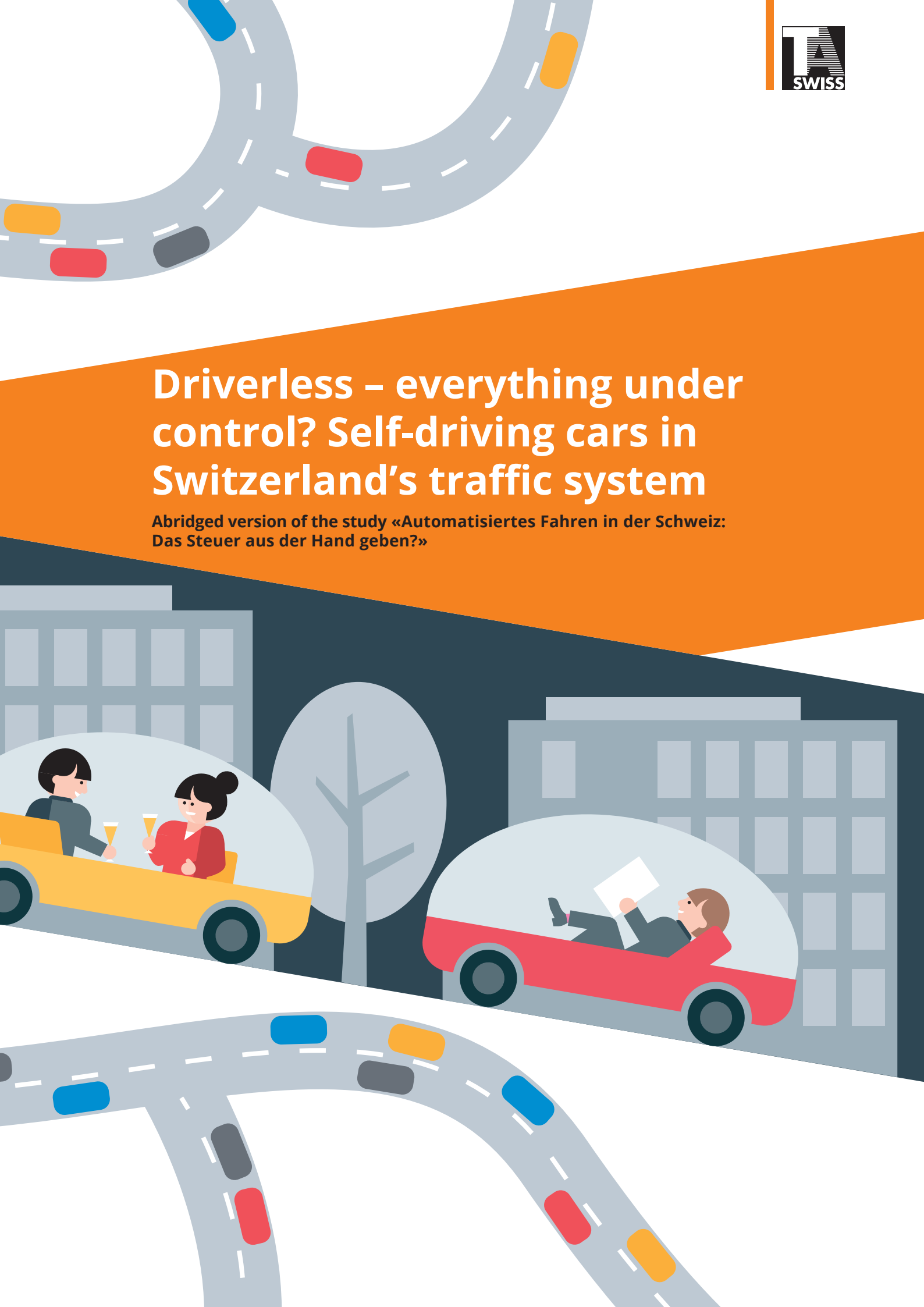
Driverless – everything under control? Self-driving cars in Switzerland's traffic system

Abridged version of the study «Automatisiertes Fahren in der Schweiz: Das Steuer aus der Hand geben?»



TA-SWISS, Foundation for Technology Assessment and a centre for excellence of the Swiss Academies of Arts and Sciences, deals with the opportunities and risks of new technologies.

This abridged version is based on a scientific study carried out on behalf of TA-SWISS by an interdisciplinary project team led by Fabienne Perret and Peter de Haan (both at EBP Schweiz AG) as well as Ueli Haefeli and Tobias Arnold (Interface). The abridged version presents the most important results and conclusions of the study in condensed form and is aimed at a broad audience.

Automatisiertes Fahren in der Schweiz: Das Steuer aus der Hand geben?

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Self-driving cars in a nutshell

Today nearly all new automobiles are already equipped with sensors and driver-assistance systems – for example, for parking or emergency braking. But the advances go further: automobile companies as well as major tech firms are working on fully automated vehicles able to reach their destination entirely without a human driver at the wheel. Experts agree that self-driving cars will enter the market sooner or later, although the exact date is uncertain.

Opportunities …

Fully automated automobiles have the potential to improve the mobility of the elderly, children and persons with a disability. Moreover, self-driving cars would help save time, as people could take care of administrative work during their commute.

Thanks to self-driving cars, new transport services could arise, for instance, collectively operated private vehicles that pick up and drop off passengers at the location of their choice. By using a fleet of automobiles to create such ridesharing opportunities, the overall number of cars on the road, and thus the volume of traffic, could be reduced.

Road safety could be positively impacted, as fully automated cars cannot be distracted (unlike people) and because they react faster than humans. In addition, if self-driving cars are connected with other vehicles and their surroundings, traffic infrastructure could be used more efficiently.

Risks …

Fully automated vehicles travelling without passengers would significantly increase traffic volume. The development could further spur urban sprawl, as access to traffic infrastructure would be a less decisive factor when choosing a place to live. In addition, self-driving cars could also enter into direct competition with Switzerland's extensive and well-established public transport network.

The mix of vehicles equipped with sophisticated technology and conventional automobiles in addition to other traffic participants brings its own risks and could reduce road safety. The legal situation remains unclear, and there are numerous open questions concerning accountability and liability in the event of an accident.

Self-driving cars collect massive amounts of data and exchange this information with other autonomous vehicles and with their surroundings. This gives rise to challenges surrounding data privacy, especially with regard to personal data.

… and some recommendations

Whether self-driving cars will ultimately lead to more efficient mobility or cause ever-greater flows of traffic is largely dependent on the political safeguards introduced. The experts surveyed in the scope of this study agreed that regulatory measures are necessary already today. They believe a laissez-faire attitude would lead to a pronounced shift from collective to individual transportation – and culminate in an increase in urban sprawl as well as in greater volumes of traffic.

Self-driving cars will have a major impact on our mobility behaviours. For this reason, it is critical that we think about and discuss transport systems of the future. A key question addresses the degree to which the government can and should impact the mobility of citizens through the introduction of political framework conditions – or the degree to which the developments should be left to the discretion of the automobile industry and its technologies.

Switzerland will therefore have to collaborate with other countries to create common and coordinated requirements for the authorisation of self-driving cars. Moreover, liability issues must be settled, and safety standards defined. In addition, driver training and further training for operating highly and fully automated vehicles should be introduced.

To prevent an increase in traffic flows, new passenger transport providers should be allowed on the market and more flexible services for collective transport should be permitted or even promoted with targeted incentives. It is also important to introduce measures regulating use of the data collected by the vehicles. In doing so, policymakers must agree on a position that serves the public interest and that allows them to fulfil their official duties while also safeguarding the data of individual citizens.

Extensive analysis of literature and discussion of scenarios
As part of this TA-SWISS study, the project group led by Fabienne Perret and Peter de Haan (both at EBP Schweiz AG) as well as Ueli Haefeli and Tobias Arnold (Interface) first examined the existing literature on automated vehicles. Based on their findings, they developed three possible scenarios that describe how various governmental interventions to regulate the entry of self-driving cars to the Swiss market could unfold. The scenarios were then discussed and evaluated with laypersons, experts and stakeholders. These discussions served as the starting point for recommendations designed to capitalise on the potential of self-driving cars while also reducing the associated risks.

Mobility at a crossroads

Travelling independently from one place to another and choosing one's mode of transportation is viewed as a basic right in Switzerland. As a result, the past years have seen a consistent increase in the volume of traffic. Now, self-driving cars have the potential to radically change Switzerland's traffic system.

The average Swiss citizen has become increasing mobile. In 2017, the Swiss travelled 134 billion person-kilometres by car or rail, which is an increase of 32 per cent compared to the year 2000. In the same period, cargo transportation also increased, although less markedly at 16 per cent. Railway lines, motorways, roads and other infrastructure have led to incisive changes in the countryside: taken as a whole, the existing traffic systems would cover a region the size of the Canton of Thurgau.

Today, the 4.5 million cars on Switzerland's roads still transport at least one person: the driver sitting at the steering wheel. But this could change. At some point in time, cars will possibly be able to circulate without a driver – a condition that would fundamentally alter the entire traffic system.

Prototypes in the starting blocks

Fully automated automobiles will not immediately become common on Switzerland's roads. Nevertheless, there are already forerunner technologies that help drivers to stay in their lane or maintain the correct distance to the vehicle ahead. These technologies are termed assisted systems (level 1). At the next level are partially automated vehicles that assume control for specific manoeuvres (level 2); these systems have already been approved and can be used to autonomously park or to drive in a lane on a motorway, although the driver must remain attentive and ready to intervene and correct course at all times. Driving conditionally automated cars (level 3) is a bit more relaxing, as these vehicles are entirely autonomous in certain conditions, for example, on the motorway. In these cars, drivers could, to a certain extent, perform unrelated tasks, but would have to be ready to assume control over the vehicle after receiving a brief advance warning.

Highly automated vehicles (level 4) would be able to circulate without monitoring in precisely defined conditions, for instance, on certain roads and within set speed limits. Fully automated vehicles (level 5) would be able to carry out all driving tasks autonomously and could, in principle, be on the road without any passengers at all. The design of these vehicles would possibly differ greatly from today's models, as they could even do without a steering wheel.

SAE Levels of Driving Automation

Level 0: not automated | Level 1: assisted | Level 2: partially automated | Level 3: conditionally automated | Level 4: highly automated | Level 5: fully automated

Technology, safety and efficiency

An inattentive moment, driving too fast in a curve or nodding off for a second: the consequences on the road are often fatal. The vast majority of accidents – roughly 90 per cent – are due to human error. Self-driving cars promise to significantly promote road safety thanks to their ability to react quickly.

In the long term, self-driving cars may – as experts hope – also help to better distribute traffic on existing traffic networks. Highly and fully automated vehicles would be safe even if the physical distance they maintain to other vehicles on the road were less that what is recommended today, as a machine can react up to six times faster than a human being. If all vehicles were self-driving cars, and if they were all connected, the traffic capacity on motorways could increase by over 30 per cent and, in cities, by 10 to 20 per cent.

Nevertheless, the increase in automation is not equal to an increase in road safety. In particular, a rise in the number of conditionally automated vehicles (level 3) would diminish rather than promote road safety. One problem is that the mix of vehicles equipped with sophisticated technology, standard vehicles and other traffic participants – including cyclists and pedestrians – brings its own risks. Another issue is that the transition phases during which conditionally automated cars transfer control from machine to driver are problematic. As such, a marked increase in safety can be expected only when mainly highly automated or even fully autonomous vehicles are on the road. Nevertheless, risks remain even under such circumstances – for instance, if hackers should succeed in assuming control of a vehicle.

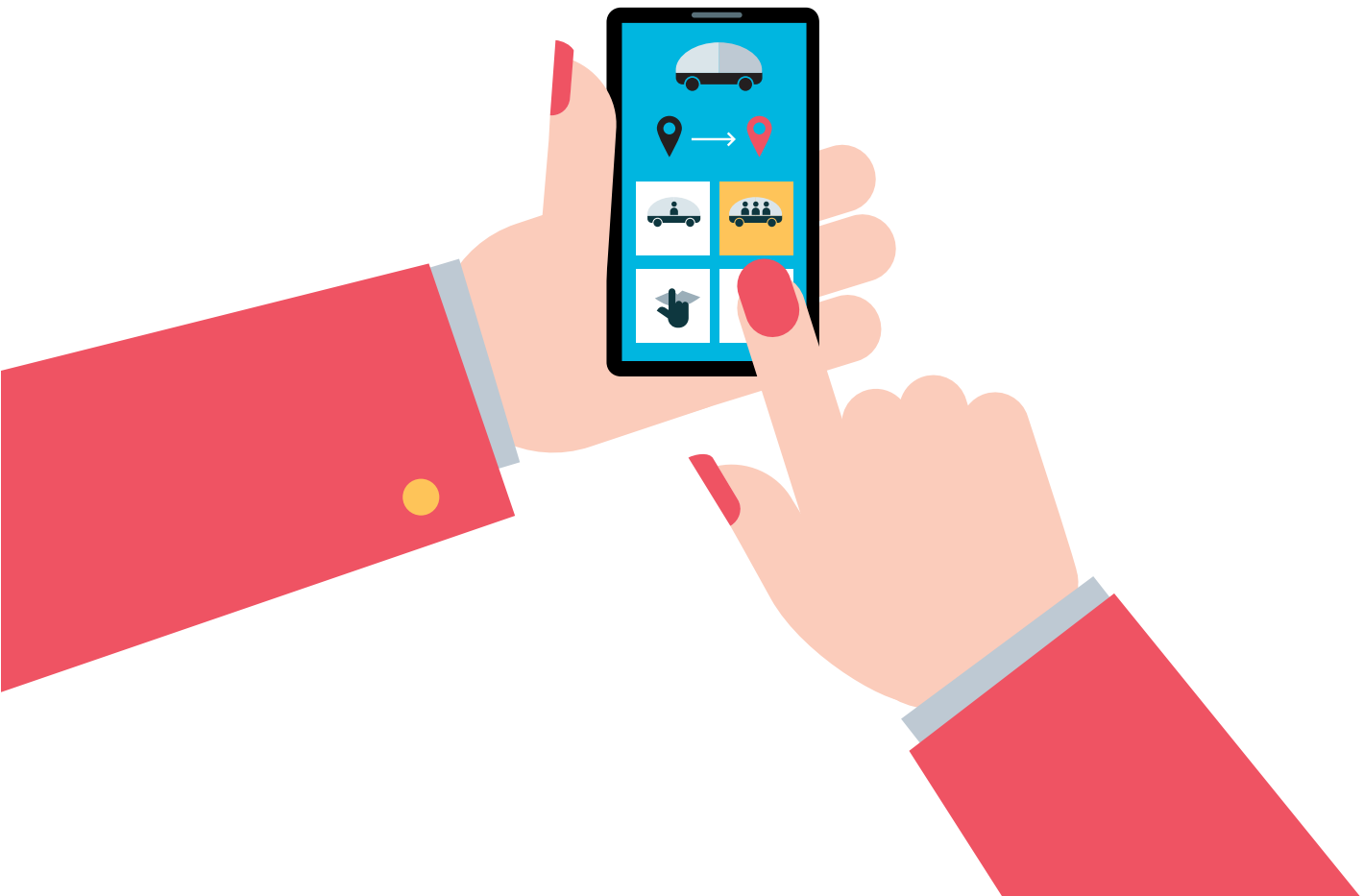
Traffic as an IT challenge

For the most part, currently authorised car models with driver-assistance systems or partial automation process the sensor data collected themselves. But to increase efficiency, self-driving cars should be able

to exchange data with other self-driving cars, with the traffic infrastructure and with their surroundings. Data exchange is necessary to optimise choice of route, adjust light signals to the flow of traffic and link the various private and public transport modes to form actual chains of transport as well as to enable individuals having the same travel destination to form a carpool. In other words: only if a comprehensive flow of data among all traffic participants is guaranteed can a cooperative, intelligent traffic system be created – one able to efficiently use existing infrastructure capacities. Smartphones (or the latest technological development) could play a key role in connecting pedestrians, cyclists and public transport with individual, private automobiles.

It is, however, clear that the technical issues and challenges with regard to data privacy are considerable. Very different kinds of data must be processed: personal data, i.e. name and age, in addition to current location, destination, other mobility needs and resources and – with an eye to payment modalities – a bank account, if needed. Other required data include information about the vehicle, its location, size and number of passengers. Finally, data on infrastructure are collected, for instance, construction status, current weather conditions, current number of vehicles on and traffic capacity of a specific route.

Concerns surrounding data privacy are especially relevant with regard to personal data, even if these can technically be anonymised. Moreover, government officials must observe the statutory provisions that determine the governmental tasks for which the data may be accessed. By contrast, a private company – for instance, within the automobile industry – simply needs permission from the user to gain access to these data. Already today, automobile manufacturers have discretionary access to the data generated by a car via the contractual sales agreement. Nevertheless, it is often difficult to determine why and to what degree data are collected and used. Moreover, when a vehicle's sensors provide information on the surroundings at large, the data collected are no longer restricted to the owner of the vehicle.



Who would benefit from self-driving cars?

Self-driving cars have the potential to increase the mobility of individuals who are not able to operate a vehicle themselves. A fully automated vehicle would allow older people or persons with a disability to independently go to a doctor's appointment, and parents would no longer have to provide a «taxi service» to pick up their children at all hours.

Commuters also see potential advantages in self-driving cars. In the time spent commuting by car, they could take care of administrative tasks and conduct meetings, for example, by phone (which is currently against the law) or by video conference. The expectations are equally high in the logistics branch: some 50 per cent of all expenditures of a transport company go towards paying the salaries of drivers, and self-driving lorries would lead to considerable savings. Public transportation networks are interested in smaller self-driving shuttle buses that transport passengers on demand in sparsely populated regions or that can be used to extend services to off-peak hours .

More freedom or more traffic?

If the new technology enables individuals who previously could not drive to operate private vehicles, a further increase in motorised private transport is to be expected. Nevertheless, self-driving cars could also give rise to new offers in public as well as collective transport. Private individuals could use their cars to create ridesharing opportunities – it is predicted that «public individual transport» options will arise that are able to accommodate the needs of passengers while also maintaining flexibility with regard to both the timetable and the pick-up/drop-off location. These collectively operated private cars would also be capable of driving passengerless and, in keeping with the model «mobility on demand», would pick up and drop off people at their location of choice.

Experts believe that collective transport options mean that the mobility demands of the population will be covered by fewer cars on the road. If private transportation were shifted from driving one's own car to sharing a fleet of automobiles, optimistic forecasts claim the overall number of cars on the road could be reduced by over 80 per cent. Cities would then require fewer garages and parking spaces, and valuable urban space could be used for public parks or residential buildings. In rural areas, by contrast, self-driving cars are likely to exacerbate urban sprawl, as people would have less motivation to consider access to public transport when choosing a place to live.

Whether self-driving cars will ultimately lead to more efficient mobility or primarily cause ever-greater flows of traffic is currently difficult to predict and is largely dependent on the future regulatory measures introduced. Experts are also in disagreement on when a majority of vehicles will achieve which automation level. What is certain, however, is that automobile manufacturers and an increasing number of IT companies are working on developing self-driving cars. To ensure that Switzerland is not overwhelmed by the development, it is important to already now begin considering ways to integrate the predicted innovations into the country's traffic system.

Law and ethics

The challenges surrounding mobility and traffic are not limited to technical issues. Legislation such as the Road Traffic Act and the Passenger Transport Act must also make provisions for the introduction of self-driving cars. A broad-based discussion of several fundamental issues is necessary.

Motorised vehicles are only allowed on Switzerland's roads after they have received type approval. The Federal Roads Office (FEDRO) determines whether a vehicle type adheres to Swiss regulations. The cantonal driver and vehicle licensing offices are responsible for issuing approval. The vehicle registration authorities, however, currently do not have type approval procedures to assess whether an automated vehicular system at levels 3 to 5 meets the necessary – yet to be defined – safety requirements. For this reason, these types of vehicles are currently only authorised by way of a special permit that also regulates liability.

International harmonisation indispensable

It is not solely Swiss regulations that govern Swiss traffic: due to cross-border traffic, Switzerland will face considerable pressure to adopt the authorisation procedures of neighbouring countries.

Minimal standards for an international coordination of vehicle authorisation and traffic rules are set out in the Vienna Convention on Road Traffic, which stipulates that a vehicle must be operated by a driver at all times. In March 2016, the Convention specified that the driver at the wheel must be able to deactivate or override automated assistance systems. The requirements for transferring control to autonomous steering systems have not yet been agreed; ensuring a safe transition to a self-driving car from a car steered by a human being will be a particularly relevant issue.

Virtual driving

Today, a driver must possess a licence attesting his or her ability to operate a car. Theoretically, such a licence would be superfluous for operating a self-driving car, although other skills might be required – and proof of these skills would be necessary, as interacting with highly automated vehicles is potentially complex and operating them can pose corresponding challenges.

One possibility is the introduction of new licence categories according to the specific automation level of a vehicle. Mixed license categories would also be conceivable: to compensate for deficits in an individual's ability to drive – in older drivers, for instance

– a licence would be issued only on the condition that their car has semi-automated driver-assistance technologies such as night vision and emergency braking systems.

Shared responsibility

The national Road Traffic Act must be amended to allow for self-driving cars, as it requires that every vehicle is operated and steered by a human being at all times. In the case of semi-automated vehicles, the human driver retains liability under both criminal and civil law, as he or she remains accountable. If control of the vehicle is transferred entirely to the automated systems, only causal liability will be generally applicable in future, or in some cases the product liability of the manufacturer – provided the vehicle was not manipulated and was used for its intended purpose. The vehicle owner cannot be held responsible for any programming errors that arise. It should be noted that the legal parameters with regard to using software based on artificial intelligence are not yet defined.

It could also prove difficult to determine exactly why a car broke down or caused an accident – and thus allocate liability. Moreover, errors can occur when collecting and transferring data; the authorities responsible for infrastructure would be accountable in such cases. In future, automated vehicles will have to be equipped with recording devices – like the black boxes used in air travel – in order to register in detail the activities carried out by the system or by the driver and thus clarify questions surrounding accountability.

Rules for ridesharing

Thanks to self-driving cars, new services at the crossroads between public and private transport could arise. For example, «mobility on demand» would be feasible, meaning passengers wishing to leave at the same time for a similar destination would no longer be bound by a fixed timetable. Instead, they could ride in a fully automated and connected vehicle.

However, the Passenger Transport Act stipulates that companies transporting people regularly and for profit must set up a timetable (Art. 13). The corresponding ordinance to the act defines a set of other conditions for companies that regularly transport passengers in vehicles with a capacity for nine or more persons. Transportation offers designed for a larger number of passengers that provide flexible services according to demand and time, route or drop-off point are clearly at variance with prevailing law. As such, the regulations surrounding the transport of persons must be amended if innovative transport services are to be realised.

New ethical challenges

At first glance, self-driving cars have the potential to improve our living circumstances, as they are likely to cause fewer accidents than vehicles driven by humans. Moreover, individuals who are unable to operate a car would enjoy greater mobility and could travel larger distances. As such, self-driving cars promise improved quality in safety and mobility. Nevertheless, standardised safeguards are essential.

Traffic accidents have become less frequent in recent years, but a wrong move at the wheel can still have fatal consequences. Moreover, when enough time remains to react not just instinctively but also prudently, the dilemma tends to take on added significance. In connection with self-driving cars, the choice between several undesirable courses of action further aggravates the issue – is it ethical to delegate reacting to a potential collision to a machine?

From an ecological point of view, the question arises as to whether self-driving cars would effectively lead a reduction in traffic volume and thus play a positive role in protecting the environment.

In addition, self-driving cars are veritable information hoarders. They exchange massive amounts of data with other autonomous vehicles and with their surroundings. This generates questions on how the individual right to one's own data should be politically weighted.

Private cars or ridesharing: three scenarios in the spotlight

Self-driving cars could become part of Switzerland's traffic system in a variety of ways. Three scenarios cover the spectrum of feasible developments and can be used to reflect possible traffic policy goals in Switzerland.

Based on comprehensive analysis of the relevant literature, the TA-SWISS study predicts that digitisation of traffic will progress quickly but that future developments are in no way preordained. In particular, the political sphere exercises a significant influence on how highly and fully automated vehicles will become part of Switzerland's traffic system. As part of the study, three different scenarios were developed that differ mainly in the degree to which the government should work towards greater collective use of self-driving cars.

Individualism shapes the overall approach

The developments in the first scenario are market-driven and largely free from political influence. In this scenario, highly and fully automated vehicles are mainly owned by private individuals who use them for their personal needs, as is the case today with conventional cars. Rides are rarely shared, and cars are often on the road with low occupancy or even entirely empty. The automobile manufacturers guarantee the flow of data required for safe navigation of self-driving cars.

Especially in cities, both individual traffic and cargo transport increases markedly, and infrastructure and energy demands rise correspondingly. The centres tend to be more difficult to reach, as traffic congestion is common during rush hour.

Ridesharing throughout Switzerland

The scenario on the other end of the spectrum envisions collective modes of transportation throughout Switzerland. This solution requires active intervention on the part of the government; energy policy and environmental objectives are given priority and corresponding laws must be enacted and enforced. Collective public transport services are offered and used in both urban and rural regions.

All vehicles are connected with each other and to traffic infrastructure; the vehicles exchange the data collected on a platform that serves all of Switzerland. The communication systems required to secure this type of infrastructure are complex and expensive. Individual passengers must accept that other passengers would want to get in or out at a location that is not directly on their route. In addition, some individuals prefer not to share a ride with strangers.

In order to guarantee a steady flow of traffic, automated and connected driving will be compulsory on certain routes and at certain times. Privately owned vehicles operated for individual use are allowed on the roads only when traffic volumes are low, thus making them uninteresting to own.

Individualism at the periphery, collectivism in the centre

The third scenario presents a version lying between the two extremes described above. In dense urban space, the public authorities create incentives to integrate self-driving cars into the collective traffic system. Cargo transportation is also part of traffic management, thus reducing the number of empty cargo vehicles. Commercial providers of ridesharing services (e.g. group taxis) enter the market, especially in high-demand urban and suburban areas. A high number of passengers continue to use trains, streetcars or buses to travel between urban centres.

In non-urban spaces, where use of the transport network is less intense, policymakers see no need for additional interventions and would allow the market to drive developments. In the peripheries, individual use of self-driving cars is therefore most common.

Aligning contradictory goals

The Federal Department of the Environment, Transport, Energy and Communication (DETEC) has defined strategic goals for future mobility in Switzerland. These goals address the introduction of an efficient, fully functional comprehensive traffic system by 2040 that fulfils sustainability requirements as well. There is, however, friction between the stated goals. On the one hand, it is important that transport systems are safe, reliable, readily available and accessible; individuals should be able to individually choose and combine their preferred mode of transportation. On the other hand, the goal is to significantly reduce environmentally damaging emissions caused by traffic and to design streamlined transport systems that do not adversely affect the landscape or the soil.

In light of self-driving cars in the future, it is also critical that the various, conflicting goals be weighed against each other. The greatest possible individual choice in mode of transportation stands in opposition to an optimal use of infrastructure and a cautious use of financial and natural resources, and the systemic approach partially negates the claims of the individual.

An additional area of friction arises between an economy geared towards growth and efforts to conserve nature. To thrive, businesses rely on a viable infrastructure and they generate higher flows of traffic – which in turn brings about economic benefits. This, however, harms the environment, as vehicles make noise and emit pollution, and roads cut through the countryside and living space.

There is no quick or easy solution to this conflict. Nevertheless, the experts surveyed in the scope of the study are clearly of the opinion that regulatory measures are necessary already today – and not first in 20 or 30 years. They believe a laissez-faire attitude would lead to a pronounced shift from collective to individual modes of transportation, which would culminate in more congestion and calls for additional infrastructure.

Future mobility to the test

In future, self-driving cars will be a regular feature in our everyday lives and traffic systems. The three scenarios developed in the study were discussed with and evaluated by three groups having different perspectives. Interested citizens took part in the first workshop, which was followed by an event for experts. In a third and final round of discussions, government officials, policymakers, economic players and representatives from associations voiced their opinions.

The three groups were charged with different tasks. The participants in the first group were asked to evaluate the three scenarios from their «layperson» perspective to form an opinion on self-driving cars, while the experts focused on various regulatory approaches and their impacts. The stakeholders were then charged with defining the political actions required for maximising sustainable use of self-driving cars.

Ambivalent views in the general public

The participants in the first group welcomed the aspects of convenience and increased safety brought about by self-driving cars while also criticising that the added convenience would boost a certain laziness in users. This ambivalent attitude is typical for the discussion amongst these participants, who were all very sensitive to the issue of data privacy protection, but whose viewpoints differed widely regarding whether the data should be collected by private companies or by the government.

There was also no consensus regarding the role of public authorities. Although a larger role on the part of the government was not rejected out of hand, especially as the scenario with a collective transport system was quite popular, and although individual participants claimed they would personally be interested in a comprehensive, Swiss-wide traffic system, they gave this scenario the lowest probability of finding acceptance in the population at large.

The participants in the first workshop studiously avoided the question of how to solve the ethical dilemma of unequal treatment of individuals in case of an accident in which people come to harm. Nevertheless, they did agree that a systematic algorithm should not be responsible for taking this decision and that a random generator should make a choice, if necessary. They said an even better solution would be programming the relevant software so as to prevent such dilemmas from arising. The participants in the «layperson» group believe that delegating ethical decisions to experts is not a viable option. In general, these discussions revealed that in safety matters, the participants believe more stringent demands should be placed on machines than on humans. The fact that it is problematic to delegate accountability – in the event that something goes wrong – to an automated technical system also led to discussions on the role of the government in regulating self-driving cars.

Doing nothing is not an option for experts

Regulations, market-based incentives, offers in services and infrastructure, technical norms and, finally, communication and dissemination instruments: these are the available tools for traffic management, and they were the main focus of the discussions amongst the specialists.

The range of opinions in this workshop was also considerable. There was, however, agreement in that waiting to act or a laissez-faire approach would likely result in a system having mainly individualistic modes of transportation, which in the end would destroy itself if no regulatory measures were introduced. At minimum, cities and suburban areas would be more difficult to reach due to a considerable increase in traffic, while urban sprawl would likely further progress in rural regions.

Experts see market-based incentives such as mobility pricing as an effective way of managing traffic peaks. Adjusting the price of travel according to the number of passengers in an automobile would make collective transport more attractive. And privileges like separate lanes for cars carrying several passengers or fleets of on-demand «share taxis» could encourage collective modes of transportation. To ensure more sustainability overall, experts also recommend that only self-driving cars with electric motors should be authorised. They also pointed to the fact that self-driving cars will possibly render today's prevailing tools to manage traffic flows ineffective or even counterproductive. For instance, a reduced number of parking places in city centres would no longer prevent people from driving their cars to such areas but indeed cause more traffic, as self-driving cars could look for a parking place on their own, or even drive home again.

The experts believe the scenario with collective modes of transportation in urban centres and individual mobility forms in rural areas has the best chance of succeeding. To protect pedestrians and cyclists, they suggest that reduced speed limits be introduced in zones featuring mixed modes of transportation.

Most regulatory measures discussed in the expert group would fall in the remit of the federal government. But the experts also believe that regional pilot projects could play a key role in promoting public debate on self-driving cars and help to gather experience with the various forms of automated driving. Moreover, they say the important role the individual cantons currently have in buying public transport services will gain in significance when new forms of public individual transport are concerned.

Defining overarching goals for future systems of transportation

In the third group, representatives of mobility providers discussed what they believe to be necessary revisions to the Passenger Transport Act, while government officials stressed issues surround liability. Policymakers were mainly concerned with the role of government, and representatives of associations placed most importance on first agreeing on the political objectives related to highly and fully automated driving. However, because finding a consensus generally takes a long time in Switzerland's political system, it is important to begin developing parallel sets of possible regulatory measures. In this context, experts spoke of an iterative process between defining goals and formulating regulatory measures.

The discussions amongst stakeholders also revealed disagreement with conclusions drawn by the other groups. For instance, they see no pressing need to lower the speed limit in mixed-traffic zones, as they believe self-driving cars will first be authorised for travel on motorways only and that this will remain the status quo for quite some time.

Switzerland as a laboratory for innovation

Because Switzerland has no automobile industry, it is unlikely that the country will function as an innovation centre for self-driving cars. Nevertheless, the three discussion groups generally agreed that Switzerland has the potential to play a pioneering role in integrating innovations into an already highly functional transport network, especially as both the political sphere and the general public are open to new modes of transportation and resources for such innovations are available. The three groups were also in complete agreement over the need to maintain Switzerland's well-established and successful mix of various modes of transportation.

Choosing the right safeguards

Regardless of which scenario becomes reality, Switzerland must develop and introduce a set of measures to regulate self-driving cars. Although the exact date is uncertain, it is clear that highly and fully automated vehicles will sooner or later be driving on Switzerland's roads.

The role and significance of self-driving cars in Switzerland's traffic system will be determined by the political safeguards adopted. These in turn depend on the function and responsibilities the people assign to government. Differing understandings of the role of government naturally result in correspondingly disparate recommendations.

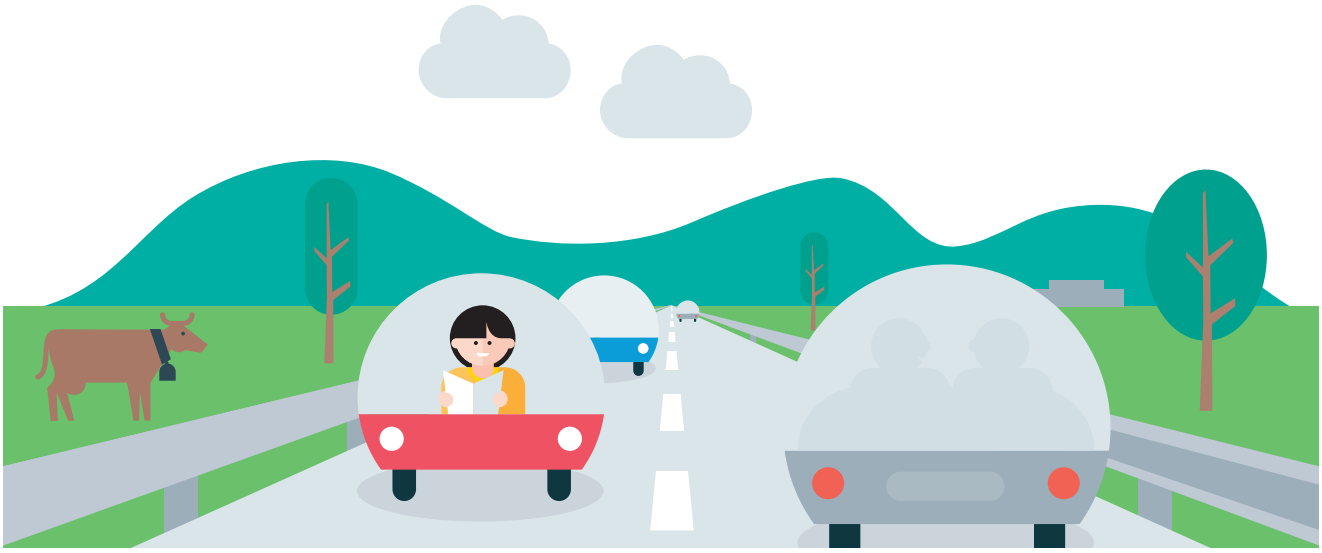
Coordination with other countries and shaping future traffic systems

Even if policymakers and government officials in Switzerland should opt for a passive approach to changes and decide on minimal regulations for self-driving cars, there are developments in neighbouring countries that demand the introduction of several overarching measures.

Switzerland is part of the global market. When automobile manufacturers in Europe and other locations introduce self-driving cars to the market, Switzerland will scarcely be able to isolate itself from the changes. For this reason, coordination with other countries is a necessity to collaborate on defining the conditions for authorising use of automated vehicles (level 3 and up) both for individual modes of transportation and for cargo transport. Liability issues and safety standards must be discussed and defined. If the authorisation of self-driving cars in Switzerland is linked to specific conditions such as having an energy-efficient motor, the relevant requirements must be assessed at an early stage.

Operating a technically sophisticated automated vehicle is under circumstances at least as complex as driving a standard car, a fact that makes driver training and further training for operating (fully) automated vehicles necessary.

Beyond these indispensable measures, there are two other basic pathways for how the government can deal with the introduction of self-driving cars to Switzerland's roads: either as an «enabler» or as a «leader».



An «enabler» that ensures responsible use of data

As an «enabler», the government can assume a constructive yet limited role in which it restricts its actions to defining liberal-economic framework conditions that permit both private and governmental players to drive market innovations and developments. Should Switzerland decide to promote use of self-driving cars as an «enabler», the following recommendations would supplement the measures described above:

The Passenger Transport Act would have to be revised in order to allow innovative transport services to be developed and offered on the market. The act should authorise new transportation providers and encourage more flexible collective transport services.

It is necessary to conduct discussions on how the collected data may be used, because the efficient use of highly and fully automated vehicles requires that the vehicles are connected to each other as well as their surroundings and able to exchange data. The general public must receive detailed information about the opportunities and risks surrounding the use of the data collected. Moreover, the government must clarify and define its data policy in order to safeguard the public's interests. This includes identifying which data are essential for conducting state business and clarifying data ownership and access rights. Finally, consideration should be given to creating an open data platform where all participants share their data and have access to the data of others.

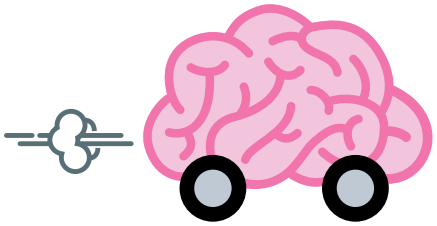
To ensure road safety, data exchange must occur in real time. As such, fast transmission is necessary. Instead of retaining the current system of a mobile network maintained by several providers, a state-run system akin to a «utility network» could be considered; private companies could also offer their services on this network.

A «leader» that defines mobility goals

Taking clear political objectives as a basis, the government could also adopt a «leader» role and actively prescribe regulatory measures designed to either restrict or delay the automation developments and interconnectivity in transport systems or, to the contrary, to promote specific aspects in such systems. If the government assumes the role of a «leader», the following measures and instruments should be implemented in addition to the previously described recommendations:

Should the government become a decisive factor in promoting a global Swiss traffic system, it is important to elaborate ideas and suggestions that strengthen collective modes of transportation and ensure that traffic management is governed by the highest authority. In addition, the technical systems implemented as well as the accompanying safety standards must be specified. In these processes, future targets for mobility in Switzerland must equally consider the needs of the federal government, the cities and the cantons as well as those of society and the economy.

The political objectives for future traffic systems in Switzerland must meet with broad acceptance in the population. For the government to take on an active, leading role, it is essential that policymakers, economic players, governmental officials and the general public engage in a comprehensive debate on how future mobility systems should be designed.



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