

UMV

NEXT GENERATION CAR

Urban Modular Vehicle



UMV

The Urban Modular Vehicle (UMV) is an intelligent electric vehicle for tomorrow's urban mobility requirements. The modularity of the UMV applies, for example, to the possibility of displaying different derivatives on one platform.

INTRODUCTION

NEXT GENERATION CAR

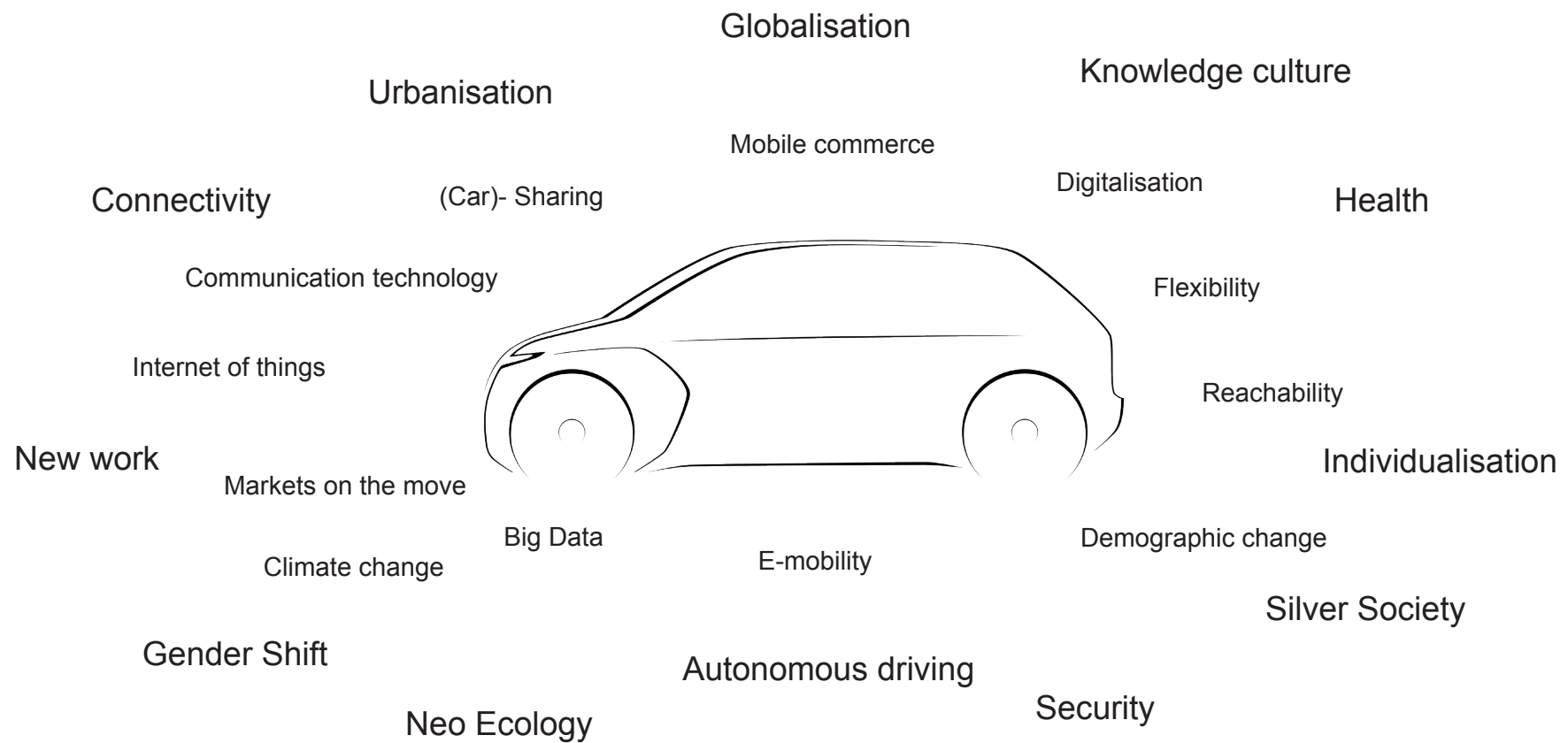
CONCEPT

URBAN MODULAR VEHICLE

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Future trends



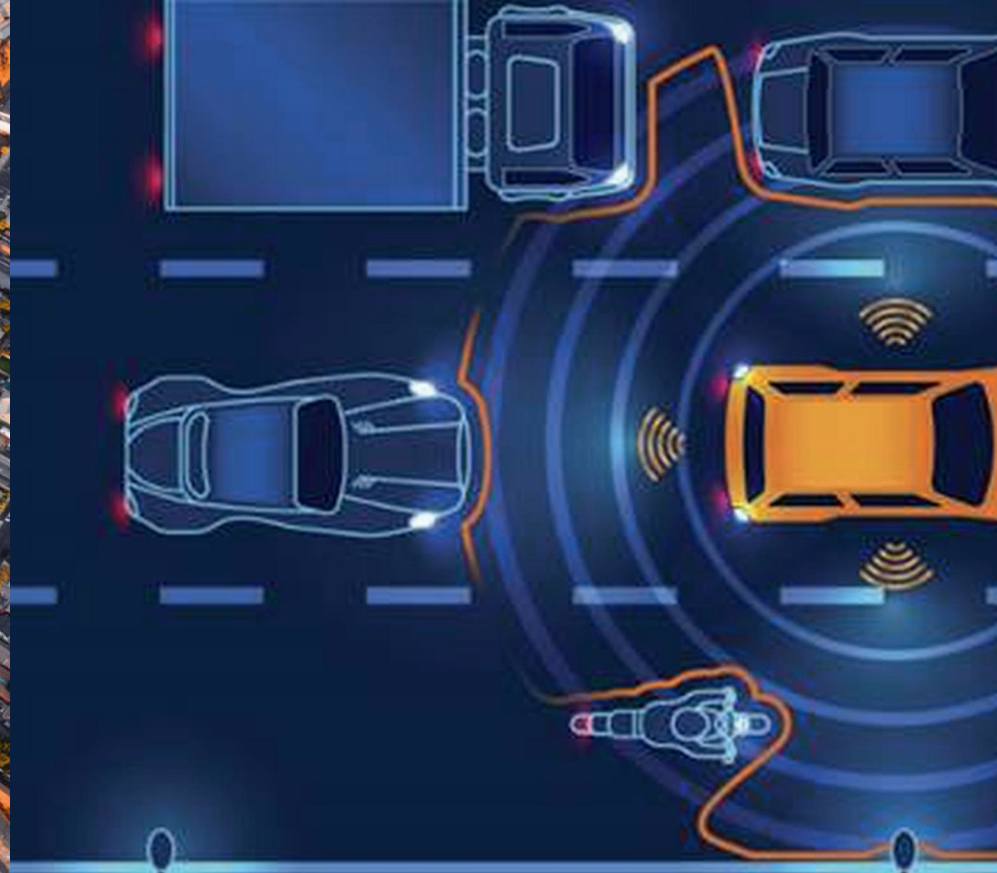
Vehicle technology & drive

Transport systems are experiencing dramatic change worldwide. The entire mobility sector is about to undergo a transformation driven by the dynamics of electrification, digitalisation and automation. The possible effects on future mobility and how terrestrial vehicle concepts will meet customer needs and offer user-oriented and individualised transport solutions are broad and diverse. The challenges to the development of environmentally sound solutions that are economically and technically feasible on the way to the mobility of the future require intensive efforts both in basic and application-oriented research.

Various future trends influence these systems, such as autonomous driving, the origins of which date back to 1925. Almost all major automobile manufacturers are currently working on technology for autonomous driving. There are already smaller start-ups with the first fully autonomous vehicles on the market today, and by 2035 up to 17 % of private vehicles in Germany could be fully autonomously driven (Trommer et al., IFMO, 2016). Autonomous driving is intended to increase safety and system reliability, optimize traffic flow and improve flexibility and comfort.

Parallel to autonomous driving, recent years have seen the promotion of research into the use of renewable energies in vehicles as a result of climate change and the decline in the use of fossil fuels. To reduce CO₂ emissions the aim is to cover more than one quarter of the global energy needs by renewable energies (International Energy Agency, IEA). To some extent future electric drive technologies for vehicles such as fuel cells (FCEV), batteries (BEV) or hybrid drives (HEV) all face the problem of short range or poorly developed infrastructure for charging or refuelling. Different types of drives offer different advantages depending on the vehicle type and location. Battery electric vehicles are suitable for short city journeys, whereas the fuel cell is more suitable for longer distances as it is capable of longer ranges.







Information and communication technology

Information and communication technology will continuously provide the driver with the necessary information concerning the vehicle and its surroundings. It will also provide entertainment and convenience. In the future safe, autonomous driving will use artificial intelligence that will enable the early detection of dangers or compensate for driver errors. Car manufacturers like Tesla are already using computer programs that can learn from the driver, memorize frequently used routes or imitate driving styles.

Vehicle networking, which is summarized under the term Connected Car, the car can alert the driver to the need for a workshop service, download software updates, make an emergency call in the event of an accident, communicate with other vehicles or road users, open the garage door or warn of traffic situations that are not yet visible, such as drivers going the wrong way down a carriageway or traffic jams. European automobile manufacturers have agreed on a common communication system called WAVE.

Infrastructure development and use

By 2030 the world's population will grow to approximately 8.3 billion people (National Intelligence Council, 2012) and the average age will rise to 34 years as life expectancy continues to increase. The increase in population and the growing regional disparities will place a heavy burden on the infrastructure, particularly in urban areas. This will call for flexible transport choices, especially in densely populated areas; the best means of transport will be selected for each route depending on price, travel time, comfort and lifestyle (ifmo, 2010). Mobility options will become increasingly diverse. Besides the various types of public transport, car sharing, bike sharing and carpooling will be on offer. Mobility apps help to show what is available and the best travel connection. This means that a person's private vehicle will spend more time parked, though seldom completely eliminated (ifmo, 2015)

NGC Metaproject

As part of the Next Generation Car (NGC) project, DLR scientists are researching vehicle concepts, technologies and mobility solutions for the road vehicles of the future.

The key challengers are:



- Reduction of the absolute energy requirement of vehicles
- Avoidance of harmful emissions, especially CO₂ and noise
- Resource conservation through the use of fuels from renewable energy sources
- Increased safety of vehicle occupants and road users
- New technological possibilities such as the networking of vehicles with the urban and interurban transport and energy infrastructure.

In the Next Generation Car, research will focus on developing holistic vehicle concepts for the road vehicle market in 2030. Cars should then be lighter, quieter, more networked, more comfortable and safer than they are today and, if necessary, also drive autonomously. They should have a lower energy requirement, use energy carriers from regenerative energy sources and generate fewer emissions.

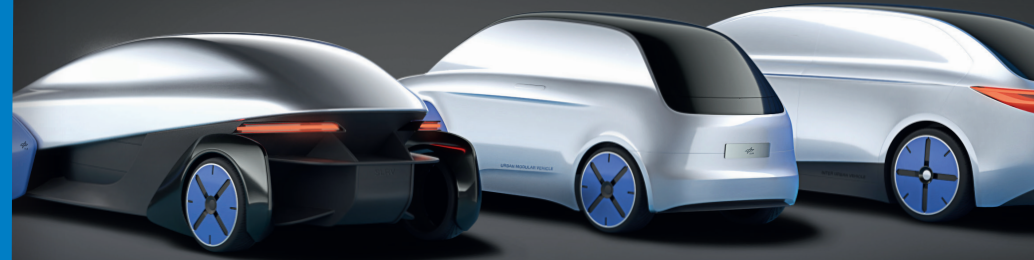
The Next Generation Car project involves 16 DLR institutes working together. The extensive competences of all institutes in different disciplines

are being used on the one hand to research the higher-level requirements of mobility needs, user behaviour, environmental protection and traffic systems and on the other hand on the technological level to develop new solutions for materials, components and systems for future vehicles.

Development of innovative vehicle concepts for the mobility of the future

Demonstration of DLR key technologies

Platform for industry cooperations

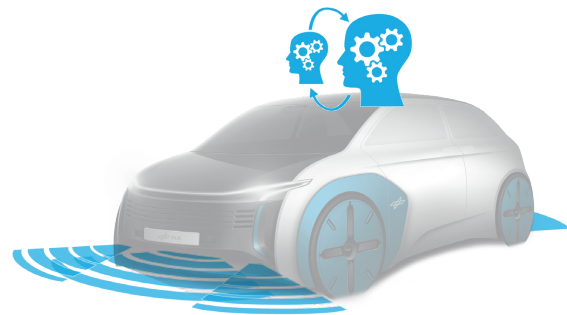


The NGC working groups

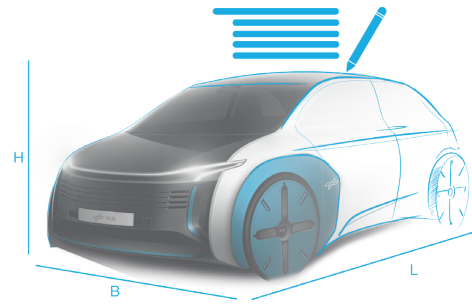
In the six research fields of vehicle concepts, vehicle structures, powertrain, energy management, vehicle intelligence and mechatronic chassis, DLR is developing technologies and solutions that will be suitable to meet future mobility requirements in the urban, long-haul and goods transport sectors.

Our vision for road vehicles is to fully integrate them into an overall mobility system, including energy and communication infrastructures. In the future we expect road vehicles to have significantly lower energy requirements, to be electrified and/or use alternative fuels, thereby reducing emissions. They will be lighter and quieter than today's vehicles, smarter and more networked, and will be able to actively balance driving errors and drive autonomously when required. For users, they will be more individual, more variable and more convenient.

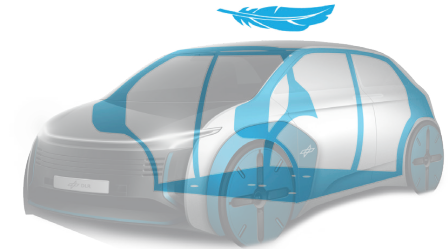
Against this background and taking into account the DLR programme Traffic Management and Transport System, e.g. socio-economic dynamics and possible future mobility use, we have systematically derived our approach to the Next Generation Car (NGC) to develop vehicle concepts with solid requirements and solutions. This has enabled us to develop next generation virtual target vehicles. The project comprises a total of three individual vehicle concepts: NGC Urban Vehicle (UMV), NGC Interurban Vehicle (IUV) and NGC Safe Light Regional Vehicle (SLRV).



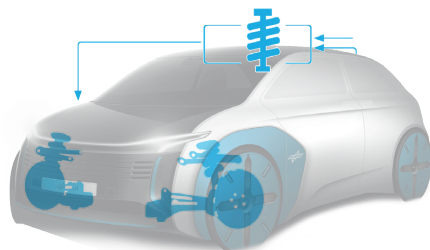
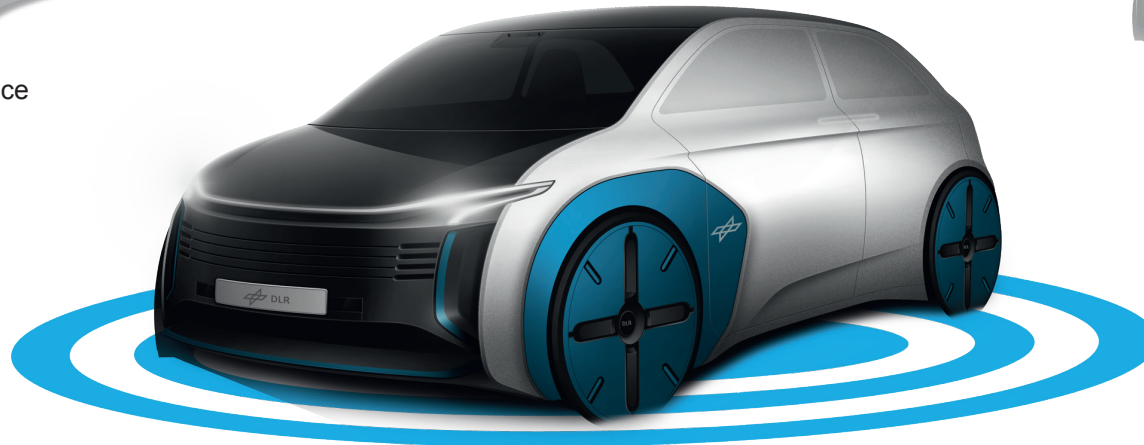
Vehicle intelligence



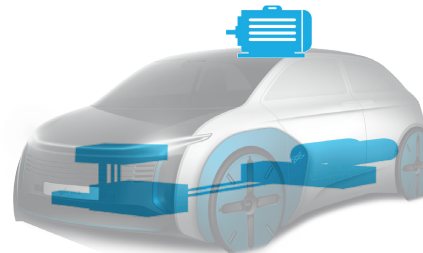
Vehicle concept



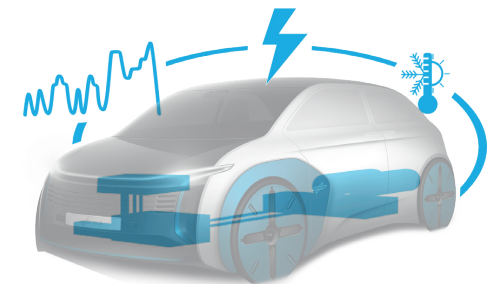
Vehicle structure



Chassis



Drive train

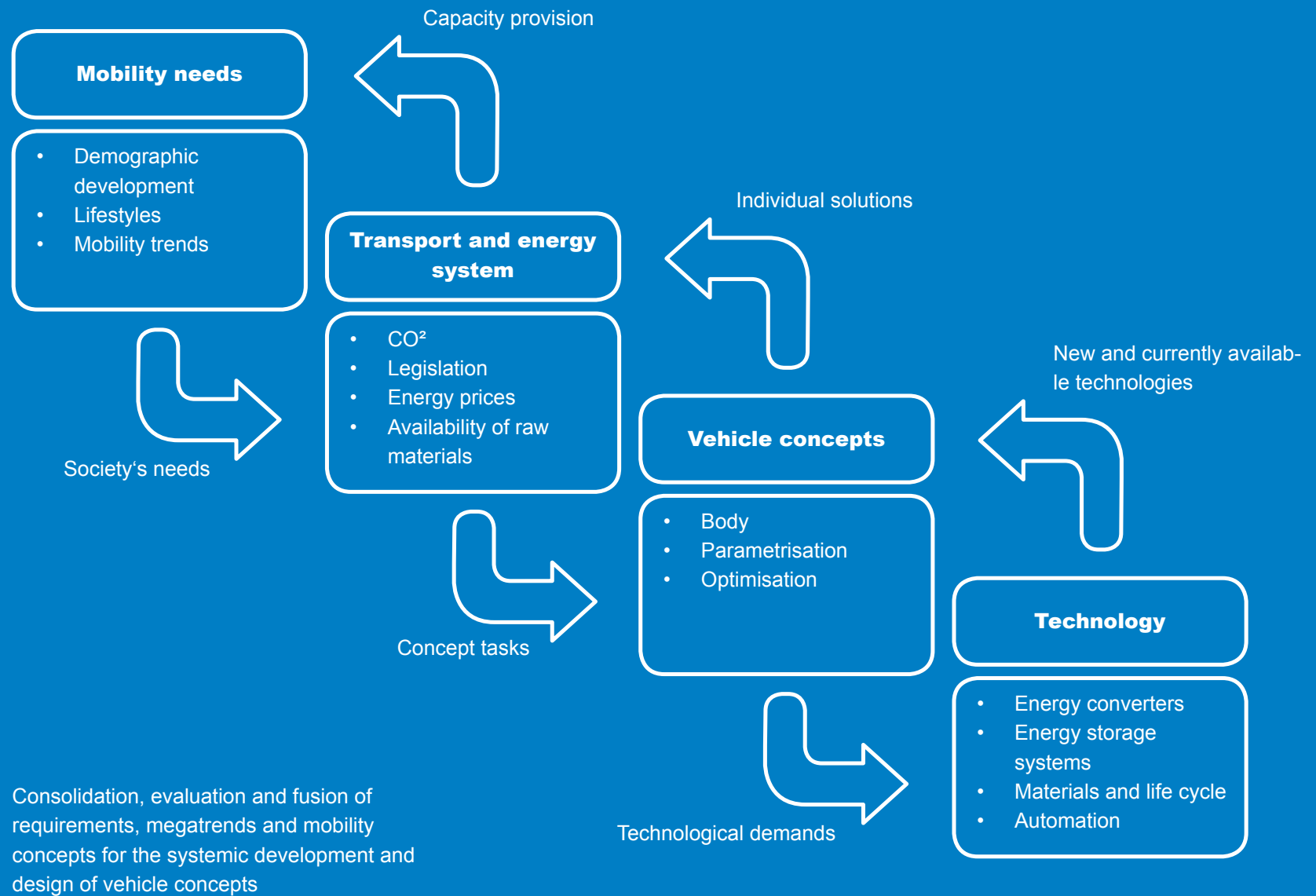


Energy management

All research activities and technology developments have been reflected and aligned in accordance with the requirements and objectives defined by NGC. Systemic relationships have been presented and existing contexts analysed. The research results served to improve databases and develop new, advanced solution concepts and development methods. The foundation for the implementation of this comprehensive approach was the close networking of our research competencies over many years:

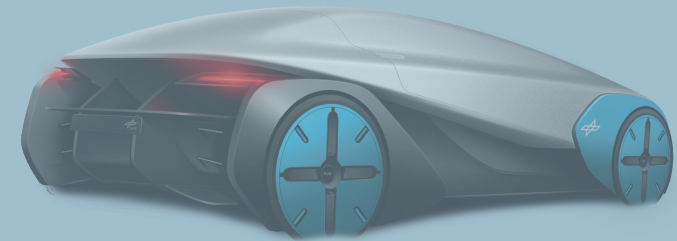
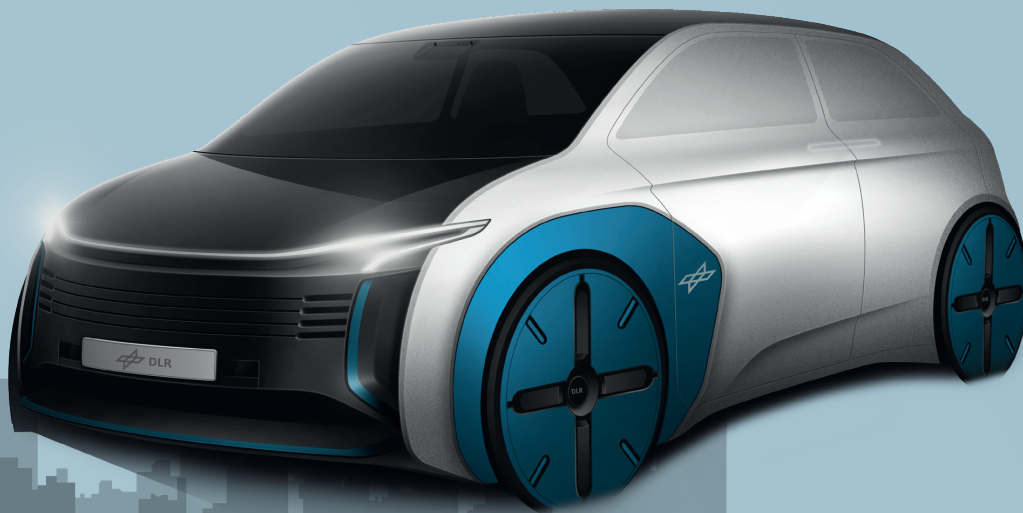
- Design, calculation, technical design and simulation of vehicle energy architectures and drives, chassis and body structures
- Development and integration of new material concepts as well as material and joining technologies
- Understanding of systems engineering for fuel cells and vehicle batteries, hydrogen storage and alternative fuel
- Synthetic capabilities for active and passive safety technologies
- Development of new solutions in aerodynamics and driver assistance
- Economic and ecological evaluation of vehicle technologies through the development of technology scenarios

There are specific DLR requirements for the work being carried out in the NGC vehicle project. These include, for example, the use of hydrogen as an energy carrier, comprehensive approaches from aviation and automotive via uniform evaluation methods, simulation and validation tools or holistic development approaches with interdisciplinary simulation methods at system and component level.

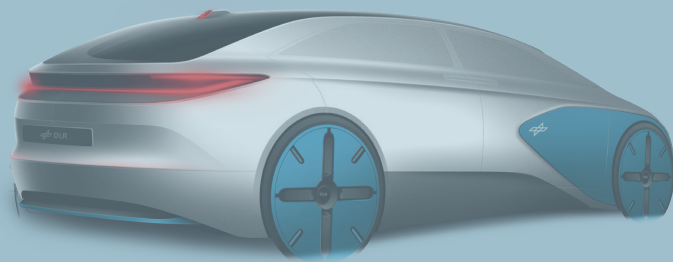


In addition to the UMV designed for urban areas, the NGC project also includes the Inter Urban Vehicle (IUV) for long-distance trips from city to city and the Safe Light Regional Vehicle (SLRV) as a safe short-distance concept or commuter vehicle.

Vehicle size



Range



Urban Modular Vehicle

The UMV Basic/Long is a 2+2 seater with a length of approx. 3700 mm / 4100 mm. At a height of almost 1640 mm, the UMV offers good visibility and an ergonomic entry height due to its double floor for housing the battery. With a battery capacity of approx. 38 kWh, the UMV achieves a range of approx. 400 km with a curb weight without battery of 680 kg and a payload of 390 kg. The basic version of the UMV's near-wheel drives achieves a rated output of 2×25 kW and accelerates the vehicle to up to 140 km/h.

The interior is characterised, as predestined for a city car, by adjustable, foldable to rotatable seats and provides different usage scenarios for singles up to the young family. The range of assistance systems in the UMV basis ranges from assisted to fully automated. The cargo derivatives have the capacity to transport up to 2800 l with a suitable construction behind the front seats in a normal and long version. The people and cargo mover derivatives, which show the maximum development of the trend towards fully autonomous driving at SAE level 5, provide an effective research platform on which the impact of the technology on concept and structure can be researched.

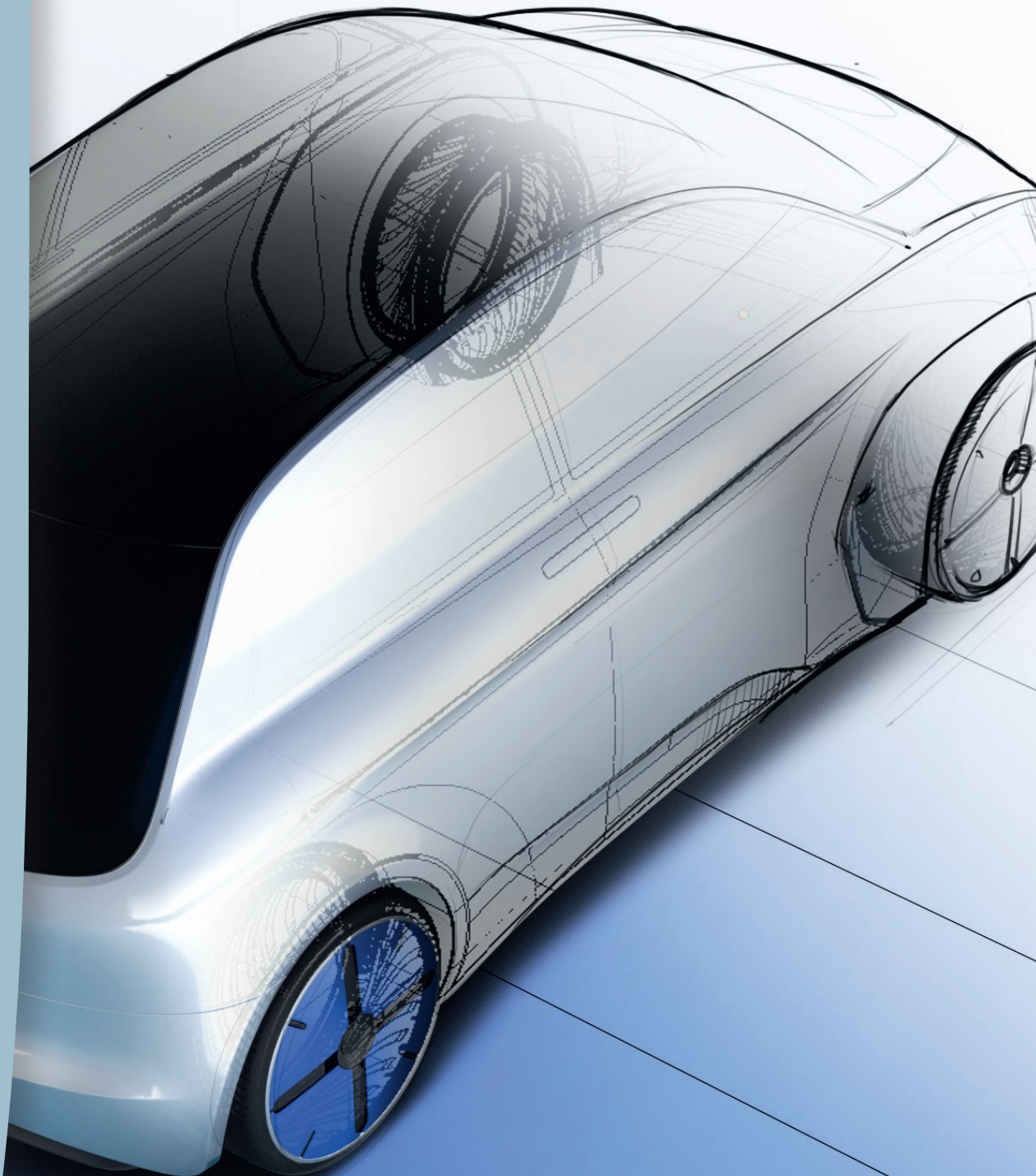
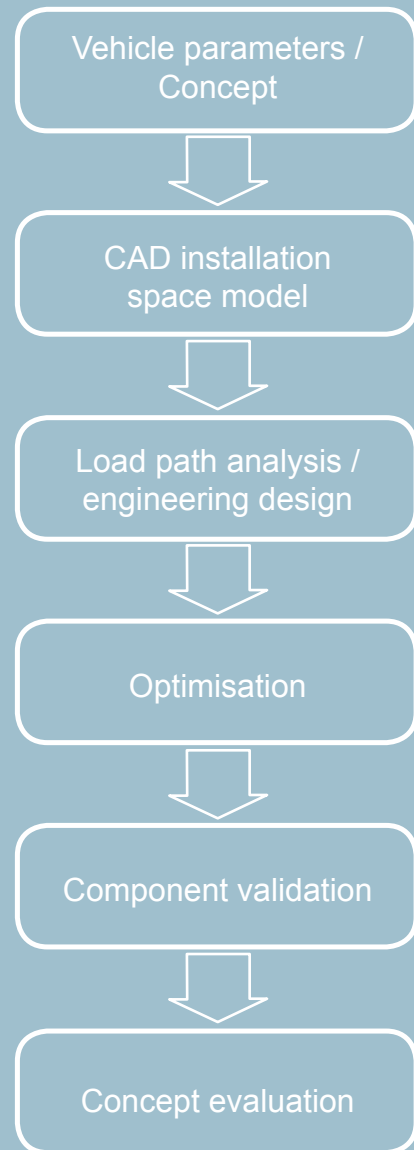
UMV Vision

The global trends of urbanization, modularization, electrification and high levels of automation require the systematic development of new vehicle concepts and bodies with new degrees of freedom and requirements. The UMV's modular system is suitable for a wide range of models from small cars to fully autonomous delivery vans.

Methodical approach

The holistic process model from the vehicle concept to the modular design of the UMV begins with the definition of requirements for the most relevant, quantifiable parameters describing the vehicle concept. The package and the dimensional concept of the vehicle are subsequently defined and brought into line with the vehicle design. To do this a parametric installation space model is constructed with which different package variants are represented and evaluated.

The package that corresponds best to the requirements is transferred to the body development phase. The aim there is to design the optimum body structure for a purely electric vehicle. Topology optimisation is used to analyse load paths at the overall vehicle level. For the development of two body structure variants, a systematic body design kit and a body database are used. One variant is then systematically partially validated at different prototype levels. The car body is designed for selected crash load cases relevant for battery electric vehicles. As a prototype validation load case, the pillar crash is selected for the new type of floor crash concept and tested on a component crash system.



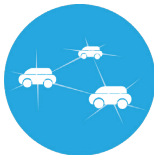
The focus of the UMV results from increasing urbanization, electrification and the introduction of autonomous driver assistance systems. The following key areas are consequently derived for UMV Vision:



Urban & Shared

The UMV is designed as a universal, compact vehicle for the urban / suburban regions. In addition to the basic version, there are 6 further derivatives for different usage scenarios and target groups that cover a wide range of applications in urban areas, from private use to car sharing and from transporting people to transporting goods.

The interior is designed to be variable and features an ergonomic 4-door opening concept.



Modular and safe body design

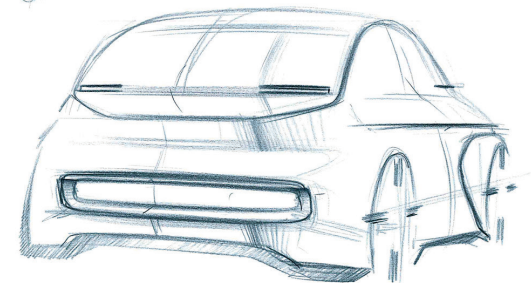
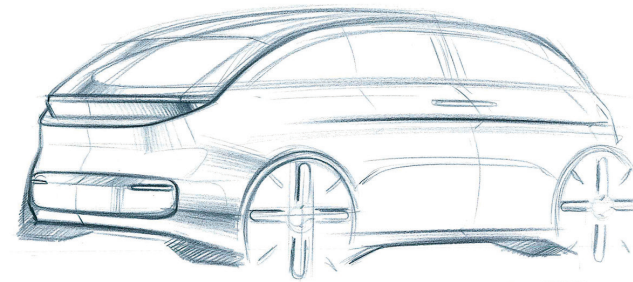
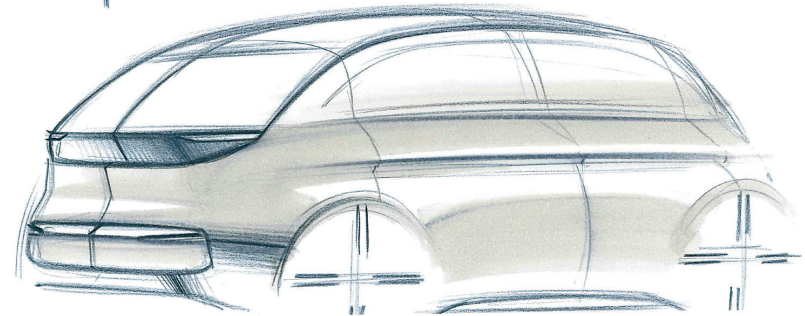
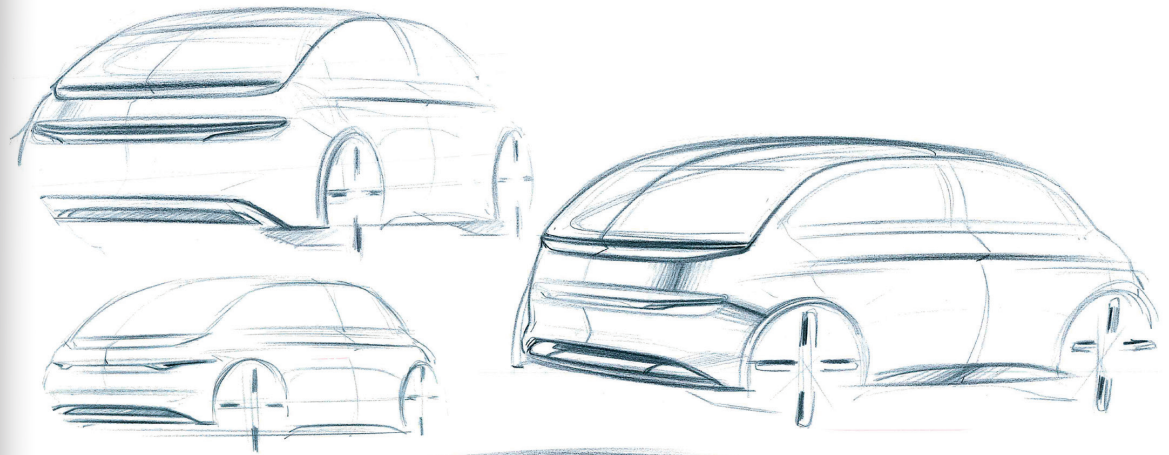
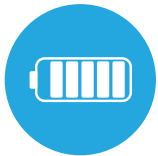
The NGC-UMV offers a modular platform concept in the body structure, powertrain and the different levels of automation.

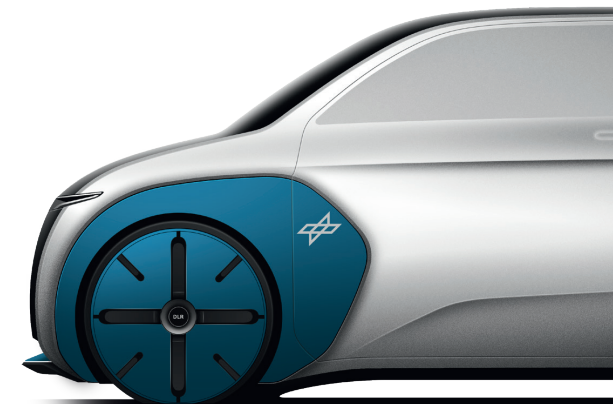
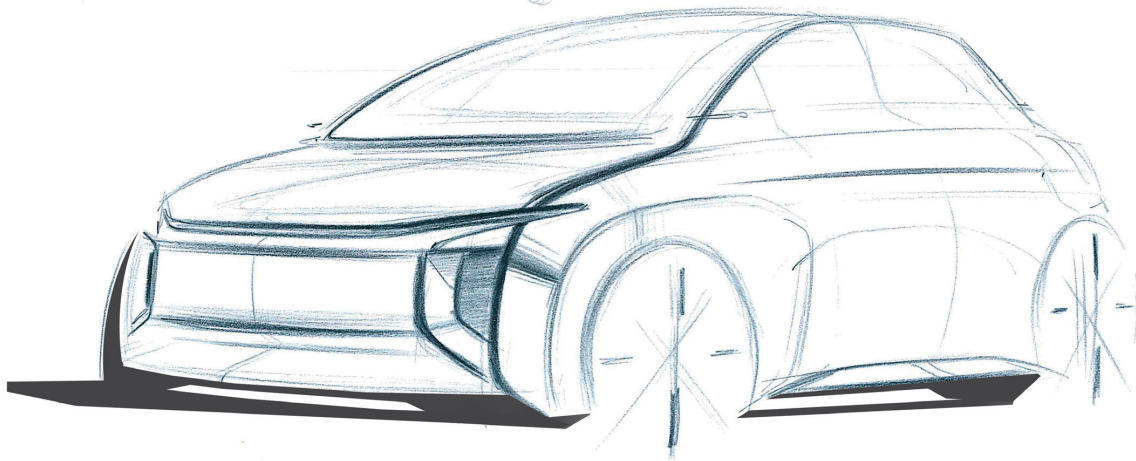
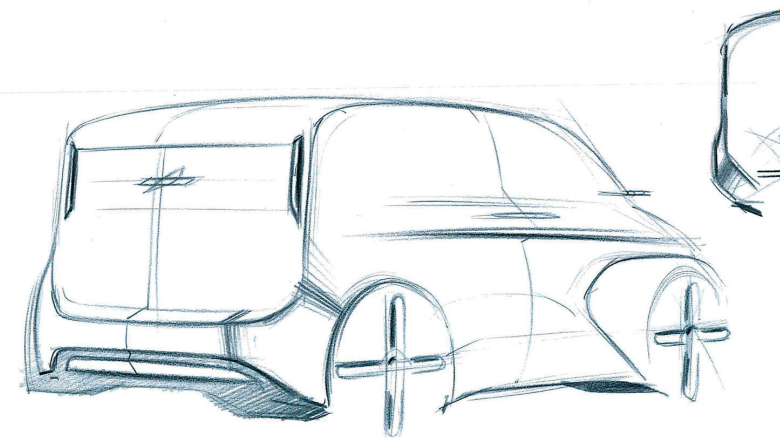
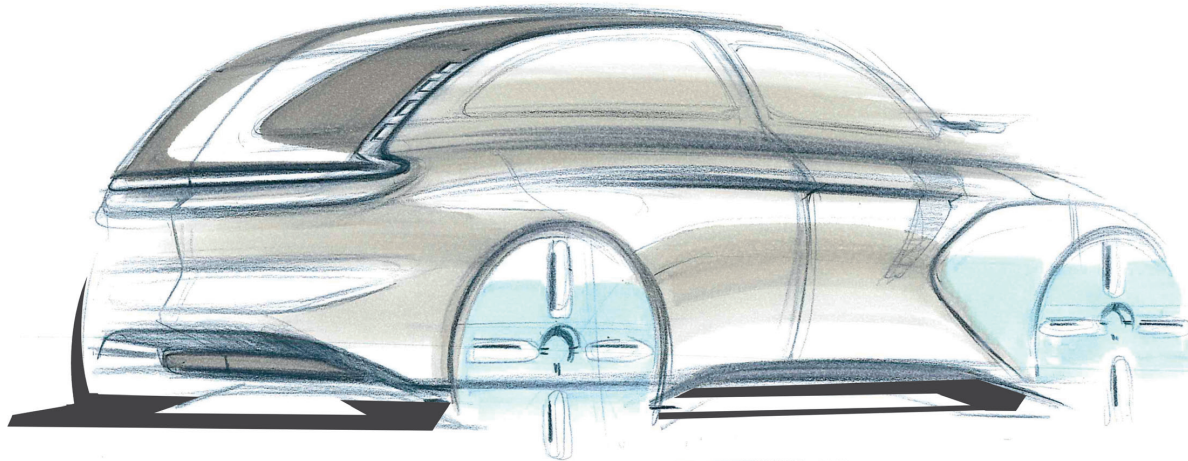
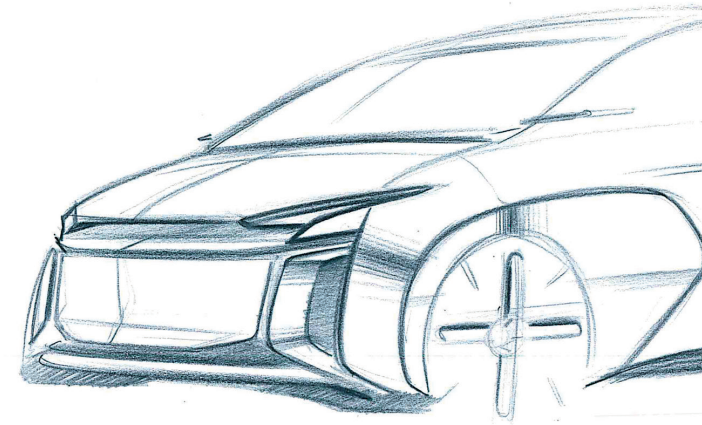
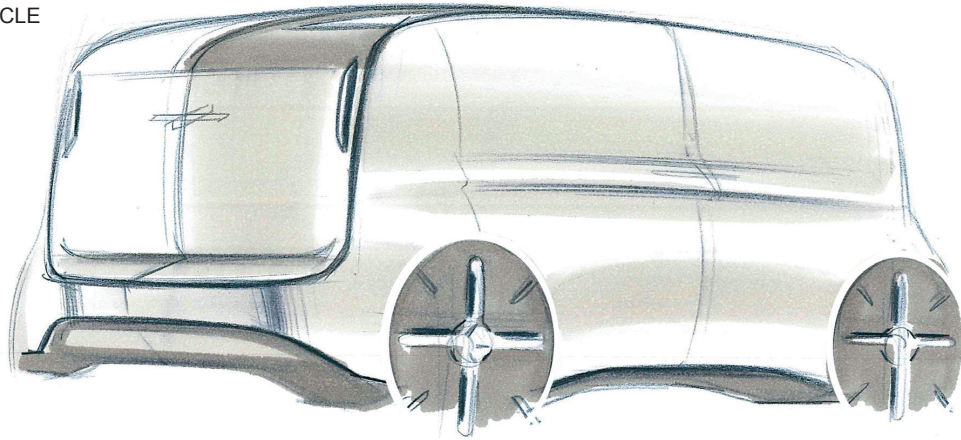


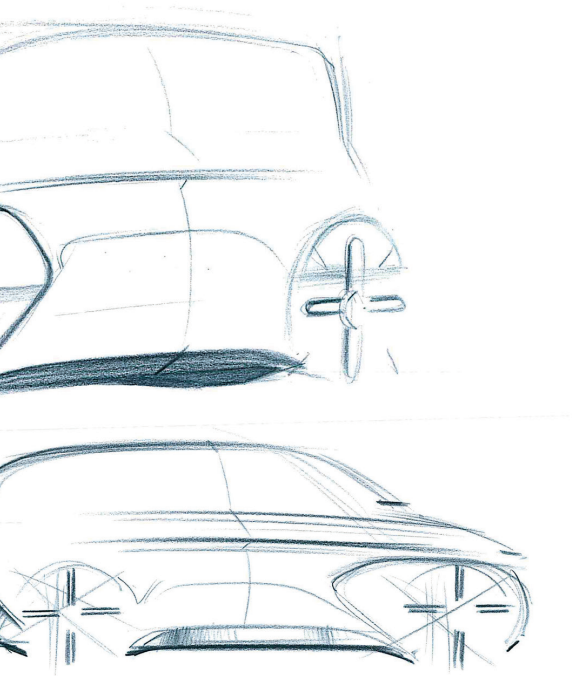


Intelligent & Electrical

The different degrees of automation are reflected in the modulation and range from assisted to fully automated. Step-by-step full 360° detection of the surroundings, C2X networking for collaboration with all traffic.







Customer benefits

automated driving
emissions
safety
seats
length [mm]
range [km]
Volume (trunk) [l]

Mobility-as-a-service
customisable intermodal
Up to SAE level 5
Local zero, BEV
Safe system approach
2+2
3700
400
210-530

ELECTRICAL

URBAN

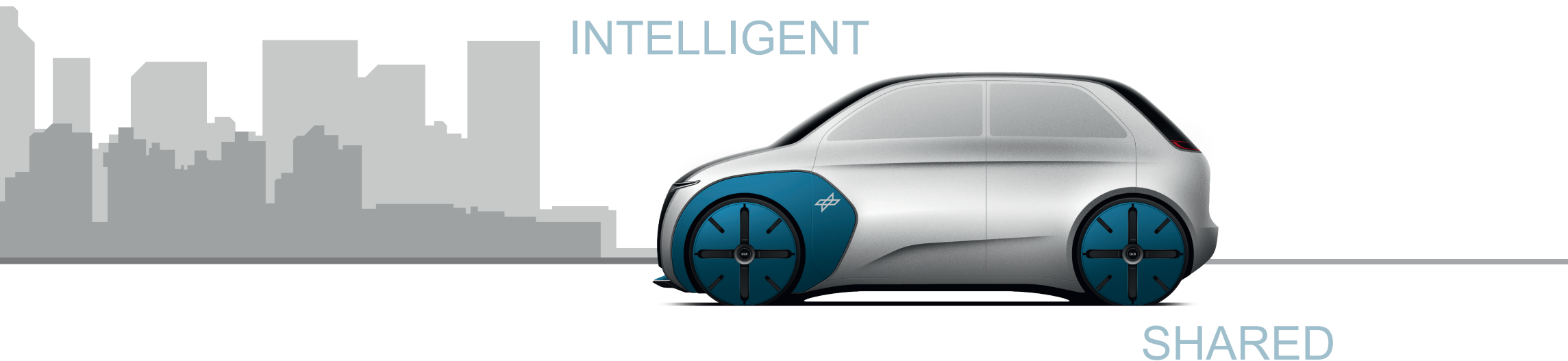











MODULAR

Urban & Shared

Today's kits and platforms are largely designed for drive topologies that are driven by combustion engines. While interfaces for hybrid and battery-electric derivatives are now common, so far they have not been the focus of attention in general vehicle design and body development. A research platform specifically for electrified vehicles is being developed as part of the Next Generation Car project using the UMV as an example.

The UMV uniquely illustrates the convertibility of a conventionally self-propelled road vehicle to a completely autonomous vehicle and offers flexibility in the platform and in production while optimising costs. The several UMV derivatives result in various usage scenarios, which are shown opposite.



UMV Basis			Seats 2+2	Length [mm] 3700	Range [km] 400	Volumes [l] 210
UMV Long			4	4100	460	550
UMV Peplemover + long Version			2+2	3700	300	280
UMV Cargo + long Version			1-2	3700 (4100)	400	2700-3800
UMV Cargomover			-	3700 (4100)	200	3800

Modular

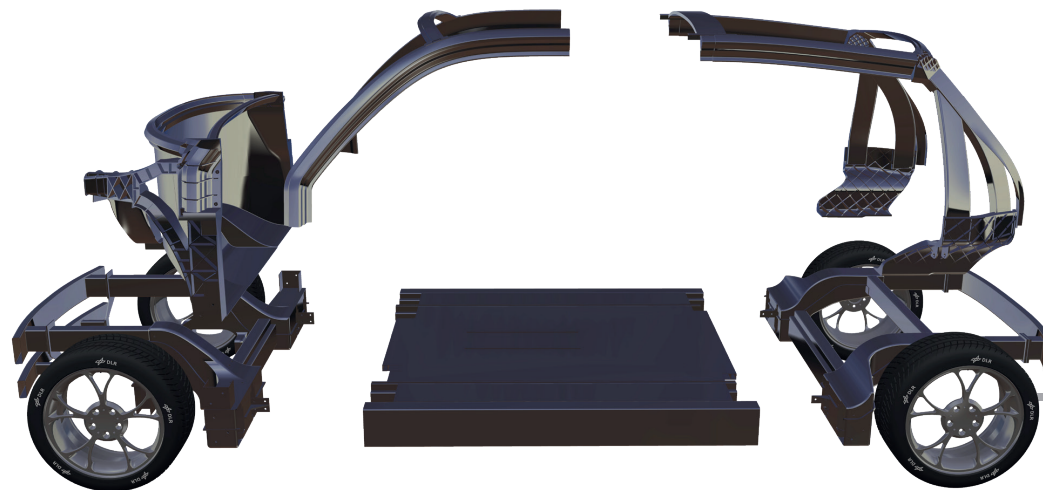
The platform made of node elements, straight profiles and sandwich panels, facilitates building different derivatives.

The systematic development and application of the methods and technologies described here will result in a reduction in vehicle mass of at least 30% compared to current vehicles within the framework of NGC vehicle concept development.

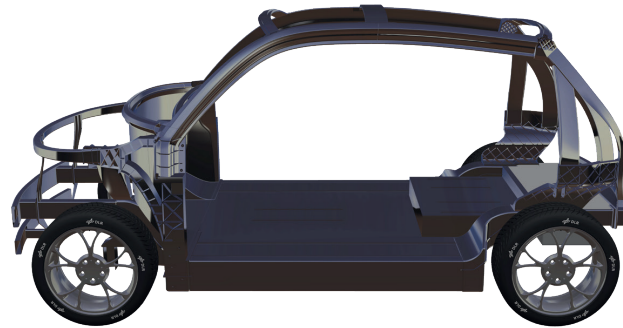
The main features of the UMV design are an aluminium-intensive frame structure consisting of profiles and nodes, function-integrated thrust surfaces as sandwich structures and flat components in fibre-plastic composites.

Thermal management is also integrated into this multi-material construction. The target mass of the UMV Basic

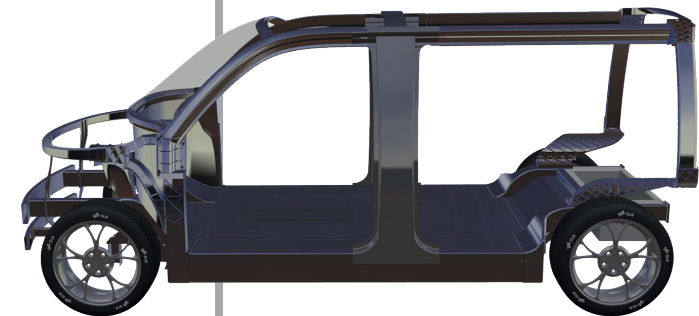
body shell is 182 kg, the mass of the unladen vehicle without battery is 680 kg.



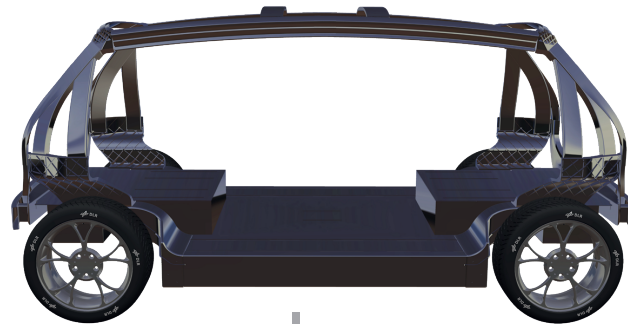
In the UMV Long variant the floor module is extended by 400 mm. The entire rear end of the vehicle and the rear part of the body structure (C-pillar, cast nodes, C-pillar, rear end) is the result of the UMV Basic takeover parts. A new, longer roof rail is only fitted at the rear from the centre of the B-pillar integrated into the doors. As the roof surface changes, the roof must also be adapted as an additional component.



The short UMV cargo variant uses the same interface on the body at the centre of the B-pillar and runs straight backwards in the X-direction. The rear part of the UMV Cargo structure is made up of unique profiles and node elements in the transition area, which enable the connection to the rear of the car. The UMV Cargo variant is also designed as a long version with a 400 mm larger wheelbase, in which only the components of the rear roof spar and the body roof surface have to be adapted.



For highly automated vehicles only intended to move with SAE Level 5, the design offers concepts in the form of the UMV Peplemover and UMV Cargomover. The UMV Peplemover, which is intended to travel in inner-city traffic, is a combination of a basic front, rear and body structure. The modular system is designed so that a large number of identical parts can be used to create very different derivatives in a cost-attractive manner.



Intelligent and Electric

A high level of automation up to SAE level 5 is being considered for the UMV and its derivatives. This is intended to make the function of the vehicles simpler and enable them to autonomously transport people and goods through urban areas.

A model-based development process for safety-relevant and cooperative man-machine systems was developed as the first important outcome in this research area. This was made possible by knowledge gained from a number of projects such as the DFG project H-Mode and European projects such as HAVEit, interactIVe or CityMobil. In addition to detailed modelling of the development phases, tool clusters were defined to enable and support the development process in all phases. The resulting processes and tools were developed in a series of projects, e.g. the European projects Adaptive

or D3CoS for the development of assistance systems, to optimise internal and external cooperation in system development and to shorten development cycles. DLR was also able to develop generic interaction designs, cooperation models for driver assistance systems and different degrees of automation.

These designs and schemes were developed in a user-centric, iterative development process and applied in European research projects in cooperation with vehicle manufacturers and suppliers. In AdaptIVe, for example, interaction designs were developed and evaluated for highly automated driving functions on motorways and in urban areas. In D3CoS, the DLR Multi-Driver-Simulator MoSAIC was used for the development and evaluation of cooperation schemes and interaction designs for cooperative lane changes. The interaction design is supported by

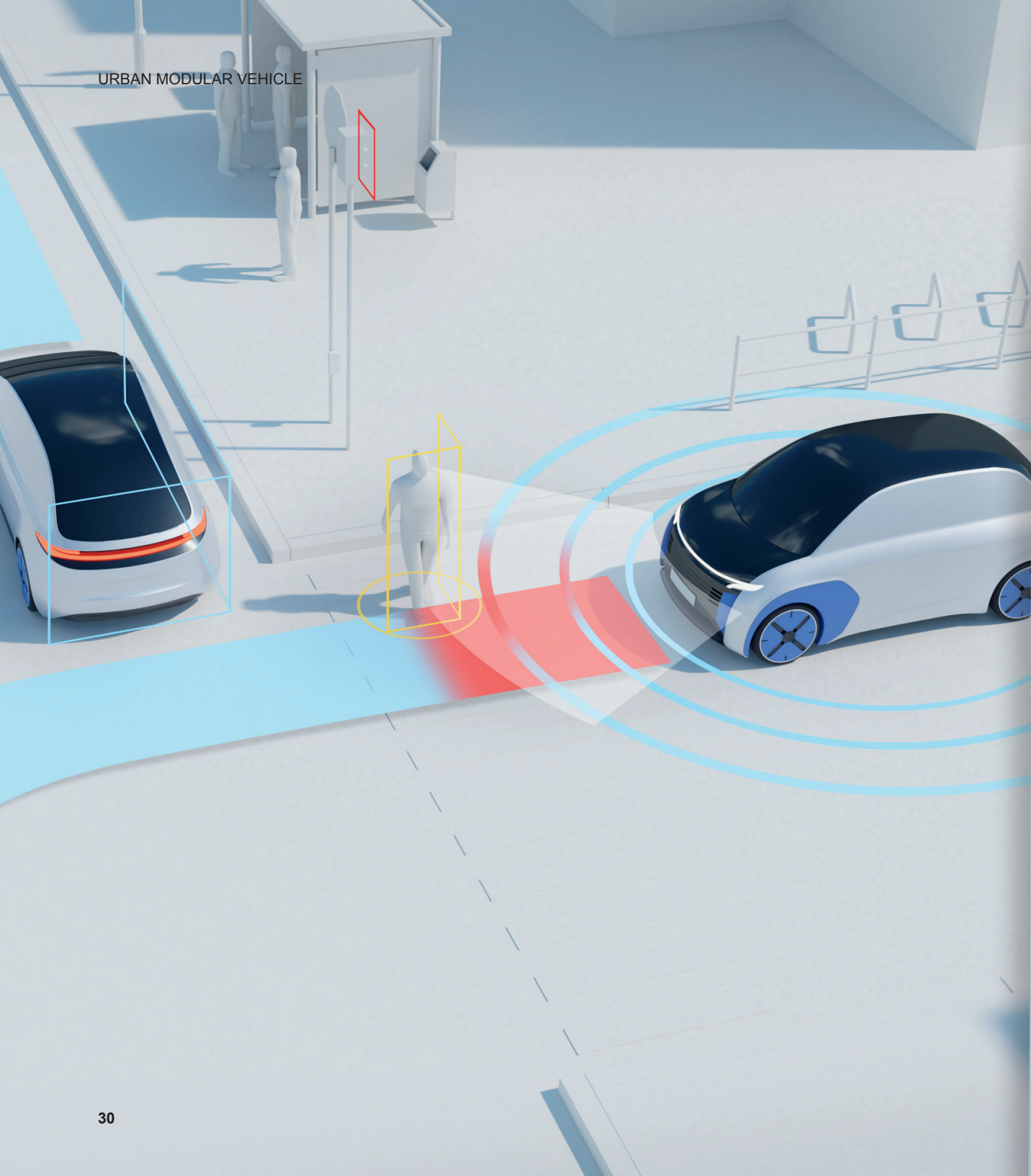
research on driver and task modelling and the continuous improvement of our model-based development processes in projects such as the European project Holides.

Urban environments form a new and important focus for DLR's functional development in the field of vehicle intelligence. Automated driving was implemented in the city of Braunschweig in a series of development steps. As part of the national project UR: BAN was centred on driver assistance systems supported by infrastructure, including a Greenlight Optimal Speed Advisory (GLOSA) system based on X2C communication between traffic lights and a vehicle.

During a public event on the DLR site autonomous driving with two-way and left to right traffic was demonstrated with an automated optimisation of the vehicle trajectory matched to the

green phases of a traffic light. A live demonstration of a DLR test vehicle with longitudinal automation on public roads was performed for the AAET Conference 2017. The vehicle reacted automatically to traffic signals, with the signal phases being communicated by SPAT C2X protocols in AIM.





With the aid of various use cases, such as automated and networked urban driving, the research contents are substantiated and advanced up to practical demonstrations in the labs, driving simulators and vehicles of the DLR. The Application Platform for Intelligent Mobility (AIM), which has been operating since 2014, enables research in virtual development environments, laboratories and the public spaces of the city of Braunschweig. This achieves a very high level of scientific proficiency and a correspondingly high level of recognition.

Highly automated driving

In the research field for automation and networking of road vehicles for urban traffic situations, the focus is on the automation level of highly automated driving. System architectures and data management → Conception and implementation of reliable and highly available hardware/software platforms for automated networked driving as well as the management of large heterogeneous data files, including semantic enrichment and data mining. Further points are the development of assistance and automation systems research and development of networked and cooperative vehicles with an integrated view of automation

development, interaction and interior design, research on human performance and potential and driver modelling, method for achieving online security and testing vehicle functions and formalisation of design and development processes or standard-compliant and model-based functional development.

Sensor technology and sensor data fusion

Another topic in the area of NGC vehicle intelligence is sensor technology and sensor data fusion, whereby vehicle-based sensor technology is always the focus of research. In-depth infrastructure-based data capture

activities are being conducted to bridge the gap between cooperative systems of infrastructure and vehicle components and support activities to test automated and networked vehicle systems.

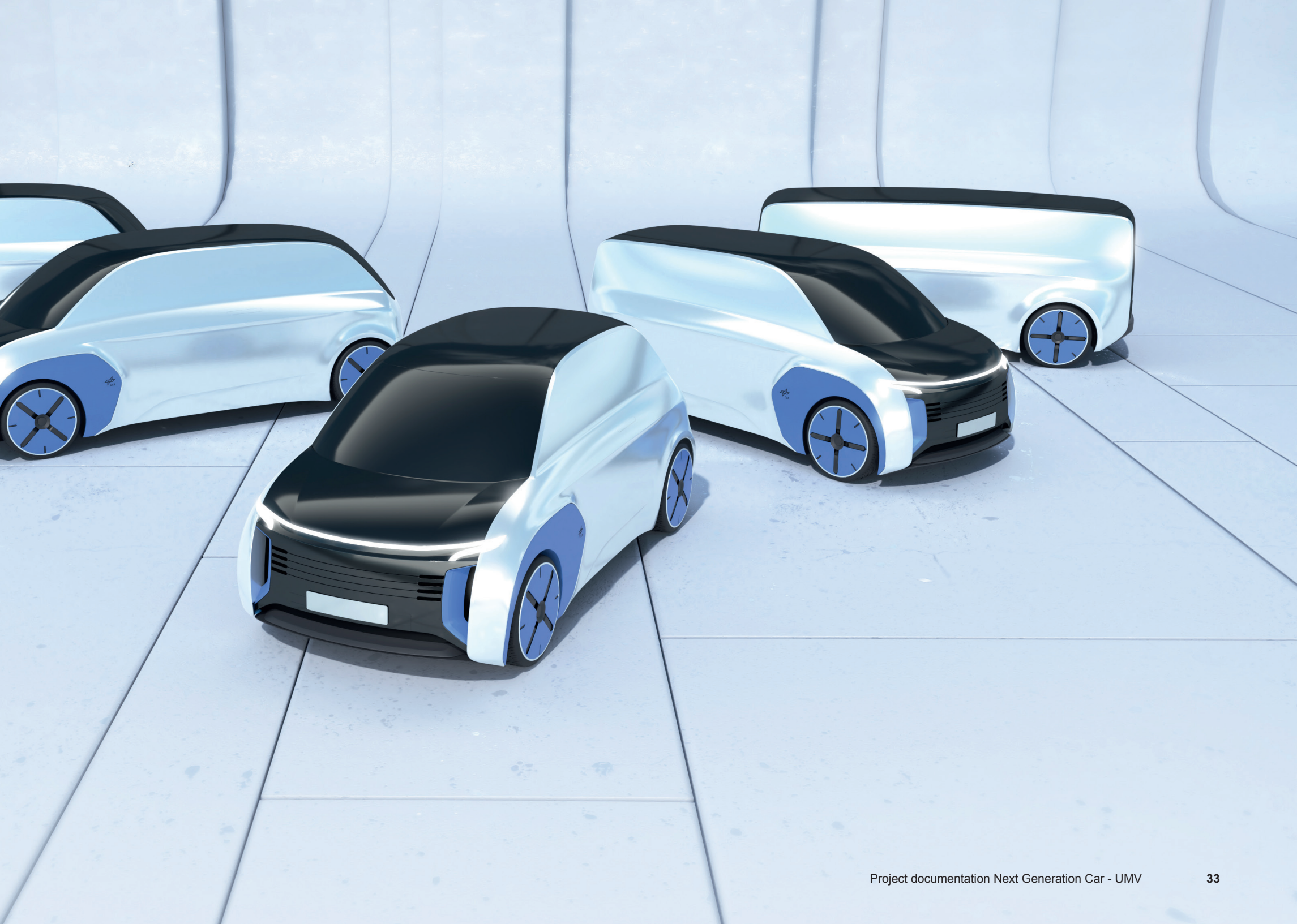
Car2X communication

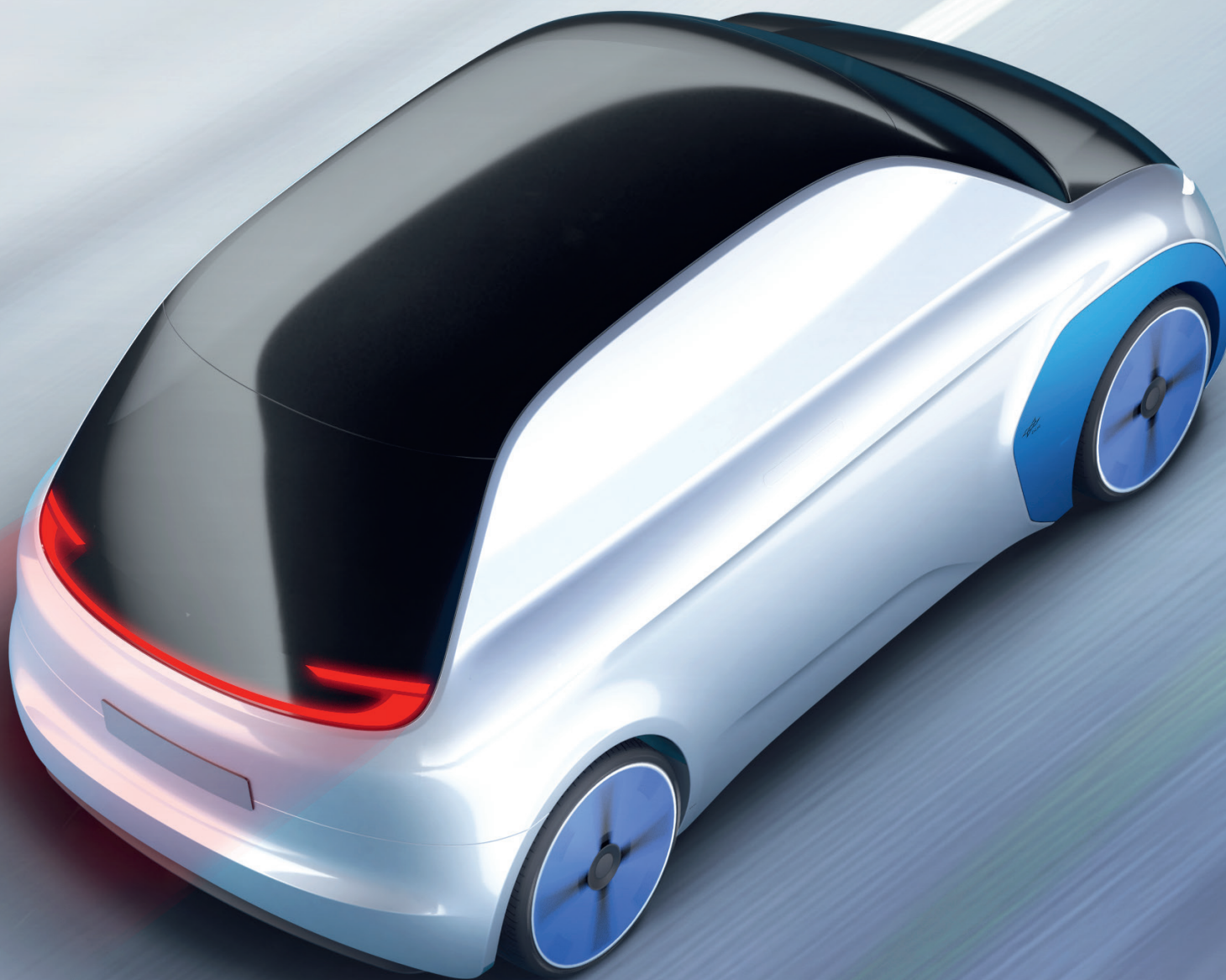
In this context, technologies such as in particular LTE/G5 and WiFi 802.11p are used for Car2X communication to construct and test cooperative functions in practice beyond the conceptual stage.

After „NEXT“

The vehicle concept and the UMV platform will be further detailed and selected components and technologies will be prototypically validated. In 2019, the UMV Derivat Peplemover will be built as a 1:1 prototype and will be further supplemented in the coming years as a research platform. The People and Cargomover derivatives will be matured at the research level. The interface to the Next Generation Train project is also to be matured with regard to nodes for logistics, freight distribution centres and passenger transport.







Contact

UMV concept

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