Basler Funds, Swiss Association of Cities
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EBP

Use of Automated Driving for Everyday Life - Possible Applications and Effects for Switzerland

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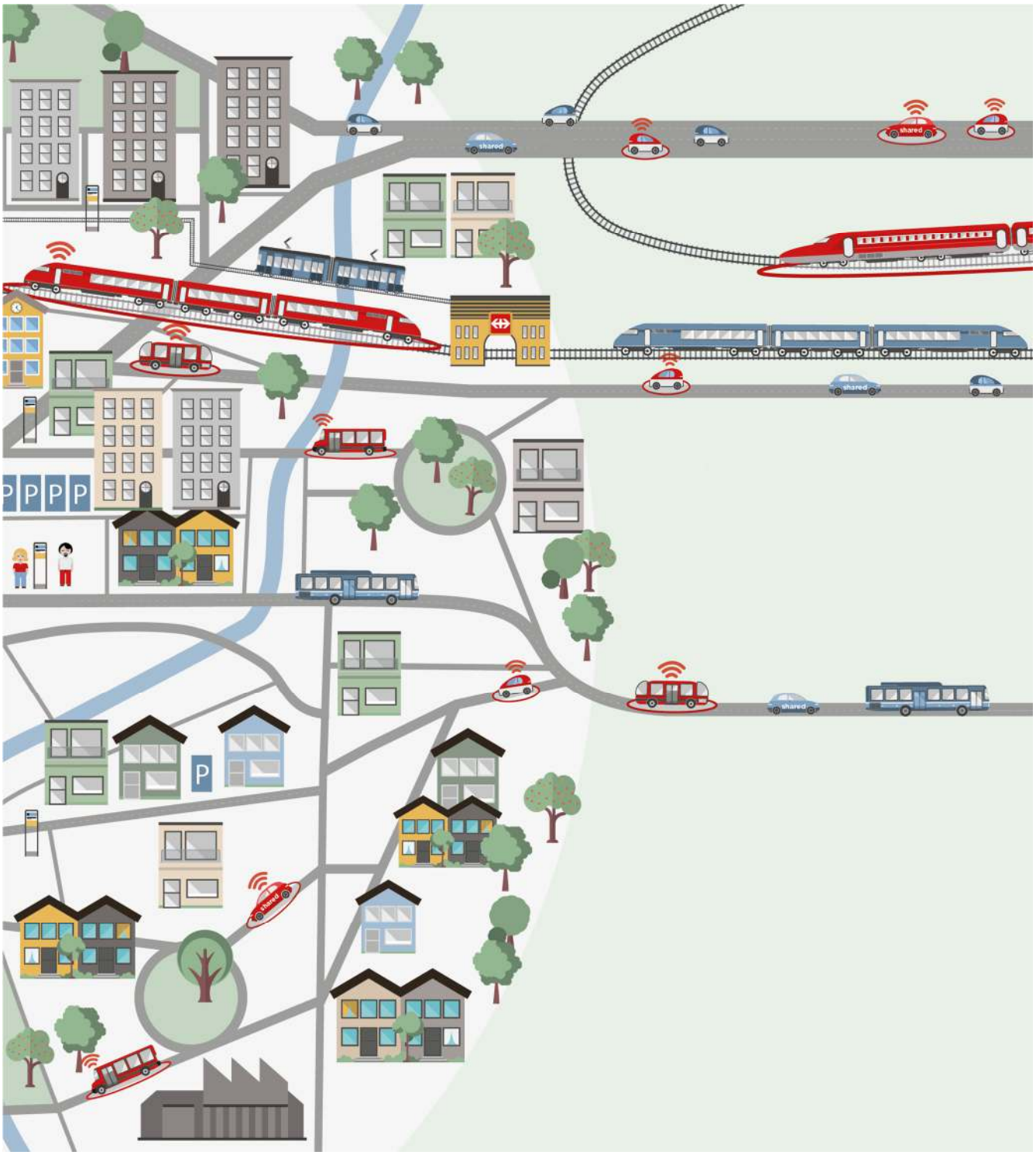

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1. Aim and Structure of the Synthesis

Interdisciplinary Study

The Swiss Association of Cities, the cities of Zurich and Berne, the cantons of St. Gallen and Zurich, the Swiss Southeast Railway (SOB), the Basler Fund and other partners (see imprint) have jointly prepared the study "Use of automated vehicles in everyday life - possible applications and effects in Switzerland". The aim was to create a foundation of interdisciplinary knowledge and to identify challenges, as well as possible courses of action for cities, municipalities, cantons, the federal government and transportation companies.

Between the summer of 2016 and autumn 2017, the study team drafted a possible development pathway for the spread of automated driving in Switzerland and identified the related challenges. During the first half of 2018, a series of in-depth studies were conducted in a variety of relevant subjects, the results of which contributed to the advancement of the draft development pathway and the identification of possible courses of action for the public sector. The following topics were examined in depth:

— Traffic engineering

— Data and IT infrastructure

— New offerings for shared transportation (public transportation and individual public transportation)

— Effects on road safety

— Freight transportation and city logistics by road

— Impact on resources, environment and climate

— Challenges for cities and other urban areas

This paper is a synthesis of the options for action, which were derived from the in-depth studies through an interdisciplinary approach. It also identifies the options for action for all levels of government and suggests how to embed them in the policy cycle (Figure 1).

The main thematic focus of the analysis was on road traffic - both for passengers and for goods. However, the development path that was drafted for the study also provides realistic steps for the automation of rail transportation. Air traffic was not considered, except for the potential use of drones for cargo and city logistics purposes.

For more technical information related to the development path, the challenges and the options for action, please refer to the final report on the base analysis and the thematic in-depth reports.

Classification within the policy cycle

The summary of the identified options for action is classified according to the policy cycle. This cycle divides the political process into several steps, whereby the steps may be described and delimited differently depending on the source of information. In this synthesis paper, we assume four consecutive steps (Figure 1):

— Identifying opportunities and challenges: problem, definition and discussion of the problem ("agenda setting")

— Develop mobility strategies: policy formulation, problem negotiation and search for solutions ("policy")

— Identify policy areas for action: decision, implementation and enforcement ("politics")

— Perform monitoring & evaluation: evaluation of the results and adaptation of the course of action ("evaluation")

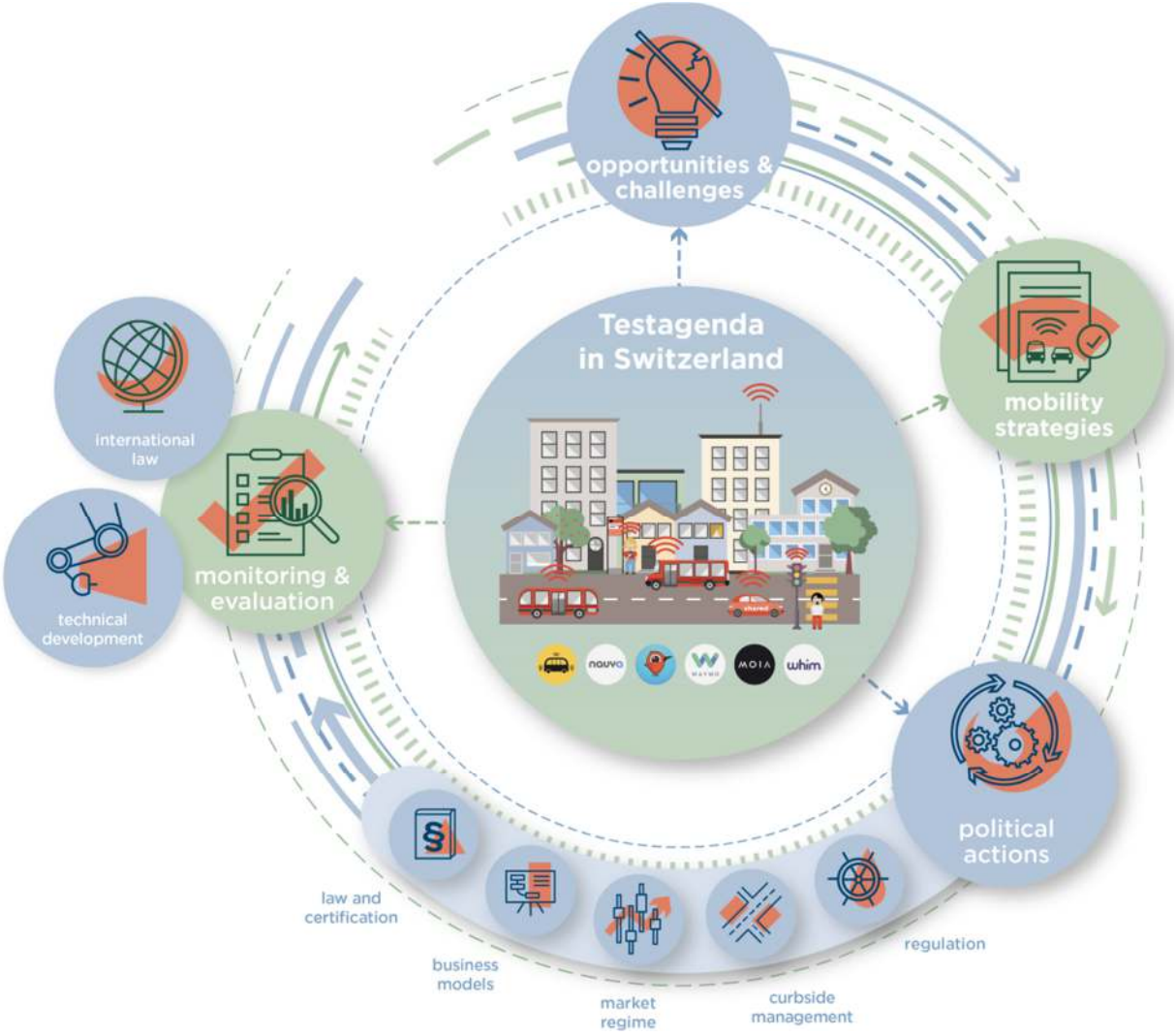

Figure 1: Policy cycle for the use of automated vehicles in Switzerland

The cycle of a political program begins when the decision is taken to deal with a problem. With the advent of automated vehicles at home and abroad and their related issues, automated driving is now high on the political, technological and scientific agenda. The political discussion requires a sound technical basis and research results to evaluate variants, formulate strategies and find optimal solutions. Once the direction of implementation has been decided, the affected policy areas must be identified, measures defined, and decisions anchored in law. These legal adjustments must be monitored and evaluated in the context of broader developments. The monitoring and evaluation stage is where the policy cycle closes in principle. However, if the evaluation reveals a need for change, the issue is set back on the agenda in order to adapt existing laws or create new regulations. One can assume, based on the many open questions and complex impacts related to automated driving, that the policy cycle will have to be repeated several times.

These four steps are described in chapters 2 to 5 in the context of the use of automated vehicles in Switzerland. For each of the four steps, options for action at the three levels of government are presented.

An important finding of the study is that trials and pilot applications are needed for all four steps of the cycle. For this reason, this paper adds an additional dimension to the policy cycle: The Test Agenda. Within the test agenda, the four steps of the policy cycle can run on a smaller scale. Since the implementation takes place via special permits, this cycle can operate faster and provide important insights for the other steps. Chapter 6 describes the requirements for running such a test agenda.

2. Opportunities and risks of automated driving in Switzerland

Automation in transportation will gradually change our mobility. Together with the possibilities offered by connectivity, it has the potential to significantly increase social welfare: On the one hand, new user groups, such as people with reduced mobility, will benefit from individual mobility and thus from greater participation in social life. On the other hand, Swiss society benefits economically from the fact that travel time can be used alternatively instead of driving.

In passenger and goods transportation, new services are becoming possible that better satisfy mobility and transportation needs. In this way, both efficiency and road safety can be increased. It is also foreseeable that new forms of services will increasingly blur the boundaries between conventional public transportation and private transportation.

However, future mobility in Switzerland also entails risks for sustainable development: more attractive and, at the same time, cheaper services generate more traffic. Longer journeys are to be expected, but also more journeys by vehicles that travel on the roads without passengers on board. The effects described in the basic analysis indicate that the potential increase in traffic is greater than the expected increase in efficiency and performance through automation and sharing effects. Accordingly, congestions and the associated problems are to be expected in the future on already heavily trafficked axes and in densely populated areas. In addition, there are new challenges, such as the question of data protection and data security associated with the connectivity of vehicles.

In the following, these opportunities and risks will be concretized with reference to the basic and in-depth studies. The development path from the basic analysis forms a uniform basis for all in-depth studies.

2.1 Distribution of automated driving in Switzerland

Thinkable development

Based on a development path with six states, the basic study shows how the use of automated vehicles in Switzerland could realistically develop using the five different levels of automation. The study assumes that there will be no isolated solutions in Switzerland, but that development, especially in individual transportation, will be coordinated with other European countries. In public transportation, it is conceivable that Switzerland will have a decisive influence on international developments or even take on a pioneering role. It is expected that there will be a generic development in the licensing conditions. This means that the technical, spatial and temporal approvals for automated driving will be granted gradually. Automated vehicles are likely to spread first on motorways and only in a second step in urban areas.

With the market penetration of automated vehicles in private transportation, there is a deviation between the technically possible functions ("what vehicles can do") and the legally permitted functions ("what vehicles are allowed to do"). This is still relatively low today, but it is likely to increase considerably temporarily and will only be brought into line again in the long term.

In rail transportation, on the other hand, the transition to automation is technically less complex than in road transportation: vehicles travel on fixed lines, are already integrated into higher-level control systems and are procured and renewed as fleets. The speed at which automated rail travel is becoming established depends on the one hand on the innovative strength of the industry and on the other hand on investments in new vehicle generations and infrastructure. Here, however, depreciation cycles are much longer than in private transportation.

Development over time
Although the development path makes a statement about the sequence of states, it does not give any indication as to when these could occur. From today's technical point of view, it can be assumed that a complete distribution of fully automated vehicles of SAE levels 4 and 5 in road traffic will very probably not be achieved for decades. Until then, in Switzerland we will find ourselves in a long-lasting transitional situation in which partially and at best highly automated vehicles will run alongside conventional vehicles. This situation poses major challenges in terms of safety, while the full potential of (fully) automated traffic cannot yet be exploited.

Mixed traffic
Regarding this development, mixed traffic between motorized and non-motorized means of transportation represents the greatest challenge for cities and all urban areas. The reason for this is the structural density, different functions of and a high volume of traffic in these areas. The long transition phase with vehicles of different automation levels must be planned proactively, as otherwise safety and efficiency losses could occur. The parallel existence of automated vehicles with pedestrians and cyclists, but also with classic means of public transportation such as trams or buses, places very high demands on the automation of mobility.

2.2 Relevant effects

Road network efficiency
The efficiency of existing road infrastructures can be improved with increasing automation and connectivity. On high-performance roads, performance gains of 5% to 10% (medium to high share of fully automated vehicles, without connectivity) or even over 30% (exclusively fully automated vehicles, with connectivity between vehicles and the infrastructure) are realistic, depending on the degree of connectivity and fleet penetration with automated vehicles. On urban roads, traffic junctions will continue to determine performance. Accordingly, lower performance gains in the range of 10-20% are expected on these roads, even with full automation and connectivity.

Additional traffic
Based on transportation statistics, literature references and experience-based assumptions, both mileage (kilometers per vehicle) and transportation performance (kilometers per person) were estimated for the six states of the development path. The alternative use of travel time, new user groups, zero-occupancy journeys, new forms of services and the changed travel behavior have different effects on mileage and driving performance. With the increasing use of fully automated vehicles, the number of vehicle and passenger kilometers increase significantly, as various demand effects overlap. A significant increase in mileage because of automation is foreseeable, particularly as a result of zero-occupancy trips. This leads to corresponding consequences for the environment.

Effects on the environment, resources and climate
The effects of the automation of road vehicles in terms of resources, environment and climate are potentially large due to the effects outlined above. The study distinguishes between the following impact dimensions: Energy demand, emissions, resources and land requirements. Across all impact dimensions, the increasing possibilities for the joint and simultaneous use of vehicles ("ride sharing") represent the greatest opportunity for resource consumption because of automation. By increasing the occupancy rate of vehicles, both traffic and mileage can be reduced, and the number of vehicles can be reduced. Regulatory accompanying measures are a prerequisite for the market success of ride-sharing services. The economic incentives for ride-sharing are currently regarded as too low.

New services and the new public transportation system
Under the term "collective transportation", the study examines all forms of services in which a person uses a vehicle offered by a company, which can also be used (temporarily) by other persons during the journey (= simultaneous sharing of the vehicle or "ride sharing"). Collective transportation comprises the conventional public transportation of today and the (new) public individual transportation. Compared to public transportation, this on-demand public individual transportation is characterized by a flexibilization of the departure time, the route/line, variable stops (without fixed stops) or a combination of these elements. It also includes commercially brokered "pooling" services. There is a smooth transition to private transportation and new hybrid forms are emerging.

The opportunities and potential for collective transportation can outweigh the risks of automatization. Conventional scheduled services with increasingly automated trains, trams and buses will continue to form the basic structure of the public transportation system. Automation and connectivity bring considerable rationalization potential to be able to offer additional and more attractive public transportation services at lower prices. In addition, public transportation will continue to be the most space-efficient motorized means of transportation in the future.

New forms of service will complement the existing Swiss public transportation system, particularly in the local transportation sector. These will primarily be small to medium-sized, fully automated vehicles, which will operate partly

or fully on demand. Similar non-automated services are already in use in other countries. In the Swiss context, automation and connectivity are creating new circumstances in which it will be possible to operate the system economically or at least financially viable. Without appropriate measures, however, the attractiveness of the new forms of service will be limited by the low quality of traffic on the roads described above.

Road safety
The study shows that at SAE levels 1 and 2 of assisted and semi-automated vehicles, the safety gains are likely to exceed the expected safety losses of automated driving. Automated driving at these automation levels would thus have a positive effect on road safety. Emergency brake assistance systems make a major contribution here.

However, the study also shows that safety increases only to a limited extent with increasing automation. With the use of restricted automated SAE Level 3 vehicles, it cannot be ruled out that the safety losses may even temporarily exceed the safety gains. To prevent this, additional driver assistance systems that monitor the driver would have to be developed further and installed in the vehicles. The main reason for this lies in the new causes of accidents in the field of human-vehicle interaction. If, in a certain situation, the vehicle wishes to return the control to the driver, but the driver is not able to take it over within the time assigned for this purpose, dangerous situations or even accidents can occur as a result of this transfer mechanism.

Only at SAE level 4 should the safety gains significantly exceed the mentioned losses. But even then, the expected safety losses are considerable. This is mainly due to the consequences of the new accident cause "mixed traffic": an increasing number of conflicts between highly and fully automated vehicles with conventional vehicles as well as pedestrians, cyclists and motorcycles. But external intervention in vehicle control ("hacking") can also be a new cause of accidents, which, according to the study, will gain in importance as automation increases.

Data and IT infrastructures
The study identifies the relevant data flows between vehicles, vehicle manufacturers and their data analysis partners and the public sector. From this, it derives challenges in the delivery and gaining of data, data sovereignty and access, data use and management as well as ethical and political issues, in particular regarding data protection and data security. A central question is the acceptance of the use of personal data with the corresponding opportunities and risks.

Freight transportation and logistics
The expected increase in traffic, together with the foreseeable higher density in the cities, will increase the pressure to implement city logistics concepts. The city's road network can be relieved of freight traffic by bundling flows of goods and combining vehicles for outward and return journeys. City logistics concepts accordingly also provide for order picking centers on the outskirts of the city or on the edge of the city center. Optimum utilization of all vehicles requires voluntary or ordered cooperation between various companies to co-

ordinate these traffic flows. This contradicts the trend towards more competition. To achieve synergies, standardization is helpful (industry-specific solutions, container systems, software interfaces, etc.). However, these challenges in freight transportation are independent of automated vehicles.

The introduction of automated freight transportation vehicles can reinforce the trend towards more traffic and thus further increase the need for innovative freight supply concepts. To limit an increase in freight traffic in urban areas and thus continue to guarantee the flow of traffic, it is very important to bundle transports on the "last mile". Automated vehicles create new possibilities such as "unaccompanied collection of goods", which can undermine the desired bundling of transports. However, new business models are also conceivable with this fine distribution. It is possible that small parcel stations or automatically delivered "parcel boxes" with self-service functions will establish themselves in neighborhoods. This, however, raises new social questions, such as how people with limited mobility can access goods if deliveries to their doorstep no longer take place as standard.

2.3 Need for action and role of public authorities

Conflicting goals
The study shows that automation could intensify the conflict of objectives between optimization at the single vehicle or individual level and optimization at the system level. This conflict is likely to be expressed, among other things, in the discussion about the degree of connectivity and the extent or limits of the overarching influence thus made possible.

Various innovators have a great interest in realizing the mentioned opportunities for road users on the market, as they see new business models in them. This is demonstrated by companies such as "Tesla", "Uber", "Moia" or "Whim" as well as ongoing national and international tests with automated buses and innovative mobility services.

Without targeted control measures for the introduction of automated vehicles, the demand-driving effects and the resulting increase in traffic will be greater than the potential for increasing performance. This applies to all areas and transportation networks in Switzerland. Although a greater potential increase in performance can be expected on the motorway, the study's estimates also show the greatest increase in demand there. In cities and residential areas, the potential for an increase in efficiency is smaller, but there too a relevant increase in demand is expected. In addition, the impact of automated transportation on the quality of urban settlement is not yet foreseeable.

The public sector therefore has the important task of setting the framework for this development in such a way that opportunities are realized, risks minimized and existing and still to be formulated policy objectives in Switzerland can be achieved using automation.

Active action
Even if the timeline for technical and legal development is not yet foreseeable, this framework should be discussed today and defined as early as possible. The following chapters show options for action, how this framework

should be designed from the point of view of the study partners. Many aspects can already be tested today so that experience and knowledge can be gathered and actively introduced into the various steps of the policy cycle.

3. Mobility Strategies

Mobility of the future

The current and future traffic situation in urban situations is characterized by the interaction between different traffic participants and means. Especially in densely populated areas, public transportation as well as pedestrian and bicycle traffic are of central importance due to their space efficiency. Automation must not question this principle, which is recognized today, but must lead much more to a further increase in efficiency and a reduction in the amount of space used by traffic in dense areas. Coordinated strategies are therefore needed at all levels of government. These strategies must show how automated driving can contribute to making mobility more efficient and space-saving and to supplementing the continuing high importance of pedestrian and bicycle traffic in a manner appropriate to the nature of the traffic. The future roles of traditional public transportation with a strong concentration of passenger flows in trams and trolleybuses and "on-demand" services with smaller automated vehicles must also be defined.

In addition, cities, cantons and municipalities can all take advantage of the opportunities offered by automation by ensuring that they can be reached and provided with basic services for the population in the long term and by making them as attractive and cost-effective as possible for all users. It must also be possible to supply towns and municipalities with goods in a way that is compatible with urban functions, despite increasing traffic volumes. The authorities have the task of creating the best possible framework conditions for a functioning economy and for the individual welfare of society, while at the same time avoiding harmful effects on the population and the environment.

Smart Cities

In addition to the mobility strategies, "Open Government Data" strategies at all levels of government will be necessary for the connectivity associated with automation. This can regulate the delivery and gaining of data, data sovereignty and data access, as well as data use and data management. Urban, cantonal and national authorities need to build the data knowledge that will be needed in the future to manage mobility in smart cities, use it for the common good and minimize the potential for false investment or cost-relevant delays in obtaining and delivering data. Finally, a coherent, sustainable and effective data policy is needed that meets the technical requirements of safe automation of transportation and is at the same time economical.

These mobility and data strategies should be negotiated on a subsidiary basis, coordinated in a tripartite process and politically decided at the respective state levels. The starting position is formed by the federal government's objectives oriented towards sustainable development (e.g. the federal government’s Orientation Framework on Mobility 2040, Energy Strategy 2050, Digital Economy, Open Government Data Strategy), the cantons (e.g. Multimodal Transport Strategies and Concepts) or the urban strategies and concepts (e.g. Urban Transport Plans and Smart City Concepts).

Societal discourse

In addition to technological developments and scientific studies, the launch of a societal and political discourse is essential as a basis for this policy formulation. This should focus in particular on what mobility we would like to see in the future. How do we weigh personal freedom against the efficiency and impact of the multimodal transportation system? Are we willing to disclose our data for an integral and affordable mobility service? How important are non-motorized road users on the one hand and non-automated means of transportation on the other? Which tasks are taken over by private stakeholders and which by the public sector? The population, as well as administration, politics and business, must be sensitized to these questions and provided with fact-based decision-making information. A dialogue on these topics should also be maintained with the relevant authorities in neighboring countries, as mobility and transportation cross national borders.

4. Political areas of action

The technical development and market-based implementation of automation in transportation will progress. However, the pace of this development cannot yet be predicted. If the opportunities are to be realized, the outlined challenges will have to be solved sooner or later. What is needed at all levels of government is active and agile action that allows the right and coordinated decisions to be taken at the optimum time. Accordingly, cities, municipalities and cantons must already deal with the various issues today to be able to react quickly before an undesirable development occurs.

The scope for action at the various levels of government varies. In addition to municipal spatial and traffic planning, cities and municipalities can primarily design urban public transportation as well as mobility and traffic management. Consequently, it is crucial to actively outline appropriate framework conditions that consider the already mentioned space efficiency as well as urban demands for safety, accessibility and basic services (see options for action in Chapters 4.1 to 4.4). The cantons and the federal government have further competences in legislation, for example regarding registration and licensing issues or motor vehicle tax (see options for action in Chapter 4.5). The needs of towns and municipalities must be heard and considered at an early stage in these formal legislative procedures.

At the same time, Switzerland's federalism should be taken into consideration: In accordance with the principle of subsidiarity, the regulations should be adopted at the lowest possible level. In principle, towns and municipalities should retain their autonomy regarding urban and transportation planning, and the cantons and the federal government should only regulate those areas where it is not advisable to lay down regulations at a lower level.

Automation and connectivity in transportation are creating new tasks at all levels of government, the integration of which into existing or future financing instruments needs to be examined.

4.1 Steering and Control

The automation must be jointly controlled by the federal government, cantons and cities in such a way that the objectives of the mobility strategies are supported. This requires decisions at all levels of government and agreements with industry are also possible. Private innovators can help to quickly and easily realize the opportunities offered by automation for the transportation of people and goods.

To fully realize the automation potential, connectivity must also be promoted. In addition to the delivery and gainment of data by all players, the standardization of interfaces, access regulations and quality requirements are also central. In addition, questions of data protection and data security must be clarified and business processes in the administration digitized.

Options for action at federal level
The federal government is predestined to take the lead in clarifying questions and requirements regarding the delivery and sharing of data. Cities, cantons

and transportation companies are required to actively contribute their needs and to participate in the data platform(s) with their own data. The federal government is also responsible for traffic management on national roads and for coordinating appropriate measures at the interfaces between road networks of the cantons, cities and municipalities.

For traffic management, fundamental decisions on the degree of vehicle connectivity are also necessary. A balance must be found between restricting individual freedom and optimizing the overall transportation system. The spectrum ranges from non-connected vehicles to the integration of even non-automated vehicles and non-motorized road users into an operations control center. Such a system could send control commands to the individual vehicle. Since traffic crosses borders, corresponding requirements must be coordinated throughout Switzerland and internationally.

Options for action by cantons, cities and municipalities
The design and implementation of mobility and traffic management is the responsibility of cantons, cities and municipalities. This is based on existing or new policy objectives as well as mobility and data strategies. These set the direction for targeted measures and instruments of (data-based) implementation. Possible options include control via incentive taxes, (temporally or spatially differentiated) bans on zero-occupancy journeys, prioritization of vehicles according to occupancy and/or purpose, distribution of time windows for journeys, influencing routing, etc. Cities and municipalities must create the framework for mobility services or city logistics concepts offered by the private sector and ensure that the policy objectives are achieved by setting appropriate targets. In addition, services can be defined in rural areas that cover the last mile to an efficient public transportation platform and thus represent a supplement to timetable-based public transportation.

The aim of all urban and cantonal mobility and traffic management concepts is to limit the increase of passenger and freight traffic potentially caused by automation. With appropriate measures, the growth can be reduced and better controlled in terms of space. Possibilities exist in the promotion of on-demand and ride sharing services, for example with own routes or (financial) incentives, the strengthening of intermodal transportation chains, the demand for operational concepts for the supply and disposal of new buildings or areas with goods or attractive and digitally from one hand bookable and affordable intermodal mobility services ("Mobility as a Service").

It is also in the interest of cities and municipalities to ensure road safety, especially in mixed traffic between motorized and non-motorized road users, but also between conventional and automated vehicles. The options for action here range from adjusting speed limits and reallocating traffic areas to setting up restricted zones for automated vehicles.

4.2 Curbside management

In urban areas, various effects of automated driving will change the appearance of road and public spaces over time. If the political process makes it clear in what form and to what extent automated vehicles are used for the transportation of people and goods, it is primarily the cities and municipalities

that must plan adjustments to their infrastructure and bring their interests to other levels of government. From the point of view of the cities and cantons, the (new) regulation of the following aspects is of utmost importance:

— Parking spaces: Will publicly accessible parking spaces be removed from city centers and/or concentrated in multi-story car parks or relocated to the periphery? Are lower and upper limits for parking spaces to be adjusted for building permits?

— Passenger handling: Is there a need for new marked areas where automated vehicles can pickup and drop-off their passengers? Can existing bus stops and/or parking spaces be used for this purpose? How will these areas be structurally designed and under what conditions may they be used?

— Cargo handling: Where will areas be set up for (automated) cargo handling? Are they on public or private ground? How are they marked? Who is responsible for the management of these areas?

— Parcel stations: Should there be (de-)central parcel stations in the future, which all providers will be required to use? Where are these located and how are they managed?

The need for space should not increase due to the automation of traffic. However, the allocation of traffic areas in urban areas must be reviewed, renegotiated if necessary and determined by the respective road owner. If, with an increasingly automated (and in the best case smaller) vehicle fleet, space gains are possible for people and goods despite new transshipment areas, it must be decided how these are to be used: As a public space? For private use? For pedestrian and bicycle traffic or conventional public transportation?

4.3 Market regime for new forms of collective transportation

The study shows that the demand for efficient and space-saving means of transportation and their prioritization will increase, especially in cities and urban areas. Public transportation and new private or public services in collective on-demand transportation can make a worthful contribution to mobility that is compatible with urban environments. Due to the cost reduction potential of fully automated vehicles, conventional public transportation can be expanded and new services (e.g. tangential lines) can be offered. To this end, a market organization is to be strived which allows for room for private services while at the same time safeguarding public interests.

Options for action at federal level
The federal government must amend the Passenger Transport Act and the Ordinance on Passenger Transport as follows:

— Basic services: In public transportation, in addition to the existing understanding of public services in general, more flexible services should be made possible (e.g. the granting of concessions that provide for more flexible territorial development defined in relation to the minimum service instead of a timetable obligation or regular transportation - provided that the efficiency of the transportation system in terms of space does not suffer as a result) and conditional simplifications of accessibility should be introduced.

— Mobility services: The road traffic law and insurance framework conditions to be laid down by the federal government must be designed in such a way that innovative mobility services are possible. In accordance with the subsidiarity principle, cities and municipalities must formulate admission conditions that are tailored to their needs.

Public or municipal transportation companies have extensive know-how in their field of activity. On the one hand, they should therefore be given the opportunity to offer new - possibly even self-sufficient - services. On the other hand, there should be a clear demarcation to the publicly ordered part of responsibility. Here it must be clarified at the federal level how a financial and/or organizational separation of these business units can be guaranteed. The challenge is to define the criteria for transportation services that are eligible for compensation and economically feasible transportation that is not. The entire range from line-related services to the provision of an overall service for mobility (all forms of collective and combined mobility including, for example, bicycle rental) must be examined.

Options for action by cities, municipalities and cantons
If the market regime is in place, cities and cantons can define the tasks of the (on-demand) public transportation and the prioritization of new services in their areas of responsibility within the framework of their mobility strategies. Building on this, they examine within the framework of adapted federal legislation which form of service (public transportation services in the conventional sense) they will offer in future and which (private or state) additional services they will make possible or allow.

Furthermore, cities and cantons must draw up the licensing procedure and the operational provisions for (private) mobility services in accordance with their own ideas. They must also examine what specific obligations and rights are associated with these authorizations:

— Potential obligations: Restrictions on traffic volume, occupancy rate and modal split (e.g. targets for maximum proportion of zero-occupancy journeys or a fleet-wide minimum occupancy rate or transportation range to prevent a modal shift from pedestrian and bicycle traffic), requirements for ensuring parking and maintenance facilities, liability insurance, demands for technical equipment and data transmission to be integrated into an urban traffic management system.

— Potential rights: Prioritization in traffic management at intersections or spatial access facilitation (or restrictions) on car traffic.

Furthermore, cities and municipalities can examine whether the number of private providers of additional mobility services should be limited for their region. After an initial market shakeout, concentration on a few providers is likely, potentially leading to the formation of a monopoly (similar to the development in the liberalized long-distance bus market in Germany). If the number of suppliers is limited, a formal procedure for the concession (e.g. auction) should be sought.

Reinvestment of saved costs at all levels
Opportunities must be created at all levels of government to support short- and medium-term innovation and investment. This will enable the medium- and long-term cost reduction potential associated with automation to be realized. Long-term savings can be reinvested in expanding services or used to improve cost recovery or reduce subsidies.

Because market participants often react to restrictions and regulations in a way that runs counter to the actual intention of the regulation or cancels its effect, the measures must be carefully examined. As far as possible, this should be done in advance by means of experiments or tests (see Chapter 6).

4.4 Positioning of today's public transportation companies

When the market regime for new forms of collective transportation has been established by the federal government, cities, municipalities and cantons, existing and new transportation providers can position themselves on the market with their services.

On the one hand, the transportation companies have the task of realizing the possible long-term cost reduction potentials from automation in a socially acceptable way. On the other hand, digitalization and connectivity also provide the opportunity to offer new services that complement the public transportation services. This applies not only to sales but also to the supplementary transportation services (e.g. improved tangential connections or services during off-peak hours). The aim should be to make public transportation more flexible in suitable areas. In addition, they can and should develop new business models that enable users to combine mobility at low cost. In

the longer term, transportation companies will have to examine which business model they are aiming for. The possibilities range from integrated models, in which a company operates, schedules and maintains its own vehicles and offers mobility services and complementary services, to specialization strategies, e.g. as a pure fleet operator/carrier or as a service provider in the area of routing/dispatching/rebalancing.

4.5 Legal basis and conditions of admission

In addition to further modifications to the Vienna Convention on Road Traffic, new regulations in Switzerland will also be necessary for the registration of fully automated vehicles. These are already being negotiated internationally today. Switzerland will have to adapt to international regulations, in particular to those of the EU, but will have an influence on their design. The federal government should make active use of this room for maneuver and therefore involve cities, municipalities and cantons. From the point of view of cities, municipalities and cantons, the primary aim should be to only approve vehicles and technologies that make efficiency and safety gains possible and cause fewer emissions. This can be influenced by the size or weight of the vehicles, the type of drive or the intended use. It should also be examined for safety reasons whether conditional automated SAE Level 3 vehicles should be approved at all.

In addition to the internationally coordinated approval of passenger cars, trucks and vans, the following legal issues are of special relevance in Switzerland:

— Traffic rules and conditions to relieve drivers in their obligation to control the vehicle

— Conditions for the approval of drivers, users, owners and operators of vehicles

— Criminality, liability and insurance policies

— Driving and rest periods in freight transportation, driving in convoys with reduced spacing (regulations in connection with "platooning")

— Use of parcel robots and drones

— Motor vehicle tax laws (e.g. regarding automated vehicle fleets)

— Required degree of connectivity and scope of data exchange, in particular the transfer of (personal) data from the operation of automated vehicles (position reports, speed, road condition/traffic situation, vehicle occupancy, etc.)

— Internationally coordinated standardization of data formats.

5. Monitoring and Evaluation

International developments need to be monitored continuously to be able to respond adequately and rapidly at all levels of government. Of particular interest are legal provisions of the EU, but also of other leading states, as well as general technological advances in automated and connected driving. International findings must be quickly incorporated into the policy cycle to evaluate the options for action in Switzerland as effectively as possible and in line with mobility and data strategies, and to revise them if necessary.

It must also be shown that suitable measures can successfully prevent or at least limit the negative effects of automated driving. To this end, the federal government, cantons, cities and municipalities must jointly develop appropriate monitoring and controlling systems at an early stage and check their applicability. The necessary data for influencing mobility and traffic must also be defined against this background. If the desired impacts are small or fail to materialize at all, consideration must be given to revising mobility and data strategies, the legal basis or implementation. All levels of government need to be prepared to take appropriate corrective action.

Cities and cantons must also check that transportation providers comply with the requirements by means of a suitable system.

6. Testagenda Switzerland

Many future opportunities and challenges of automated driving are difficult to predict or model from today's point of view. However, test facilities and pilot projects can be used to gain experience and insights into traffic and spatial effects.

Various tests in public transportation are already taking place in Switzerland. However, the tests are poorly coordinated, and their financing is not regulated transparently. In contrast to other countries, there have been no tests of private (digital) mobility services or automated driving in Switzerland to date, such as "Moia" in Germany, "whim" in Finland or "Waymo" in the United States. The aim is to examine how the federal government, cities, municipalities and cantons can get involved in obtaining and supporting such market-oriented tests.

The study partners therefore call for the consistent pursuit of the following directions:

1) Experiments with innovative forms of mobility regarding the automation and digital connectivity of mobility must be made possible and promoted by all levels of government within the framework of their competencies - regardless of whether they are private or public providers.

2) In the case of public (co)funded experiments, the object of the tests shall be coordinated, and the findings and results systematically collected and exchanged. Where possible, the findings of private tests should also be integrated - for example, by imposing appropriate conditions on special permits.

3) The effects of regulations and specifications must be tested with pilot applications before they are introduced throughout the country. This is the only way to identify and avoid adverse effects at an early stage.

To obtain an overview of current and planned tests by public transportation companies and as many private pilots as possible, a first step is to create a national exchange platform in which all companies and experts involved in the tests can participate. Building on this, a tripartite test agenda for Switzerland is to be formulated and principles agreed for a systematic exchange of experience between cities, municipalities, cantons and the federal government.

The experience gained from these applications should, on the one hand, create evidence and point to targeted applications for Switzerland. On the other hand, the federal government should also contribute its findings to legal issues within the framework of its international activities.

Current pilot projects in Switzerland focus on automated minibuses and new booking and billing platforms. Central to Switzerland's future mobility system, however, is the acceptance and impact of on-demand services and new forms of public transportation. The requirements for such services can already be introduced in tests today, independently of automation - for the time being with a driver at the wheel. In this context, the effects of (automated) on-demand services on small- and large-scale spatial structures are of particular interest.

Test applications are also needed to clarify data needs and open questions regarding delivery, exchange, sovereignty and access to the data. Such tests provide important information for the (international) definition of standards for data quality and for monitoring and controlling. Among other things, private providers, for example within the framework of digital test fields, should also be attracted with appropriate incentives for test applications. The public sector must look for (new) ways of cooperation in order to benefit from the findings of these tests despite corporate secrets. International cooperation is also an option here, for example by participating in existing digital test fields in Austria and Germany.

It is important that the public test agenda is technology-neutral, that all experiences and findings are systematically recorded and exchanged among actors at all levels of government and, if possible, with industry. In addition, interdisciplinary scientific studies are to be developed on questions that are particularly relevant or cannot be answered clearly from today's point of view. Today, the interface between man and machine seems to be particularly uncertain in the transfer of control of vehicles, the interactions between automated vehicles and non-motorized road users, or effectively realizable capacity gains, especially because of increased ride sharing.

The creation of an institutional framework for such a public test agenda as well as the clarification of its financing are, from the point of view of the actors involved in the study, priority areas for action which affect all levels of government and must be tackled quickly. To this end, a suitable organization must be created that integrates both experts and political representatives from all levels of government as well as from universities.