in various collaborations. The nature and content of the technical requirements for communication between vehicle and infrastructure are assessed very differently.

Co-operative Intelligent Transport Systems (C-ITS) enable the exchange of information between vehicles and the road. The expansion of the technical infrastructure for a vehicle2x communication opens up numerous possibilities for traffic flow optimization and road safety assistance. Not only classic car transport benefits from this infrastructure. There are also benefits and opportunities for local public transport or rescue vehicles. Finally, the functionalities of the C-ITS can also be applied to bicycle or pedestrian traffic.

The City of Stuttgart is therefore investing in new traffic control systems and is participating in the definition of general standardisation processes, e.g. for the system architecture for traffic control systems. However, investments in the infrastructure must be made from an economic point of view. The City is therefore pursuing a path of "forward-looking market observation". The expansion of the infrastructure is being driven forward according to the state of the art.

Regarding the scope and level of detail of required road and traffic data (e.g. road conditions, road markings, sensors) there are still great uncertainties; standards are missing. Some

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developers of automated vehicles rely on their own sensor technology; other developers request large amounts of data in the course of trials. The City of Stuttgart already provides existing data. It remains to be seen to what extent further requirements for data collection and provision will arise.

Therefore, the City experts are in constant exchange with other municipalities and companies via committees (e.g. Platform for Urban Mobility (PUM), Open Traffic Systems City Association e.V. (OCA e.V.)). Monitoring the technical development steps ensures that investments in infrastructures are arranged reasonably and established at appropriate times.

3.2.7 Road infrastructure / C-ITS			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures ✓
Actions by the city of Stuttgart	Road Construction Authority, Road Traffic Authority: Market observation, (co-)development of standards, implementation		

5.3.2.9 Traffic Management (strategies and operation)

Especially with a view to the gradual market penetration of automated driving, the close cooperation between municipal traffic management and providers of vehicles, vehicle technologies and mobility services is of utmost importance.

The Integrated Traffic Control Centre (IVLZ) has been in operation for a long time, for example, through the NAVIGAR project. The aim is to make municipal traffic control strategies accessible to routing providers or mobility services and to provide them with added value. In addition, routing functions do not autonomously guide traffic through cities using their own algorithms, but rather use the urban strategies for taking over traffic control. For this purpose, they must prove to be target-oriented for the end customer.

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Figure 35: NAVIGAR - Integrated And intelligent: Navigating Through Stuttgart

With a view to various objectives such as the optimization of traffic flow, public transport prioritisation or air pollution control, IVLZ is continuously expanding its data and control system.

Numerous projects have been initiated as part of the City's mobility package and by the “Immediate Clean Air Action Programme 2017 - 2020" (Federal Ministry of Transport and Digital Infrastructure). These projects enable an enhanced data exchange and sharing traffic management strategies.

Traffic Management (strategies and operation)			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures (✓)
Actions by the City of Stuttgart	IVLZ (Road Traffic Authority, Road Construction Authority, SSB): Market observation, (co-)development of standards, data exchange, implementation and operation of traffic management strategies		

5.3.2.10 Digitisation

The progress and possibilities of CCAM are closely linked to the ongoing digitisation processes.

The digitisation of work processes creates usable data. With regard to automated driving, possible options are for example new work processes for the approval of construction sites or the identification of infrastructure defects, in order to generate timely and highly accurate localised data and make it available for transmission.

The City of Stuttgart has adopted a strategy for a Digital City Administration (DigitalMoveS). On this basis, work processes will be successively digitised. Technical developments are also being driven forward to provide working tools and data hubs.

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The extent to which funds are needed in the municipal sector for investment, operating and personnel costs must be taken into account when setting standards. Considering automated driving, this concerns in particular responsibilities in the Road Traffic Authority and the Road Construction Authority.

A high-performance and nationwide gigabit-capable broadband network is an indispensable prerequisite for supporting digitisation processes on site. Numerous applications also for CCAM are made possible in terms of a secure, high volume and high-speed data transmission between vehicles and roadside infrastructure. Gigabit Region Stuttgart GmbH is a joint venture of the Wirtschaftsförderung Region Stuttgart GmbH (business promotion) and has been established in 2019 by the State Capital Stuttgart and five administrative districts. In partnership with Deutsche Telekom, the region will be supplied with fiber optic cable area-wide.

Traffic Management (strategies and operation)			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures **(✓)**
Actions by the city of Stuttgart	Digitisation of processes, adaptation of work structures and tools, expansion of infrastructure		

5.3.2.11 Acceptance

The creation of acceptance in new technologies is not an original task of the administration. Nevertheless, in the context of a sustainable mobility strategy, it is important to take the expectations and fears of citizens seriously. According to a study by Ernst & Young from 2017[10], the citizens surveyed see some advantages of automated driving, such as better traffic flow, more comfort, reduced consumption and emissions, more safety and time for other things. But they also see disadvantages such as unresolved liability issues, “loss of fun", lack of data protection, too large data volumes. Only approx. 26% of motorists were prepared to travel in an autonomous vehicle in the future. As the report of the Ethics Council of the German Federal Government[11] shows, there are a number of ethical and socio-political questions in connection with automated driving, the answers to which are fundamental to the acceptance of the new technology.

Acceptance			
Timeline	Automation Awareness ✓	Planning for Automation Readiness ✓	Implementation of Automation Ready Measures -
Actions by the City of Stuttgart	Stakeholder involvement, political discussion, participation in pilot projects and studies		

[10] Ernst & Young GmbH (2017): Autonomes Fahren in Deutschland – Ergebnisse einer Befragung von 1.000 Verbrauchern

[11] Bundesministerium für Verkehr und Infrastruktur (Juni 2017): Automatisiertes und vernetztes Fahren. Bericht der Ethik-Kommission

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5.3.3 Use case impact assessment and lessons learned

Based on the evaluation of chances, risks and uncertainties, the central questions examined were the effects of autonomous driving on traffic volume, traffic flow/capacity and public transport (see chapters 5.3.2.2, 5.3.2.3, 5.3.2.6), using the example of Stuttgart in CoEXist.

In use cases 7 and 8, the University of Stuttgart modelled the following questions using a macroscopic traffic demand model and taking into account different levels of market penetration:

Use case 7: Impacts of CAV on travel time and mode choice on a network level

- What changes can be expected on motorways, on urban arterials and on urban roads with mixed traffic?
- What impacts can be expected on road capacity, congestion levels and travel times?

Use case 8: Impact of driverless car- and ridesharing services

- What impact will the introduction of car- or ridesharing services have on modal split and traffic volumes?

The macroscopic multimodal Visum model for the Stuttgart Region was used to investigate the impact of automated vehicles on road capacity, route choice and mode choice. The model includes detailed car and public transport networks. Travel modes for passenger transport that are considered in the mode choice are walking, cycling, public transport, car driver and car passenger. The figure on the right shows an overview of the study area.

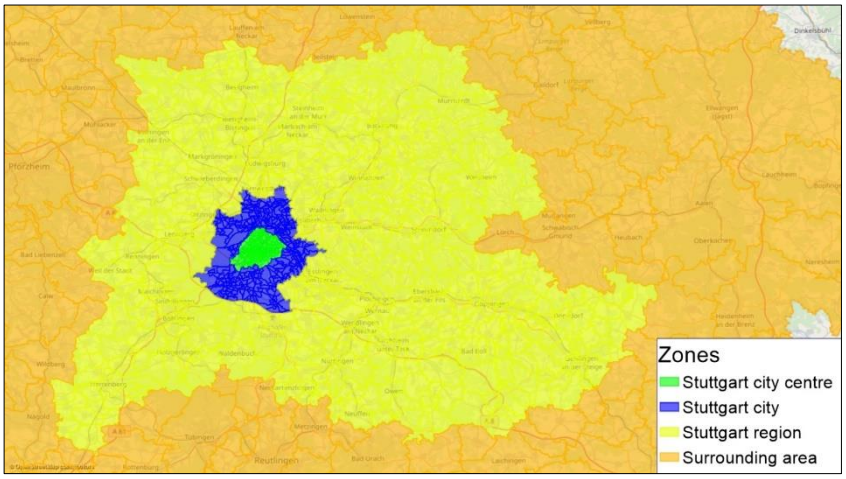

Figure 36: Overview on the study area

5.3.3.1 Use case 7: Impacts of CAV on travel time and mode choice on a network level

Use case 7 looks at the effects of automated vehicles on travel time, mode choice and route choice, resulting from changes in traffic performance and changes in comfort of car usage. An extended version of the existing travel demand model of the Stuttgart Region is used to examine the impacts of highly, but not fully automated vehicles.

The use case examines the effects of the following variables on travel demand:

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- CAV stage: The stages introductory, established and prevalent vary the characteristics of CAV. In the introductory stage, the driving logic of CAV leads to careful driving which reduces road capacity. In the established stage CAV outperform conventional vehicles on motorways and arterial roads, where cars and non-motorized modes are separated. The prevalent stage assumes that CAV can even operate efficiently on urban streets.
- CAV-share: The share varies between 0% and 100%
- Network: Two cases are distinguished. The case "motorway" assumes that CAV can operate automated only on motorways or on roads with a similar characteristic. The case "main road" additionally includes main roads as CAV-ready roads.
- Perception of travel time: Drivers of CAV may use some of the in-vehicle time for non-driving tasks. This can reduce the perception of the actual travel time. Perception factors of +/-0%, -15% and -30% of CAV travel time are considered, to account for changes in travel time perception.

Combination of variables are used to examine 60 scenarios. Running the travel demand calculation each scenario produces values for a set of indicators:

- number of trips by mode
- total distance travelled by mode
- total time spent by mode

5.3.3.1.1 Overview of results

- In the introductory stage, CAV perform worse than CV and cannot operate automated on urban streets. This partially reduces the road capacity and leads to small modal shifts from car modes other modes.

- In the established and the prevalent stage, CAV perform better than CV on some parts or most parts of the network. This enhances the road capacity in the network and improves the traffic flow conditions for car traffic. As a result, car traffic increases to some extent.

- The model results indicate that the comfort benefits of CAV have a higher impact on travel demand than capacity gains. Scenarios assuming a different perception of travel time, lead to longer trips and to a shift from public transport to car. The combination of capacity gains and changes of travel time perception may increase car traffic by more than 10%.

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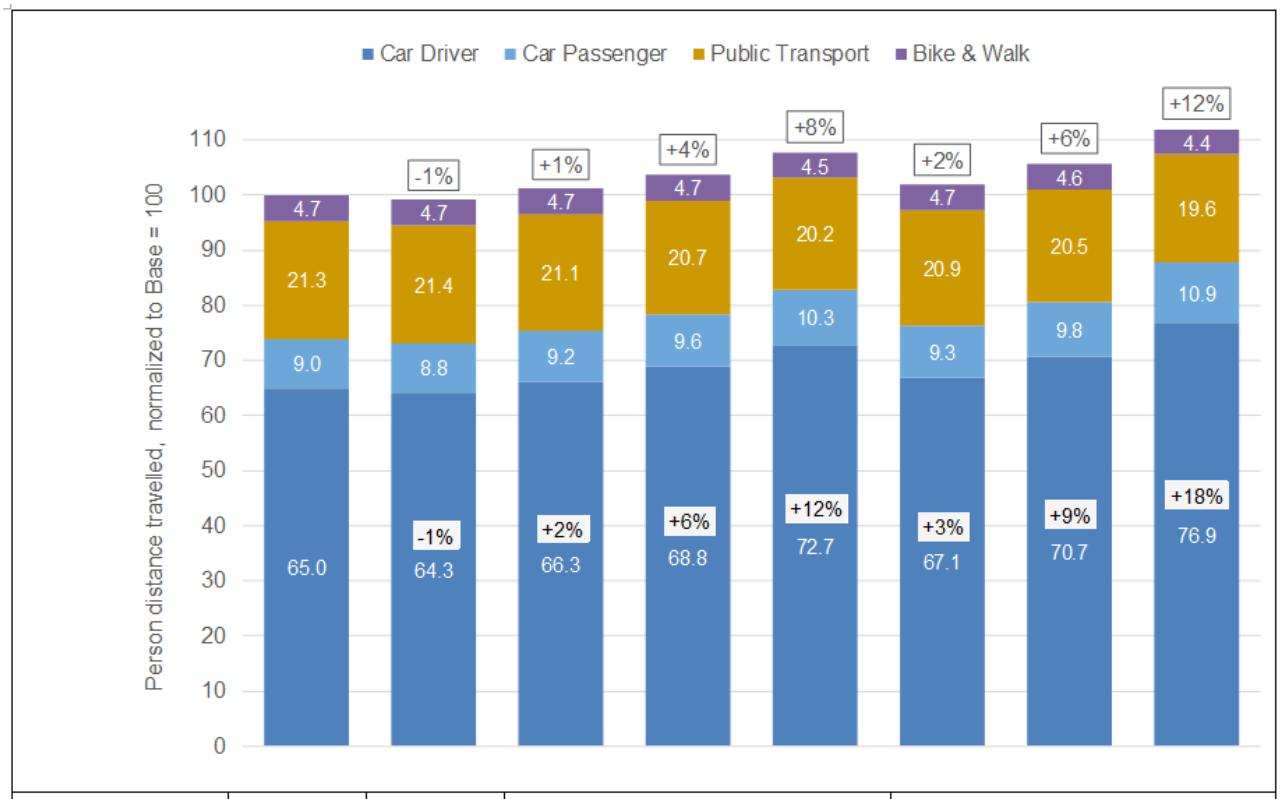

Stage	Base	Introductory	Established			Prevalent		
CAV-share	0%	40%	60%			80%		
Network:								
Motorway	☒	☒	☒	☒	☒	☒	☒	☒
Main road	☐	☐	☐	☐	☒	☐	☐	☒
Perception	+/-0%	+/-0%	+/-0%	-30%	-30%	+/-0%	-30%	-30%

Figure 37: Changes of person distance travelled, use case 7 (CoEXist, University of Stuttgart)

5.3.3.2 Use case 8: Impact of driverless car- and ridesharing services

The aim of use case 8 is to examine the impacts of automated car- and ridesharing services on demand. The basic assumption is to have 100% CAV capable of operating completely automated (and therefore driverless) within the Stuttgart Region.

The examined scenarios vary the characteristics of the supply and assumptions on the behaviour:

Supply characteristics: Case 0 corresponds to the baseline scenario. Cases 1-3 each cover one additional mode with sharing vehicles on top of the traditional modes available in the base case. Case 4 investigates the impact of on-demand services integrated into public transport under the assumption of omitting bus service completely. Carsharing as a competitive mode added to the case 4 is covered by case 5.

Prices: Prices for shared vehicles (CS, RS-) consist of a fixed booking price and a distance-based price. Integrated ridesharing (RS+) is included in the public transport ticket.

Car ownership: Car ownership is an input variable to the model. In some scenarios, car ownership is reduced assuming that persons are willing to share vehicles or rides.

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Case	Public Transport			Car Transport		
	Bus	Rail	Ridesharing RS+	No-Sharing NS	Carsharing CS	Ridesharing RS-
0	yes	yes	no	yes	no	no
1	yes	yes	no	yes	no	yes
2	yes	yes	no	yes	yes	no
3	yes	yes	yes	yes	no	no
4	no	yes	yes	yes	no	no
5	no	yes	yes	yes	yes	no

Figure 38: Scenarios of use case 8 (CoEXist, University of Stuttgart)

Mode	Properties
Bus	Buses operate as in the baseline scenario, no specific assumptions on automation
Rail	Light and heavy rail operate as in the baseline scenario, no specific assumptions on automation
RS+	Ridesharing integrated into public transport. This can come in the form of a last mile service or as direct service in areas with low demand (bus on demand). The system operates with one vehicle size (6 seats). Passengers must transfer to bus/rail, if this provides a reasonable service. Travel time depends on road saturation.
NS	No sharing, cars are privately owned. No specific assumptions on automation. Travel time depends on road saturation.
CS	Carsharing, travel time depends on road saturation. This supply is equivalent to a personal on demand service.
RS-	Ridesharing not integrated in public transport. Travellers always travel without transfers. The system operates with one vehicle size (6 seats). Travel time depends on road saturation.

Figure 39: Overviews of modes in use case 8 (CoEXist, University of Stuttgart)

5.3.3.2.1 Overview of results

- The modal shift from public transport to independent ridesharing (RS-) or carsharing (CS) depends on the prices of the services and on car ownership levels. Assuming that the out-off-pocket costs for these services are approximately 50% higher than public transport and that car ownership remains at current levels, independent sharing services will attract a relatively small amount of all trips (around 2.5%).

- Ridesharing integrated into public transport (RS+) can operate as a feeder service for traditional public transport and offers direct trips where public transport service quality is insufficient. Direct RS+ services provided at the cost of public transport gain a large modal trip share of around 25%. This leads to a total public transport share of 33% (baseline: 14%) and a reduced share for car modes of 41% (baseline: 54%).

- Assumptions on the willingness of people to give up their private vehicle and to share vehicle have a high impact on vehicle traffic. If half of the persons with access to a car give up car ownership, vehicle distance travelled will go down by approximately one quarter.

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- As ridesharing eliminates parking costs demand with ridesharing vehicles will increase more in urban areas with paid parking.

- The number of required vehicles can be reduced, if ridesharing integrated into public transport (RS+) and carsharing is available. In this case, up to 25% of all vehicles can be omitted. This number can be further reduced with an increasing willingness to share.

5.3.3.3 Lessons learned

The results of the Stuttgart use cases confirm that automated driving represents a challenge for urban transport planning if the objectives of 'sustainable transport' and 'urban design' in the sense of the European City are taken as planning objectives.

Regarding the achievable practicability of automated driving, it should be noted that this depends strongly on local (road) conditions. Further specific consideration is required for individual urban structures and road spaces.

Even if there are still uncertainties regarding the effects and requirements, the upcoming technological development of automated driving must be taken into account in future mobility plans. The increasing attractiveness of automated vehicles requires consistent objectives and concepts in transport, urban and regional planning.

Similarly, automated driving and its recognisable effects must be taken into account today in future legislative and standardisation procedures. This applies, for example, to the planned liberalisation of the Passenger Transport Act from the perspective of a strong and efficient Public Transport in terms of services of general interest.

5.4 Stakeholder engagement: Automation-ready Forum in Stuttgart

5.4.1 Objectives and scope of the event

The main aim of the Automation-ready Forum was to create a uniform, knowledge-based (results from use-cases and the actions done during the CoEXist project) understanding of the chances and possibilities but also of the risks of automated driving in a city like Stuttgart. This includes the awareness and definition of the role and responsibilities of the affected municipal units.

Based on a position paper the following questions were discussed:

- What is the City's strategy, taking into account the state of the art and with regard to future urban- and mobility planning?
- Which resources will be needed – financial, technical, structural and personnel?
- Do the existing organisational structures fit to future developments?
- Are there enough qualified human resources?
- Which technology do we need, which investments?
- At what time the City should take action in projects and take the initiative?
- Question about the general acceptance: What‘s the position of the local City council concerning the recommendation of the municipal administration?

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5.4.2 Analysis and lessons learned

For the Automation-ready Forum interviews with experts of municipal key departments (see chapter 5.1.2) as well as representatives of the local public transport authority (SSB) have been conducted. With this methodology, a cross-section of the organisation was represented.

During the interviews, systemic questions were dealt with along an interview guideline with regard to 8 design components (technology, organisational structure, tasks, decision-making system, information system, reward & control system, development & renewal system and human being) of systems. In this way, a transparent actual-picture of the "readiness level" of the city was developed within the framework of self-diagnosis/reflection.

In step 2, which also took place in preparation of the Forum, the interview results were condensed; statements of the different experts were derived and assigned to the various mobility aspects considered in CoEXists Automation-ready framework[12]: policy, infrastructure, planning and capacity building.

The Automation-ready Forum confirmed that:

- the complexity achieving of Automation-readiness addresses various and specific skills and responsibilities in different municipal departments and linked organisations. As an example, Figure 22 shows the departments / organisations which would have to be involved mainly in the planning / implementation of a shuttle project with automated vehicles.

- the mobility aspects (policy, infrastructure, planning, capacity building, traffic management) take place in different planning and implementation periods (awareness, planning, implementation). The figure 23 shows an exemplary overview of the activities already running or carried out by the Stuttgart administration.

[12] CoEXist: Deliverable 1.1 (2018). Automation-ready framework. www.h2020-coexist.eu/wp-content/uploads/2018/12/D1.1-Automation-Ready-Framework-Preliminary-version-1.pdf

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Dept. Strategic planning and sustainable mobility	Strategic planning, Project management
Dept. Urban and transport planning	Urban and Transport planning, Traffic demand analysis, Road design, Planning drop on-/-off areas
Road construction authority	Road building and maintenance, Road markings and signs, Traffic lights, Data exchange
Integrated traffic management centre (IVLZ)	Traffic situation analysis, Traffic management strategies, Traffic management operations, Real time traffic information, Data exchange
Road traffic authority	Traffic regulations, Traffic safety, Construction site management, Permit for passenger transport, Traffic surveillance
Dept. Business development	Contact for business and research, Project acquisitions, Project management broadband development
Dept. of Information and Communication Technology	IT systems and services, Mobile networks coverage
Dept. Land surveys	Geodata and –services, mapping
Public transport authority (SSB)	Public transport planning and operation, Real time traffic data
...	...

Figure 40: Schematic overview of departments / responsibilities

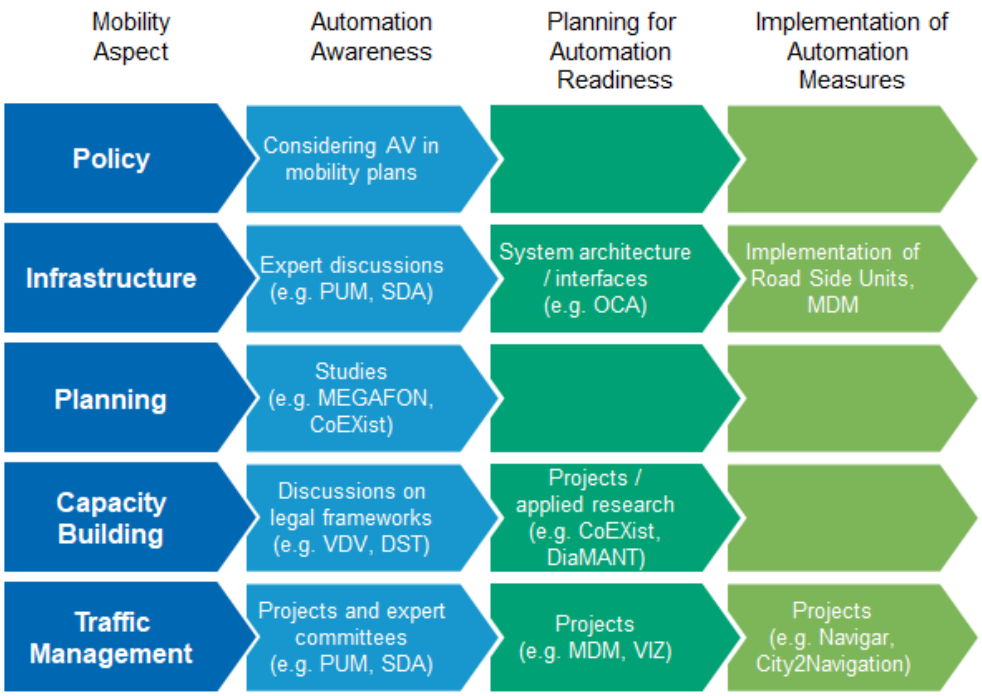

Figure 41: Exemplary activities in the City of Stuttgart with regard to automated driving

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It became obvious that

- projects at various levels are already being planned and implemented in the fields of C-ITS and traffic management as well as in the area of public transport. However, the area of transport planning is not yet affected in the course of daily work, as the framework conditions are too undetermined.

- the activities of the specific departments and organisations have to be linked and coordinated. A common understanding and a continuous exchange of expertise and activities has to be established.

- the uncertainty about general conditions of CAAM is a challenge or an obstacle for a generalised strategic approach. The process is complicated above all by its complexity, which is currently hardly suitable for political decisions.

- the City can and will continue to promote concrete developments, e.g. within the framework of research project on traffic management technologies or data management. Following this strategy, important skills are continuously developed; basic infrastructures is under construction.
- need for human and financial resources must be monitored and provided to guarantee a continuous work – concerning strategic, planning, administrative and technical aspects.

5.4.2.1 Lessons learned

Based on the situation in Stuttgart the following lessons learned can be derived:

- Achieving automation-readiness is a complex process and an overall coordination and an implemented knowledge transfer are essential due to the complexity and variety of tasks and skills.

- Technical, planning and regulatory requirements and frameworks are developing at different speeds. Therefore, automation-readiness is of varying importance for the different departments and their daily work.

- Automation-readiness has to be understood as a long-term process. This process is depending on various external settings, especially legal frameworks and company driven decisions on technical standards.

- A common understanding and reflection of all currently known chances and risks of automated driving in a city is needed as a basis for a knowledge-based proceeding.

- Concerning the complexity and dynamic an overall working structure guarantees the necessary exchange of information, knowhow, or activities. Such a working structure enables a municipality to deal with dynamic settings and to work and agree on a strategic approach.

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- Currently, pilot projects and test operations enable the successive development of skills. At the same time, this approach addresses the framework conditions and standards still open (e.g. technical standards, legal framework).

- Therefore, appropriate resources must be provided proactively, such as specific experts in various administrative units.

5.5 Roadmap towards automation-readiness in Stuttgart

5.5.1 Self-assessment of current situation

For the self-assessment interviews with experts of municipal key departments (see chapter 5.1.2) as well as representatives of the local public transport authority (SSB) have been conducted. With this methodology, a cross-section of the organisation is represented (see chapter 5.4).

On the basis of the Automation-ready Forum and taking into account the various activities carried out during and before the CoEXist project, it can be concluded that the administration of the City of Stuttgart as well as the SSB has acquired outstanding expertise in the following CCAM relevant issues:

- Physical and digital infrastructure
- Data management
- Traffic management
- Public transport and new mobility services

The City administration's experts are well networked and involved in important regional and national specialist committees.

In the process towards automation-readiness, further milestones have been reached with the CoEXist approach. These relate to the knowledge-based and coordinated cooperation of the specific municipal departments and to the findings of the impacts of automated driving on urban traffic.

In urban and transport planning as well as in the political discussion, automated driving and its possible effects must now be successively considered. A reflection with the overall urban target fields is necessary in order to make use of the advantages of CCAM and at the same time to set the framework conditions in the interest of the City.

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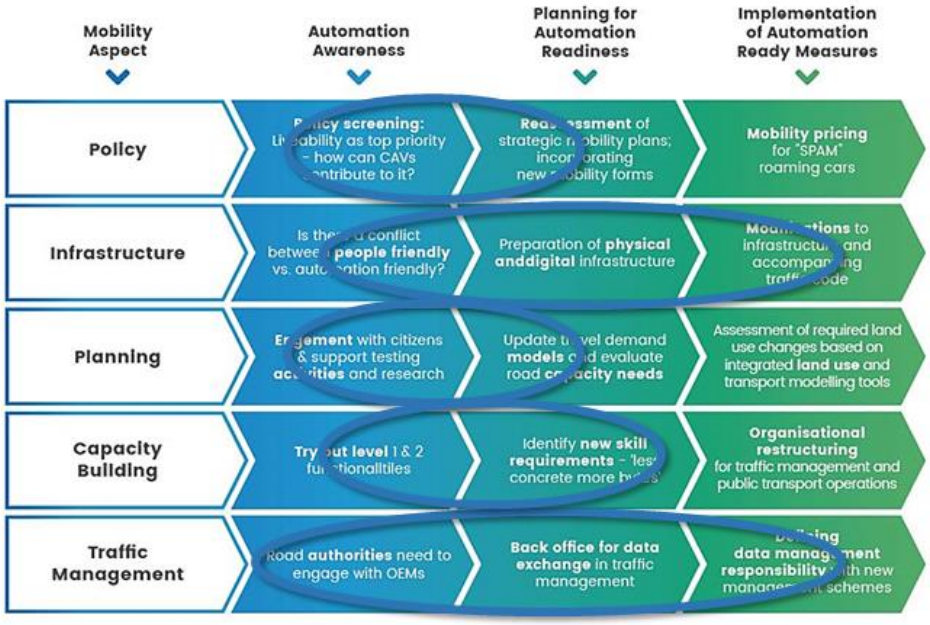

Figure 42: CCAM relevant skills and activities in Stuttgart

5.5.2 Strategy and roadmap

The Stuttgart strategy can be summarised as following: “The City of Stuttgart accompanies the developments on all levels - from legal frameworks to technical infrastructure - critically but constructively.”

Critical but constructive means, in particular, that the overall goals of the City of Stuttgart are crucial when making decisions. Outstanding CCAM relevant target fields are shown in figure 25.

Critical but constructive also means, that decisions are taken knowledge-based and at the appropriate time. The monitoring and testing of the technical development steps, for example, ensures that investments in infrastructure are made on a substantiated basis.

Critical but constructive finally means that innovation and research projects combined with expert dialogues are considered an excellent way of testing and generating expertise.

This strategy is particularly useful in terms of the gradual market penetration of automated vehicles. It enables the active participation of a city to exploit the opportunities of this technology and minimize the risks.

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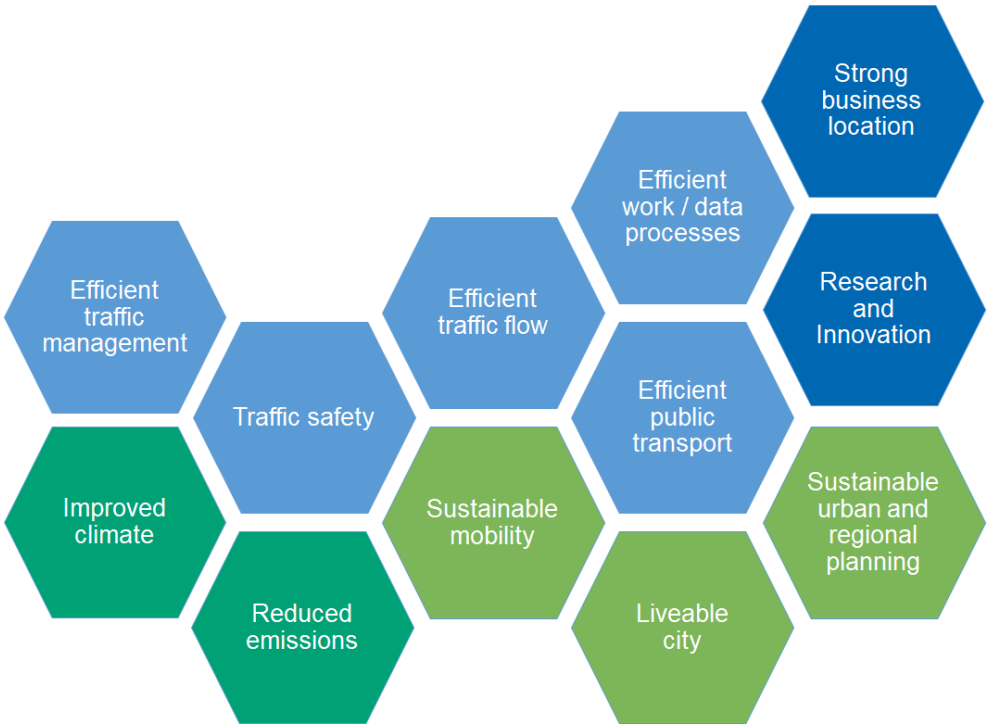

Figure 432: CCAM relevant target fields in Stuttgart

Due to the planning and technical complexity of CCAM, a wide variety of municipal strategies and master plans must be linked to the process of achieving automation-readiness.

These are, for example, subject-related master plans, such as the transport planning concepts mentioned in chapter 5.2.2. At the same time, concepts for climate protection or the clean air plan must be taken into account. Several digitisation projects in the fields of C-ITS or traffic management are anchored in the Green City Masterplan. The digitisation strategy of the Stuttgart City (Digital MoveS) also promotes necessary process adjustments.

Based on self-reflection, the "critical but constructive" approach and the integration into urban strategies and master plans, the Stuttgart roadmap towards automation-readiness is structured as follows:

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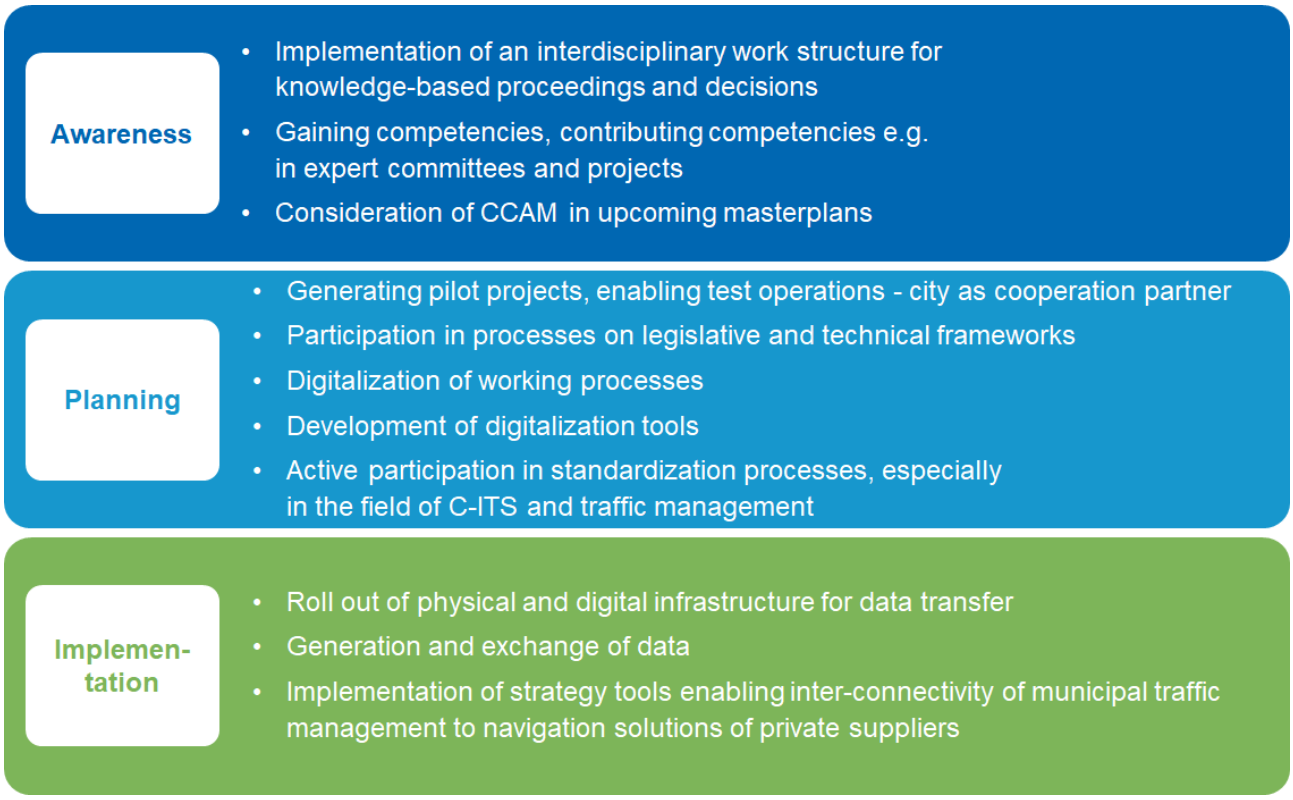

Figure 443: Stuttgart's roadmap for automation-readiness

With reference to this roadmap, the following chapters describe the activities that have been initiated or implemented during the time of the CoEXist project.

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5.5.3 Automation awareness creation

As identified in the Automation-ready-Forum and the self-assessment, CCAM affects various skills and responsibilities of a city administration with varying degree of relevance to its daily business. Automation-readiness means a continuous, long-term and complex process. It was therefore evident that a coordinated and knowledge-based approach across responsibilities is required.

The Automation-ready Action Plan elaborated during CoEXist forms the basis of the common knowledge and is the roadmap for further activities.

The specialist offices responsible for transport and mobility issues in Stuttgart traditionally work together in a strategic working group (AG Mobilität). It was agreed that CCAM activities will be regularly reported in the AG Mobilität. In accordance with the motto “Stuttgart as cooperation partner”, a coordination unit will be set up in the Department for strategic planning and sustainable mobility. This unit will coordinate necessary networking and centrally coordinate research and project inquiries as well as care of required resources.

The departments responsible for C-ITS and traffic management are already closely networked, for example in the IVLZ steering committee. The coordination of technical developments and strategies will continue to take place there - also with regard to CAAM.

The participation of municipal experts in designated working committees / projects has proved to be particularly valuable in order to gain expertise and bring in municipal interests in the technically dynamic and professionally differentiated subject areas.

CCAM will gradually change the urban mobility situation. For this reason, automated driving must be taken into account in upcoming master plans and frameworks, even if its relevance for the various specialist departments varies.

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Automation awareness creation

Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Automation-ready Action Plan	Common understanding on automation-readiness and future strategies / measures for CCAM	City of Stuttgart, Road Traffic authority	Knowledge-based and concerted proceeding	2017-2020	-
Coordinator for "New forms of urban mobility"	Staff for the coordination of project and research requests and activities	City of Stuttgart, Department for strategic planning and sustainable mobility	Knowledge-based and concerted proceeding	06/2020	Internal
Strategic / cross-section Working Group (AG Mobilität)	Regular reports of current and coordination on future CCAM-activities (projects, committees, technological developments)	City of Stuttgart, Department for strategic planning and sustainable mobility	Knowledge-based and concerted proceeding	2020	-
IVLZ Steering Committee	Regular reports of current and coordination on future CCAM-activities (projects, technological developments, investments)	City of Stuttgart, Road traffic authority / IVLZ, road authority, SSB	Knowledge-based and concerted proceeding	Ongoing since 2017	-
Participation in expert committees / projects	Participation in PUM, SAD, DST, VDV, OCA, FGSV, etc. for exchange with experts / OEMs and development of studies and strategies / frameworks	City of Stuttgart, all departments, SSB	Knowledge-based and concerted proceeding	ongoing	-

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Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Masterplans	Consideration of CCAM in urban strategies / masterplans (e.g. Transport Development Plan - NVEP, 2018)	City of Stuttgart, all departments, SSB, VVS	Reflection on impacts, decision making	Ongoing since 2017	-
Automation-ready Action Plan	Report to the City council and other stakeholders e.g. Greater Stuttgart Region (VRS)	City of Stuttgart, all departments, SSB	Policy awareness	2020	-

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5.5.4 Planning automation-readiness

During the term of CoEXist, various projects were generated. The Road construction authority and the Road traffic authority / Integrated Traffic Control Centre as well as the Dept. for business development and the SSB proceeded in planning issues on the following projects:

5.5.4.1 DiaMANT

The project "Dialogue for automated, networked and electric mobility: applications - user interests - technology (DiaMANT)" brings modern mobility to life.

In phase 1 a real test bus was used as a roadshow to experience automated mobility in public transport. In phase 2 the SSB tested autonomous functionalities. Standard buses performed regular work processes in the depot fully automatically in order to investigate the economic optimisation potential of vehicle automation. The project was funded by the Ministry of Transport of the State of Baden-Württemberg.

5.5.4.2 VIZ

Since the end of the 1990s, Stuttgart's road traffic authority uses a specific traffic information and control system (VIZ). This software framework enables the integration and processing of traffic data as well as for digital approval and control processes at the road traffic authority, the integrated traffic control centre (IVLZ) and the specialist offices involved in the process as well as external partners of traffic management such as the police and SSB.

While retaining the important basic functions and connections to existing and future eGovernment procedures and interfaces, VIZ is to be completely redesigned, migrated to a new system and made future-ready. Work processes can be digitized and traffic information can be communicated faster to the public or to mobility service providers. The VIZ project is funded by the federal government's support programme "Immediate Air Action Programme 2017 - 2020".

5.5.4.3 Traffic Control: System architecture / interfaces

The aim is to develop a common understanding in the dialogue between cities and industry regarding the design of urban mobility of the future and to identify the necessary upgrades of light signal systems, control systems and communication infrastructures.

To this end, OCA e. V. is conducting system studies and drawing up specifications for the adaptation of the traffic infrastructure in preparation for the introduction of assistance systems for the cities of Düsseldorf, Hamburg, Cologne, Munich, Stuttgart and Kassel.

The data collected from the infrastructure will also be made available to prepare the introduction of C-ITS in the cities and as a basis for further measures. This project funded by the federal government's support programme "Digitisation of municipal transport systems".

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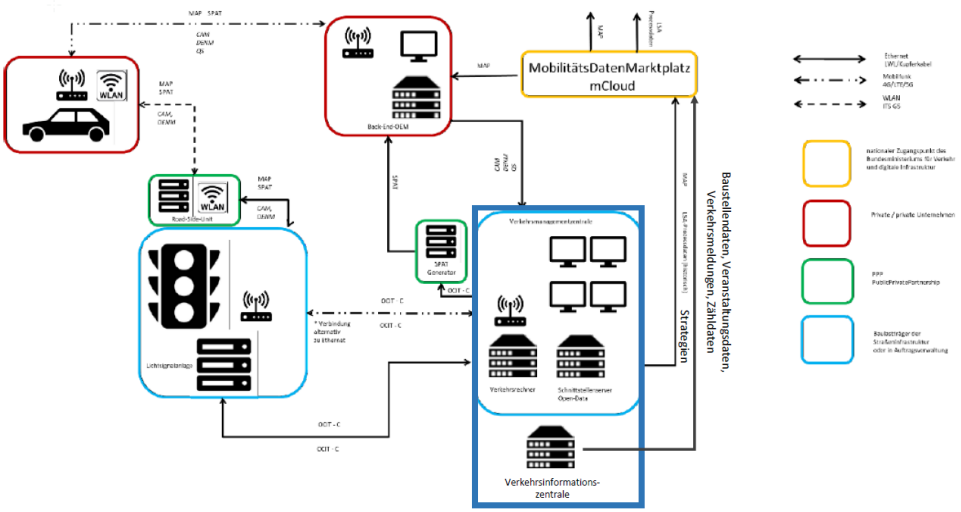

Figure 454: Scheme of system architecture and uniform interfaces (OCA e.v.)

5.5.5 Smart Zone: Digital delivery zone management in Stuttgart

The "SmartZone" project aims to better control delivery traffic in the City of Stuttgart. In cooperation with Fraunhofer IAO and the platform provider PARKUNLOAD, the project will conceptualise, pilot and evaluate the digitalisation of loading zones.

The digitally supported delivery zone management is based on the use of a smartphone application in combination with sensor-based traffic signs. By using the app, the drivers of the delivery vehicles have the possibility to check the availability of free loading zones in real time. With this project, the City complements the digitisation process with regard to the last mile of delivery traffic. The project is funded by the federal government's support programme “Immediate Air Action Programme 2017 - 2020".

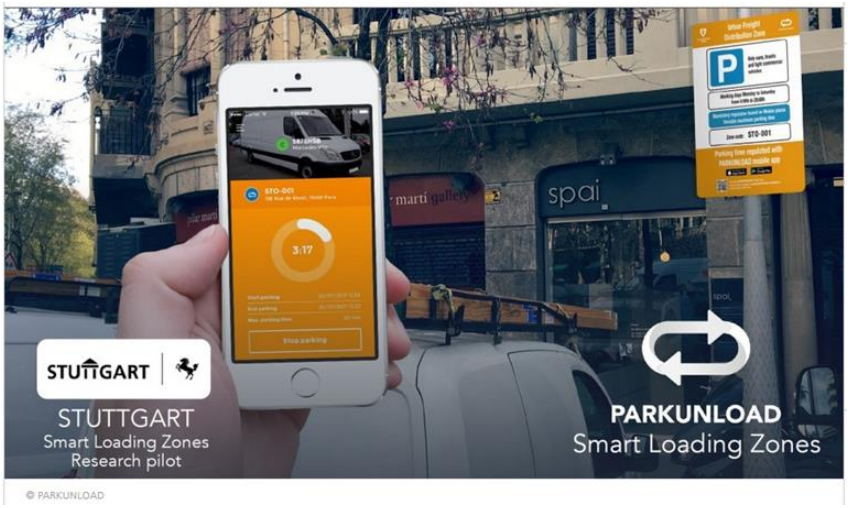

Figure 46: Smart Loading zones (Parkunload)

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Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Participation in processes on frameworks	Participation in PUM, SAD, DST, VDV, OCA, FGSV, etc. for exchange with experts / OEMs and development of studies and strategies / frameworks	City of Stuttgart, all departments, SSB	Knowledge-based and concerted proceeding	ongoing	-
CoEXist	Assessing impacts of CAAM in Stuttgart	University of Stuttgart, City of Stuttgart, Road traffic authority	Increase knowledge of impacts of CAV on travel time and mode choice and of driverless car- and ridesharing services	2017 - 2020	EU Horizon 2020
DiaMANT	Dialogue for automated, networked and electric mobility: applications - user interests - technology	SSB	Roadshow, Testing vehicle automation in a bus depot	2018 - 2020	Ministry of Transport BW
Digital MoveS	Strategy for a Digital City Administration	City of Stuttgart, Dept. of Information and Communication Technology	Digitisation of working processes	Start in 2020	Internal
VIZ	Tool development for traffic data and digital approval and control processes in road traffic, part of environmentally sensitive traffic management	City of Stuttgart, Road traffic authority	Digitisation of working processes, generating traffic data	2017 - 2020	Federal Ministry of Transport and Digital Infrastructure

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201-2

Planning automation-readiness

Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Traffic Control: System architecture	Definition of a system architecture and uniform interfaces for communication between traffic light systems and vehicles	City of Stuttgart, Road construction authority	Reference architecture, facilitates C-ITS applications	2017 - 2020	Federal Ministry of Transport and Digital Infrastructure
Smart zone	Conceptual design and testing of digital loading zones in Stuttgart	City of Stuttgart, Dept. for business development	Digitisation of data processes, Testing	2017 - 2020	Federal Ministry of Transport and Digital Infrastructure

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201-2

5.5.6 Automation-ready measure implementation

During the term of CoEXist, various projects were generated by the municipal departments. The road construction authority and the road traffic authority / Integrated Traffic Control Centre implement currently the following measures / work on these projects:

5.5.6.1 Road infrastructure / C-ITS: Road side units (RSU)

Road side units (RSU) enable communication between traffic lights and vehicles via WLAN and enable to implement systems like green time assistance, green time extension or signal requests for public transport and emergency vehicles.

Figure 47: Road Side Unit (City of Stuttgart, Thomas Hörner)

RSUs are being installed at selected junctions to upgrade traffic signal systems. The aim is to gain initial experience with these transmitters, which enable communication between traffic lights and vehicles via WLAN. The expansion will be partly financed by the federal government's “Immediate Air Action Programme 2017 - 2020".

In addition, RSUs are being tested in cooperation with the Dr. Ing. H. c. F. Porsche AG on a selected route leading to the company side in Stuttgart-Zuffenhausen. Objectives of this cooperation project are to test green time assistance, exit assistance and probably green time extension for the public transport.

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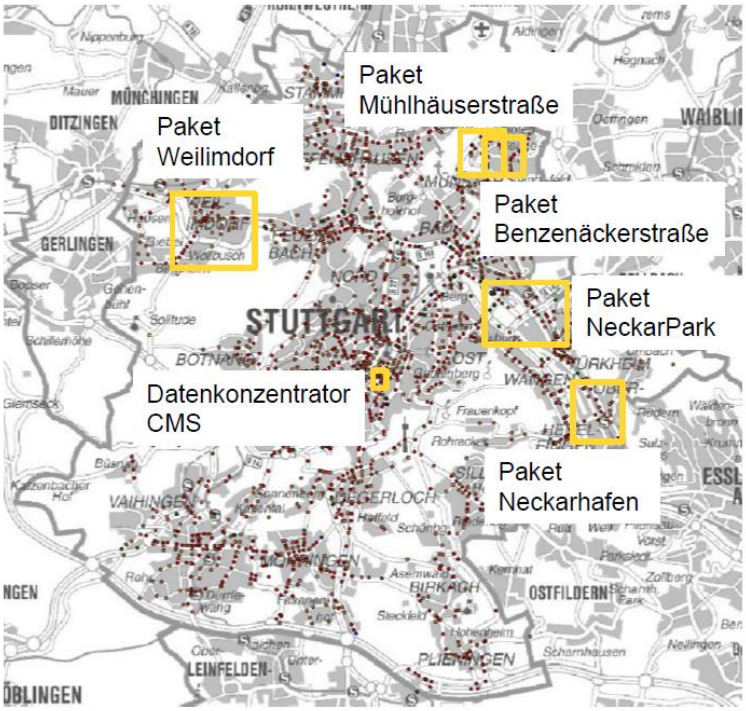

Figure 48: Locations of C-ITS Project - Immediate Air Action Programme 2017 – 2020 (Stuttgart, road construction authority)

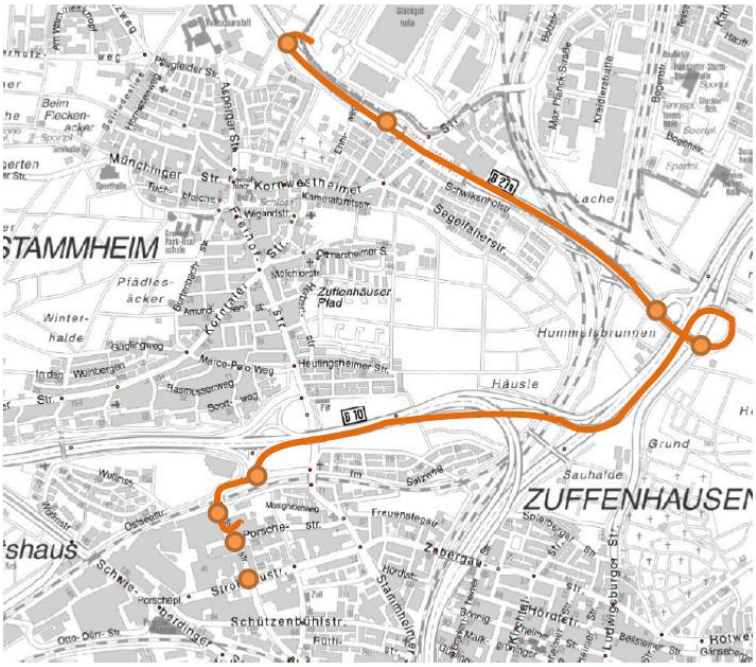

Figure 49: C-ITS Project – Adestraße (Stuttgart, road construction authority)

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Further RSUs are planned with the projects renewal of the parking guidance system and the Rosensteintunnel being under construction. RSUs are now part of every tender, so that when signalling systems are renewed, RSU are automatically installed.

5.5.6.2 Road infrastructure / C-ITS: Standard messages

Within the Vehicle2X communication, different message types are transmitted with defined standards. These are Map, SPaT and DAM for phase assistance, green waves and signal requests. DENM for warnings and IVI for informational messages.

Currently MAP, SPaT (forecast is in planning) and IVI are sent. With these data, use cases are planned for phase assistance, signal requests for public transport and emergency vehicles and for information and strategies with the parking guidance system.

5.5.6.3 Road infrastructure / C-ITS: Data exchange / MDM

The EU promotes the development of Intelligent Traffic Systems (ITS) through a separate Action Plan and an ITS Directive. It lays down that every member country is to have a national access point for traffic data. In Germany, this role is taken up by the MDM for the area road traffic.

The City of Stuttgart is member of the MDM User Group. Less time-critical traffic information such as parking data are being distributed via the MDM to enable a better flow of information to the end user. The connection of municipal IT systems to the MDM is funded by the federal government's support programme “Digitisation of municipal transport systems".

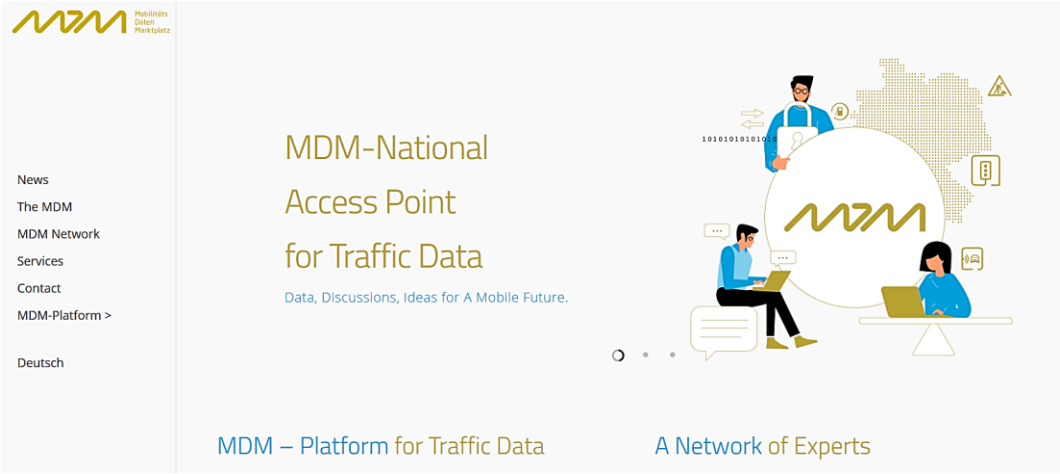

Figure 50: MDM – National Access Point for Traffic Data (https://www.mdm-portal.de)

5.5.6.4 Traffic Management (strategies and operation) - City2Navigation

CITY2NAVIGATION aims to link municipal traffic management with routing and navigation systems of third parties.

At present, private navigation and routing services operate independently of the traffic guidance strategies of the public traffic control centres (VLZ). Strategy information published by the ATCs can only be processed by the navigation services to a limited extent. In addition, the services are designed to optimise routes for individual users, while public strategies are geared towards

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optimising the overall transport system. This ultimately leads to suboptimal use of transport infrastructures.

The goal of this study commissioned by the Federal Highway Research Institute (BASt) is to develop an ITS reference architecture for an information exchange between public traffic control and private routing providers. In addition to the development of the reference architecture, a functional description of the C2N service will be developed as a basis for its standardization.

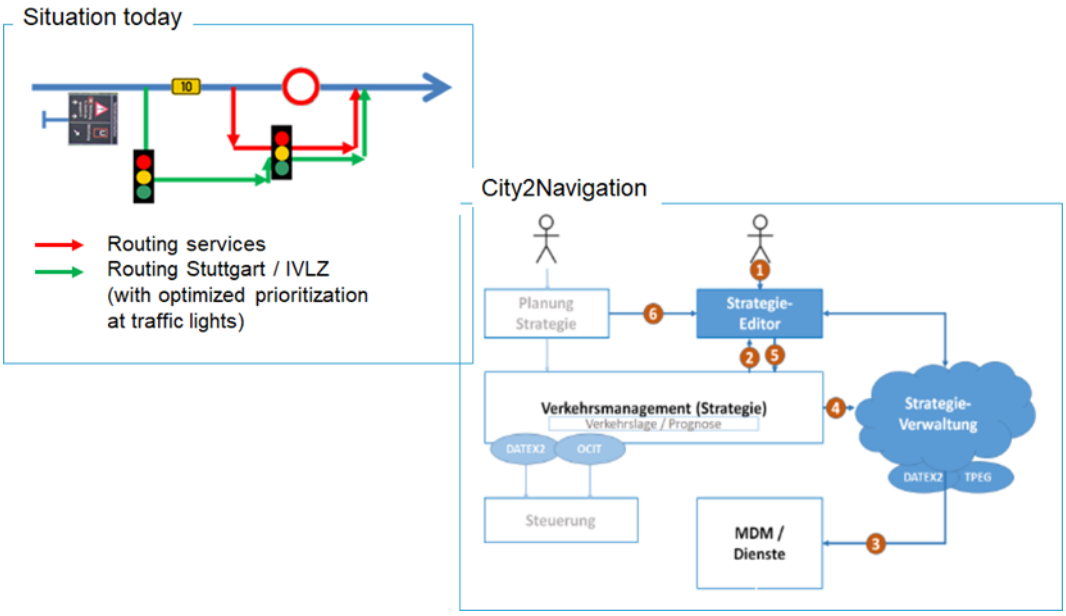

Figure 51: City2Navigation (TCP International, Stuttgart / IVLZ)

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Automation-ready measure implementation

Measure	Description of Measure	Responsibility	Relation to Automation-ready vision	Time of implementation	Funding Source
Gigabit Region Stuttgart	Area-wide fibreglass extension	Gigabit Region Stuttgart GmbH, City of Stuttgart, Dept. for business development	Facilitate high speed communication (5G)	2019 - 2030	-
Road Side Units	Implementation of RSU	City of Stuttgart, Road construction authority	Enabling car2x communication	2017-2020 ongoing	Federal Ministry of Transport and Digital Infrastructure
Implementation of SPAT/MAP/IVI services	Setting up SPAT/MAP/IVI subscription services	City of Stuttgart, Road construction authority	Enabling car2x communication	2017-2020 ongoing	-
MDM	Connection of municipal IT systems to the MDM	City of Stuttgart, Road construction authority	Exchange of data	2017-2020 ongoing	Federal Ministry of Transport and Digital Infrastructure
City2Navigation	Linking of municipal traffic management with routing and navigation systems of third parties	City of Stuttgart, Road traffic authority / IVLZ	ITS reference architecture for information exchange Functional description of the C2N service	2020	Federal Ministry of Transport and Digital Infrastructure

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5.6 Conclusions and outlook

Within the framework of the CoEXist project, the City of Stuttgart has fundamentally examined the effects of CCAM. The City aims is to play an active and knowledge-based role in the design of CCAM.

It is obvious that CCAM brings along opportunities and risks for urban space and urban transport. To understand potential impacts, CCAM's primary effects (e.g. increased efficiency of traffic flow) and secondary effects (e.g. effects on transport demand, modal split) were examined in uses cases and quantified in scenarios.

Discussions revealed that CCAM currently affects the departments responsible for transport and mobility issues in varying degrees. While strategic, regulatory and technical issues are already being discussed and implemented, urban and transport planning is not yet confronted with CCAM in everyday life.

Since the technical systems and traffic management are closely interlinked with the ongoing digitisation process, CCAM ultimately affects other administrative units outside the transport sector.

It can be noted that

- many technical standards are not yet fixed and the development of standards is largely determined by software companies and vehicle manufacturers.
- CCAM is closely linked to the strategies and concepts of mobility or transport service providers (shared mobility). Here the developments are also very dynamic and economically oriented.
- the City administration is confronted with a simultaneity in the further development of technical systems, of digitisation processes and regulatory frameworks.

Although numerous development steps need to be taken before the introduction of highly and fully automated driving, the complexity and dynamics of CCAM require the development of corresponding skills in a city administration. In view of the opportunities and risks, expert knowledge must be provided both at the strategic level and in the area of technical, digital and regulatory implementation. CCAM also requires further or new organisational coordination of relevant specialist units within a city administration.

The results of CoEXist indicate that automation can jeopardize sustainable transport and urban planning. To avoid this, possible developments and effects of CCAM on urban and regional mobility as well as on spatial structures should already be "thought along" in the coming master plans and regulatory frameworks. Those plans should also consider ways of using CCAM for strengthening efficient and attractive public transport. Pilot projects with CCAM offer important opportunities to test systems, analyse impacts and thus generate knowledge.

This requires a holistic approach covering the many facets of CCAM in the fields of network planning, traffic engineering, traffic management, urban logistics and regulations. The City will accompany CCAM at all levels of automation in a critical but constructive way from the awareness and planning stages to implementation.

Critical but constructive means, in particular, that the overall objectives of the City of Stuttgart are decisive in decision-making.

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Critical but constructive also means, that decisions are taken knowledge-based and at the appropriate time.

Critical but constructive finally means that innovation and research projects combined with expert dialogues are considered an excellent way of testing and generating expertise.

The CoEXist project was a milestone for the City of Stuttgart in its efforts to engage with CCAM in strategic, planning and operational terms within a European expert-network. The action plan and road map developed form the basis for the transition from conventional to automated transport. On this basis, the City of Stuttgart can and will continue the discussion in the political and expert committees and will take actively its responsibility for strengthening the role of the City as a location for business and innovation.

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5.7 Annex: Selected past and current activities of the city of Stuttgart with regard to AV-Readiness

5.7.1 Department for strategic planning and sustainable mobility, city of Stuttgart

- Coordinator for “New forms of urban mobility” to be installed in July 2020 as part of the staff of the Department. The person will work closely with the existing coordinators for Air Quality, E-Mobility and Climate Protection.
- Expert committee “Automated and connected vehicles” under the roof of PUM (Platform for Urban Mobility). PUM consists of nine big cities (Hamburg, Munich, Hannover, Leipzig, Ludwigsburg, Bremen, Cologne, Düsseldorf, Stuttgart) and nine companies of the automotive industry (Volkswagen, Daimler, Porsche, Ford, BMW, Audi, Bosch, Continental, Schaeffler).
- Working Group “Automated vehicles in public transport” in the framework of the “Strategy Dialogue Automotive Industry” of the Government of Baden-Württemberg https://stm.baden-wuerttemberg.de/fileadmin/redaktion/dateien/PDF/181009_SDA-Flyer_englisch.pdf
- Cooperation with “Agora Verkehrswende”, a think tank initiated by Stiftung Mercator and the European Climate Foundation. Its aim is to promote the creation of a sustainable, climate-friendly transport system. https://www.agora-verkehrswende.de/en/12-insights/driverless-vehicles-are-ideal-for-shared-use/
- Cooperation with Fraunhofer Institute IAO in the project “Logwert”: First step: Screening of 50 projects in Europe. Second Step: Workshops with Cities, Companies and Universities about new approaches to city logistics. Autonomous delivery was part of the study. https://www.logwert.de/de/news/Cityscreening/jcr:content/contentPar/sectioncomponent/sectionParsys/linklist/linklistParsys/downloadcomponent/file.res/C:/fakepath/Screening_City_Logistik_2018_FraunhoferIAO.pdf
- Project “Acceptance of Air Taxis” with Hochschule für Technik Stuttgart (University of Applied Sciences), Volocopter AG, Daimler AG and the State Government of Baden-Württemberg https://www.hft-stuttgart.de/fileadmin/Dateien/Marketing_/Publikationen/_Whitepaper__AirTaxiS_HFTStuttgart.pdf
- AFKOS-Study of Fraunhofer Institute IAO. The study describes Autonomous Mobility in the context of the City of the Future (2035). There are three visions presented. The chosen exemplary interactive space was the City of Stuttgart. https://www.iao.fraunhofer.de/lang-de/component/content/article.html?id=2169&Itemid=

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5.7.2 Department for public engineering - road construction authority (incl. road construction and infrastructure for traffic management), City of Stuttgart

- Member of the MDM user group
- Expert committee PUM (Platform for Urban Mobility)
- Expert committee OCA e.V. (Open Traffic Systems City Association e.V.)
- Project “Car2X Immediate Air Action Programme 2017 – 2020” getting infrastructure ready for Car2X communication and C-ITS use cases
- Project “ITS Adestraße” in association with Dr. Ing. h.c. F. Porsche AG testing and evaluation of Car2X Technology and C-ITS solutions on a real operational logistic route
- Project “MDM Immediate Air Action Programme 2017 – 2020” getting database ready for C-ITS use cases
- Project “PLS Immediate Air Action Programme 2017 – 2020” expand Stuttgart’s parking guidance system with Roadside Units for testing an implementation of new C-ITS use cases relating to sharing strategies
- City representative at Deutscher Städtetag (Association of German Cities), expert commission Road Infrastructure

5.7.3 Department for public affairs – road traffic authority (incl. traffic management strategy and traffic regulations), City of Stuttgart

- Project CoEXist “Enabling Automation Ready Transport Planning”, EU Research and Innovation programme Horizon 2020
- Project NAVIGAR “Transfer of urban traffic management measures to the navigation systems of private suppliers”
- Project City2Navigation “Linking of municipal traffic management with routing and navigation systems of third parties to improve the use of existing urban road capacities”
- Project VIZ “Traffic information and control system”, Immediate Air Action Programme 2017 – 2020
- Project “Digital traffic flow optimization”, Immediate Air Action Programme 2017 – 2020
- Expert committee PUM (Platform for Urban Mobility)
- Expert committee OCA e.V. (Open Traffic Systems City Association e.V.)
- Expert committee AKIVS (working group on Intelligent Traffic Systems) at OCA e.V.
- POLIS, city representative in “traffic efficiency and mobility” group
- City representative at Deutscher Städtetag (Association of German Cities), expert commission Metropolitan Road Traffic Authorities
- FGSV expert group “Traffic Requirements for Ride Pooling Systems” (FGSV Working Group 1.6.1)
- Participation “Future mobility pact for the Stuttgart Region”, expert for traffic management

5.7.4 Department for urban planning - transport planning, City of Stuttgart

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- City representative at Deutscher Städtetag (Association of German Cities), expert commission Transport Planning and working group “Mobility- and traffic management”

5.7.5 Department for business development, City of Stuttgart

- Project-management broadband expansion
- Project Smart Zone “Digital delivery zone management in Stuttgart”, Immediate Air Action Programme 2017 – 2020

5.7.6 Public Transport Authority (SSB)

- Participation in the MEGAFON study (model results of shared autonomous vehicle fleets of public transport)
- Project partner in the DiaMANT study (Dialogue for automated, networked and electric mobility: applications - user interests - technology): Vehicle automation in the bus depot Gaisburg
- External project partner at MobiLab: Subproject TP-08 autonomous CampusShuttle
- Participation in verWEGEn - Ideas Conference on Digital Mobility (VM Baden-Württemberg)
- Support of VDV activities regarding the PBefG amendment
- Cooperation on VDV Notice 9067: Ridepooling as part of public transport

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6 Glossary

Automation-ready:	Capability of making structured and informed decisions about the deployment of Cooperative Connected and Automated Mobility
CAV:	Connected and Automated Vehicle
AV:	Automated Vehicle
CCAM:	Cooperative, connected and automated mobility is one of the next big trends in the automotive industry. This initiative is designed to support EU countries and the European automotive industry in their transition to connected and automated driving, while ensuring the best mobility environment for the public.
C-ITS:	Cooperative Intelligent Transport Systems include wireless technology for connected vehicles, road infrastructure, pedestrians, bicyclists, motorcyclists, agriculture machinery and railway equipment that share and use information for coordinating their actions in public spaces.
DST:	Deutscher Städtetag (Association of German Cities)
FGSV:	Forschungsgesellschaft für Straßen- und Verkehrswesen e. V. (Road and Transportation Research Association)
GCP:	Masterplan zur Gestaltung nachhaltiger und emissionsfreier Mobilität - Green City Masterplan Stuttgart (Master plan for sustainable and emission-free mobility Stuttgart)
MDM:	The EU promotes the development of intelligent transportation systems (ITS) through a separate action plan, an ITS directive and corresponding Delegated Regulations. These Delegated Regulations lay down that every EU member state is to have a National Access Point for mobility data. In Germany, the MDM (MobiliätsDatenMarktplatz) takes up the role of such National Access Point.
Levels of: Automation:	Degree of automation of a driving system, in accordance to the scope of its functionalities.
OCA e.V.:	Open Traffic Systems City Assosiaction
ODD:	Operational Design Domain – a specific set of conditions under which an automated driving system is designed to operate properly. It can include environmental conditions such as weather and visibility due to daytime/night time, geographical conditions, roadway types, traffic laws and regulations, and speed range, among others
PBefG:	Personenbeförderungsgesetz (Passenger Transport Act)
POLIS:	POLIS is the network of European cities and regions cooperating for innovative transport solutions.

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PUM:	Plattform Urbane Mobilität (Platform urban mobility)
Ride Sharing:	Ride Sharing is a collective term for rides shared by private individuals. One person rides a certain route with his vehicle and takes another person with him who has the same destination. Such rides are usually arranged and billed via websites or apps. Alternatively, the term car-pooling ("merging") is used.
Ride Hailing:	With Ride Hailing, the customer uses an app to book a ride in a car. A professional driver picks up the customer at the agreed meeting point and takes him to his desired destination. The customer has the ride exclusively for himself, just like a taxi ride.
Ride Pooling:	Several passengers share a professional driver. Example: Person X has booked a ride pooling service, because he wants to go from A to B. Coincidentally, person Y makes a request to the same service provider for the same or a similar route. An algorithm is used to merge the trips.
SAE levels:	Classification of driving automation levels, as defined by SAE International: https://saemobilus.sae.org/content/J3016_201806
SDA BW:	Strategiedialog Automobilwirtschaft Baden-Württemberg (Strategy Dialogue Automotive Industry Baden-Württemberg)
StVG:	Straßenverkehrsgesetz (Road Traffic Act)
SUMP:	Sustainable Urban Mobility Plan/Planning (www.eltis.org/mobility-plans/sump-concept)
VEK 2030:	Verkehrsentwicklungskonzept der Stadt Stuttgart (Urban Transport Development Concept Stuttgart)
VDV e.V.:	Verband Deutscher Verkehrsunternehmen (Association of German Transport Companies)
VRS:	Verband Region Stuttgart (Greater Stuttgart Region)

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