



**TECHNOLOGY-ENABLED MOBILITY:  
VIRTUAL TESTING OF AUTONOMOUS VEHICLES  
AND CHANGES IN URBAN MOBILITY PATTERNS**





## TECHNOLOGY-ENABLED MOBILITY

In the era of the digital revolution everything is inter-connected. And so, even mobility became digitized. Whilst the introduction of the first advanced driver assistance systems laid the cornerstone for self-governing cars in the mid-1990s, today, 20 years later, fully automated vehicles are no longer simply a vision. It's only a matter of time before algorithms replace humans at the steering wheel and fully automated vehicles seize inner-city streets and highways. Until then, the intelligent vehicles require only one thing: practice. They need to be taught how to act in a civilised manner. Now entering the final stages of testing, validation and safety checks, the automotive industry is accessing the next phase in the evolution of the car.

Along with the vehicular evolution new digitized mobility models are emerging, such as the concept of shared mobility, which will revolutionise not only the way people move and goods are transported, but they might also change the entire society. The technological trends determined by car manufacturers pose challenges to the cities, but what these challenges will be, is yet to be known. While the industry has already turned visions into reality, the future for cities begins now. They are about to align their strategy to shift the challenges of new forms of traffic into opportunities. And the transition in mobility patterns promises to bring many benefits: Less traffic, reduced congestion, lower emissions, better land use, a decrease in traffic accidents, as well as many other advantages.

The state-of-the-art solutions by the PTV Group enable both the automotive industry to simulate and virtually test the impact of automated vehicles, as well as municipalities to perceive the potential the changes of technology-enabled mobility will bring and define sustainable concepts for better cities.



# BENEFITS

## BENEFITS FOR THE AUTOMOTIVE DEVELOPMENT



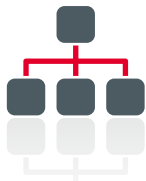
### VIRTUAL TESTING OF AUTONOMOUS VEHICLES

Apply PTV Vissim, the world's leading multimodal microscopic simulation software, for the evaluation of the behaviour of any level of automated vehicles as a cost-effective and efficient alternative to field testing. The capability of the software to model all modes of transport and their interactions integrated in a single tool allows users not only to test the dynamics of automated vehicles but also to convey a valid assessment of all traffic-related aspects.



### MAXIMUM ACCURACY TO DETAIL

Achieve the maximum accuracy to detail with PTV Vissim. With ready-to-use standardised and customisable scenarios provided in the software, users may test any possible scenario as complex as in reality. The ability to depict local factors in the simulation, such as any existing type of roads or streets, as well as to take into account local driving behaviour or even weather conditions, such as rain or fog, prove PTV Vissim can be applied for any scenario testing – whether it be in Paris, New York City, Rio de Janeiro or Tokyo.



### FLEXIBILITY & INTEGRATION CAPACITY

Opt for a virtual reality tool that can be customised to suit your needs and that can be fully integrated with other vehicle development solutions such as vehicle dynamics simulators. Furthermore, generic interfaces guarantee that PTV Vissim is a perfect fit for any other application used for the testing of autonomous vehicles, as well as all specialised software solutions like sensor simulation.



### SCIENTIFIC APPROACH

Rely on a software package that is based on decades of intensive research, close networking with customers and continuous development. You will have access to a stable simulation tool that always incorporates the latest findings from research and that sets new standards.

## BENEFIT FOR THE CITIES



### ALL-ROUND SOLUTION FOR STRATEGIC ASSESSMENT OF MOBILITY CONCEPTS OF THE FUTURE

Prepare your city for changes driven by technology-enabled mobility with the state-of-the-art solutions and services by the PTV Group. Trust a company who is engaged in understanding the future of mobility and effect it will have in the cities and mobility as a whole, changing the way we go about day-to-day-life. Providing integrated tools, the PTV Group is the technology company that has driven the understanding of the impacts these will bring and assist cities, regions and governments to embrace tomorrow's mobility.

# SOLUTION FOR THE AUTOMOTIVE DEVELOPMENT:

## VIRTUAL TESTING OF AUTONOMOUS VEHICLES

New technology enables cars to become more and more independent. Today, fully autonomous vehicles are ever more developed. However, the same way as humans need assistance in order to reach maturity, cars also need professional guidance during the development process until they become fully independent. The way in which vehicles equipped with advanced technology move, may be observed in reality - yet the examination of their behaviour in the field is a costly and time-consuming endeavour allowing to only test a limited number of scenarios. Virtual testing with a microscopic traffic simulation offers a cost-effective and efficient alternative.

### VIRTUAL REALITY IN PTV VISSIM

























PTV Vissim, the world's leading multimodal microscopic simulation software, enables car manufacturers to virtually evaluate the behaviour of any level of automated vehicles in a thorough manner. Applying PTV Vissim, means being able to create a comprehensive virtual testing environment representing the real world: Through the software's capability to simulate all modes of transport depicting their very own motion characteristics and their mutual interaction, users can not only examine the driving behaviour of autonomous vehicles but also their impact on the entire traffic flow.

### TESTING OF ANY POSSIBLE SCENARIO

Whether testing the behaviour of autonomous vehicles in the context of city traffic during rush hour or on motorways with or without speed limits - PTV Vissim provides car manufacturers with a powerful set of functionalities to conduct virtual reality tests for any situation possible. With the provision of ready-to-use standard and customisable traffic scenarios, the software enables users to take into account all local conditions such as street or road types in all cities around the world - whether it be Paris, New York City, Rio de Janeiro or Tokyo. Even the evaluation of extreme scenarios where weather conditions such as rain, fog or even snow might need to be considered in the simulation is possible, thus proving PTV Vissim to be a valuable testing environment and as realistic as testing in the real world.

### SYSTEM INTEGRATION

PTV Vissim can be fully integrated with other vehicle development tools like vehicle dynamics simulators. With a number of interfaces, the simulation tool is a perfect fit for any other application used for the testing of autonomous vehicles, as well as specialised software solutions like sensor simulation.

SAE Level	Name	Steering, acceleration, deceleration	Monitoring driving environment	Fallback performance of dynamic driving task	Virtual testing in PTV Vissim
0	<b>NO AUTOMATION</b> the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems				
1	<b>DRIVER ASSISTANCE</b> the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task				
2	<b>PARTIAL AUTOMATION</b> the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task				
3	<b>CONDITIONAL AUTOMATION</b> the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene				
4	<b>HIGH AUTOMATION</b> the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene				
5	<b>FULL AUTOMATION</b> the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver				



# OPPORTUNITIES FOR CITIES FROM CHANGES IN URBAN MOBILITY PATTERNS

As of 2014, around 1,23 billion passenger and commercial cars were used on streets across the world. With every year, this number continues to grow, causing even greater congestion in megacities and mid-sized cities. The average usage of passenger cars, which dominate the share of modal split with 907 million of them, is estimated to be 50 minutes per day. In order to prevent a collapse of the mobility system, the world needs to change for the better. Bringing change by making improvements is the key task of technology. And the latest technological advancements are promising for the world's mobility. New, already existing technology-enabled mobility systems such as car sharing or ride sharing, as well as autonomous vehicles in the coming future will revolutionise urban mobility patterns, possibly with some very disrupting effects. It is certain however, that those new developments have the potential to create sustainable and efficient mobility solutions. The industry is driving the technological transformation intensively. It is worthwhile for cities to take a look at these evolving technological changes which are unfolding before them. Defining how to actively and effectively shape mobility constitutes a strategic challenge. Therefore, it's crucial for municipalities to recognise the opportunities arising and to align their strategy for the future, as it will be game-changing for those who are prepared.

## OPPORTUNITIES FOR CITIES FROM TECHNOLOGY-ENABLED MOBILITY SYSTEMS

### ► Sustainable Mobility

Mobility customers look across a variety of options seamlessly adapted to their mobility needs. With values changing towards using resources efficiently, they re-think their relationships with cars, using on-demand mobility services such as car and ride sharing with growing acceptance. This new supply, combined with a shared fleet of self-driving vehicles, as well as high-capacity public transport, may remove up to 90% of all cars in a mid-sized city and thus reduce congestion on the roads.

### ► Environmental efficiency

A big step towards becoming cleaner and more energy efficient has already been made by the industry. A drastic reduction in the number of cars replaced by technology-enabled mobility, as well as through the optimisation of driving and trips, bring the possibility to address even more ecological issues, such as the reduction of CO<sub>2</sub>.

### ► Improved accessibility

New offerings of mobility as a service, as well as on-demand autonomous vehicles, offer better accessibility and travel flexibility to all. New mobility services promise to make everyday trips considerably easier - for elderly and disabled people, as well as those living in sub-urban areas.

### ► Road safety

Approximately 90% of road traffic accidents are caused by human errors. Driverless cars as well as those equipped with advanced driver assistance systems may reduce accidents, enabling cities to create a safer environment for all road users and at the same time achieve Vision Zero.

### ► Re-definition of logistic supply chain

Automated commercial fleets, as well as automated drones designed for parcel delivery are being already tested in the field. Automation technology will open the way to optimise the logistic supply chain and operations by increasing efficiency and flexible distribution.

### ► Better land use

Technology-enabled mobility services might change society's mobility behaviour. This means, a city may be able to reduce up to 80% of off-street parking and potentially remove the need for all on-street parking. In turn, vast spaces become free, allowing the development of a city focused on its citizens.



**PTV GROUP**

Haid-und-Neu-Str. 15  
76131 Karlsruhe, Germany

**+49 (0) 721 96 51-300**  
[traffic.info@ptvgroup.com](mailto:traffic.info@ptvgroup.com)

[vision-traffic.ptvgroup.com](http://vision-traffic.ptvgroup.com)  
[youtube.com/ptvvision](https://youtube.com/ptvvision)