Innovation Talk

The Volkswagen Software Offensive

June 2021

Notes:

This press release can be found online at www.volkswagen-newsroom.com along with images and videos of the Innovation Talk.

All equipment specifications apply to the German market.

1) ID.4 GTX – power consumption in kWh/100 km (NEDC): 16.3 (combined); CO_2 emissions in g/km: 0; efficiency class: A+.
2) The vehicle is a concept car.

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In brief

Volkswagen's digital offensive continues to pick up speed: software is the key to the automotive future

Overview of important facts

- **Software as the DNA of the brand.** Volkswagen ushering in a new era of mobility with its own software
- **Clear strategic direction.** For Volkswagen, software is an elementary factor when it comes to creating value and standing out from the competition
- **Transformation.** Volkswagen is transforming itself from being a pure car manufacturer into a software-oriented mobility provider
- **ACCELERATE.** Volkswagen is once again speeding up development in key future areas such as digitalisation
- **Business Model 2.0.** Volkswagen is winning over new customers with software-based services such as WeShare and WeCharge
- **Software project house.** At Volkswagen, the latest software is developed in a project house that works just like a tech company
- **Smart technologies.** Software enables new technologies such as Travel Assist and augmented reality head-up display
- **Local hazard warnings.** Sophisticated software revolutionises safety on board the latest Volkswagen models via Car2X technology
- **Mobile updates.** Over-the-air updates will constantly update the operating system of ID models
- **Automated driving.** A future software architecture will make automated driving possible

The Volkswagen Software Offensive

Wolfsburg, June 2021. Volkswagen is on the road to the future – with smart software. This makes it possible to bring highly innovative functions on board the latest vehicles and opens up completely new possibilities. Software is becoming a new factor in competitive differentiation and value creation. Volkswagen considers software development to be a core competence of the brand. In the past, Volkswagen stood for the

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democratisation of mobility with global successes such as the Beetle and Golf: today, software development also forms part a crucial of the Volkswagen DNA.

Ralf Brandstätter, Chief Executive Officer of Volkswagen Passenger Cars, sees the topic of software as absolutely crucial. "The real gamechanger is digitalisation," says Brandstätter. "Electrification, software-defined products, new business models and autonomous driving – these four major forces are driving future developments in the automotive industry. With our enhanced ACCELERATE strategy, we are now giving digitalisation at the brand an extra boost."

Thomas Ulbrich, Member of the Brand Board of Management for Research & Development, says: "Software is the key to the future! Having our own software competence is of the highest priority for Volkswagen." Klaus Zellmer, Member of the Brand Board of Management for Sales, Marketing and After Sales, explains: "Volkswagen combines the best of two worlds – safe, appealing hardware and intelligent software. We will exploit the potential of this fusion more than ever before through continuous over-the-air updates."

Software changes everything. State-of-the-art software enables the most up-to-date interactive communication. It offers increased comfort, dynamics, sustainability and ultimately a better quality of life. Thanks to the extensive customisation options, software is also shaping the character of the new Volkswagen models. In addition, software acts as a gateway to new business models, which will be brought together under the umbrella brand Volkswagen We. Thomas Ulbrich: "Our customers can already find services here such as WeShare for rental of electric Volkswagen cars, for example in Berlin and Hamburg. Or WeCharge for simple charging and payment at more than 200,000 charging stations in Europe."

Volkswagen is well ahead of other volume manufacturers with the launch of these data-based business models and is therefore already reaching a

new customer group. Last but not least, software is also making it possible for Volkswagen to realise highly innovative technologies such as IQ.DRIVE Travel Assist for partly automated driving – available from the new Polo up to the Touareg – or the first augmented reality head-up display on board the ID. models. Systems of this kind make the new Volkswagen models more valuable, more comfortable and safer.

Breakthrough of electric mobility. Software has also provided the decisive impetus for Volkswagen to initiate the breakthrough of electric mobility. Thomas Ulbrich: "In recent years, my colleagues and I repeatedly said that we as the Volkswagen brand wanted to transform electric mobility from being a niche into a volume market. Today, in 2021, I am certain that no-one has any doubts that Volkswagen is delivering on this promise." This development would not have been possible without the company having its own unique software. One thing is certain: the new technology highlights catapult mobility further into the 21st century and offer clear added value.

Software as a factor in differentiation and value creation

Software is a key factor when it comes to competitive differentiation in the automotive market of the 21st century – a way in which Volkswagen sets itself apart from other manufacturers. An intelligent and future-oriented software architecture is a major selling point for a car – and a factor that will become increasingly important in the light of continuing digitalisation and automation.

Volkswagen sees progressive software as an elementary factor in value creation, and it opens the door to new business models. Already today, customers can use services such as WeShare to rent electric Volkswagen models or WeCharge for simple charging and payment. In the future Business Model 2.0, the company plans to generate new revenues during the use phase of its cars – with charging and energy services, with

software-based features that the customer can add as needed, and with automated driving.

App updates and features on demand in the MQB

Status quo. All those who drive a new Volkswagen benefit directly from the systematic interaction of the hardware and software. The Polo, Golf, Tiguan, Passat or Arteon are perfect examples of this – bestsellers based on the modular transverse matrix (MQB): Using the mobile network, the latest In-Car Apps can be installed and also additional functions (features on demand) activated via We Upgrade. In the new Golf – the most digitalised modular transverse matrix (MQB) model – it is possible to enable features such as Adaptive Cruise Control ACC, advanced main-beam control Light Assist, intuitive voice control or the integration of Amazon Alexa. Many customers will benefit from these new possibilities because 80 percent of all Group models are based on the MQB – one of the most successful vehicle platforms in the world.

Firmware updates made over-the-air in the MEB

Evolution of the operating system. Making use of the momentum from its MQB experiences, Volkswagen has developed the modular electric drive matrix (MEB) for the new zero-emission models of the ID. family. The ID.3, ID.4 and ID.4 GTX[1] have already been launched in Europe. These models are prepared for a new evolutionary stage of over-the-air updates: In future the ID. models will receive updates for the control units, and thus also for the operating system, via mobile data transfer. This means that new software versions can be installed at any time so that the firmware (operating system) is always completely up-to-date. In addition, possible bugs will also be eliminated and functions enhanced – because software programming is and remains an evolutionary process.

The new end-to-end electronic architecture of the ID. models

Software plus hardware. The updates are installed directly onto the new high-performance computers (ICAS) in the ID. models; ICAS stands for In-Car Application Server. These computers form the core element of the new end-to-end electronic architecture E[3] in the ID.3, ID.4 and ID.4 GTX[1]; they perform functions that are otherwise distributed among a large number of control units.

The new electronic architecture is not just more powerful and intelligent, but also simplifies exchange of data and functions between the systems in the vehicle. For this reason, the new end-to-end electronic architecture in combination with the ID. software – the operating system – also makes possible a new evolutionary stage of over-the-air updates. These will allow owners of the ID. models to update the software of their cars when parked outside their front door, at work or at any other location with a good mobile network connection. Silke Bagschik, Head of Marketing & Sales, Product Line e-Mobility: "The firmware update is the ultimate over-the-air update. It's a case of updating the operating system online and thus also updating the control units for enhanced performance or new functions."

Software will permit automated driving

Every level of automation. The new Volkswagen software and electronics architecture will enable the breakthrough of automated driving and thus a new level of convenience and safety in the medium term. Defined scenarios such as driving on motorways are gradually becoming increasingly automated. Volkswagen brings together the current and new assist systems for automated driving under the umbrella brand IQ. DRIVE; these are functions that can be activated by the driver. Conventional driving will therefore remain the starting scenario in personal transportation. Thanks to the current Travel Assist – available in the Polo (new model), ID.3, Golf, ID.4, Tiguan, Passat, Arteon and Touareg product

lines – driving at level 2 with automated lateral and longitudinal guidance is already a reality in Volkswagen vehicles. The driver must continuously monitor the systems at this level.

In the medium term, Volkswagen will continuously increase the level of automation with future vehicle projects such as the Trinity[2], planned for 2026. Over the course of the years, the scale will range from level 3 (highly automated driving; the driver no longer has to monitor continuously but must be potentially able to intervene) up to level 4 (fully automated driving; no driver is needed in the specific application). In the long term, automated driving level 5 (from start to destination without a driver) will be implemented; Volkswagen provided a preview of this with the avant-garde Gran Turismo concept car, the ID.VIZZION[2]. Volkswagen has already laid the digital foundation for this new age with its latest electronic and software architecture, and is one of the first volume manufacturers worldwide to do this.

Software project house paves the way into the future

New learning culture. The software is developed in a project house in the Volkswagen Development Centre. The teams there work in the same agile way as in a pure tech company. Their work is characterised by processes that are fully synchronised with the special challenges of software development. These processes take into account the fact that the cars of today and tomorrow incorporate far more closely integrated functions than was previously the case.

As a result, there are many more programmers working on these closely integrated functions. Their interaction takes place in a completely different way in the project house to in classic vehicle development. In the project house, the software development marathon is divided into countless small sprints. This accelerates and improves the integrated programming of the functions.

The fast, lean processes from the project house will in future also have a positive impact on other development areas and change the way in which new Volkswagen models are developed. Thomas Ulbrich: "With the project house we have improved the speed and quality of software development tremendously and have simultaneously reduced the complexity of the processes. As a logical consequence of this, there are flat hierarchies in the project house, and these go hand-in-hand with fast, function-oriented decision-making processes. This is a model that we will also transfer to other development areas."

Key aspects

Volkswagen software development in the project house

Software development follows its own rules. Software is the key to the future for Volkswagen. Different rules apply to its development than to the development of automotive hardware. That is because software development is a closely linked and integrated chain of programming steps that must not be broken. Software that does not work disrupts an entire function chain. As a result, the vehicle would not drive at all in extreme cases. In software development, time and continuity are therefore infinitely valuable commodities.

Project house for software development. Against this background, Volkswagen has implemented software development in what is known as a project house. This was set up in advance of development of the MEB models and very latest MQB models. MEB stands for modular electric drive matrix and thus for the new ID. models. MQB is the acronym for modular transverse matrix, on which global bestsellers such as the Tiguan, Passat and latest generation of the Polo and Golf are based. The project house views vehicles and mobility services holistically, but specialises above all in developing the underlying software. Volkswagen is one of the first large

volume manufacturers to combine the world of car manufacturers and the sphere of tech giants in the project house.

Clearly defined processes. The work of the project house specialists is based on processes that are fully synchronised with the special challenges of software development. These processes take into account the fact that the cars of today and tomorrow incorporate far more closely integrated functions than was previously the case. As a result, significantly more programmers work on these functions. Their interaction takes place in a completely different way in the project house to in classic vehicle development.

In the project house, the development steps and clearly defined, attainable goals in software development are first divided into middle-distance intervals (12-week rhythm) and then into multiple sprints. In 14-day sprint intervals, the teams compare whether and how the goals have been implemented. In a parallel process, every software version flows directly into a fleet of test vehicles to check what has been achieved. 14 days to reach the first goal, 14 days to reach the second goal; 14 days instead of what can be several months in classic hardware development.

This meant that the current ID. software for the ID. family based on the MEB was developed in record time. And the current software of the latest MQB models such as the current Golf and Golf Estate was also perfected in ever faster steps. Software development is an evolutionary process. Any bugs that are detected are therefore combatted by means of a fast update. Software bugs – which can never be fully excluded by any company in the world – are therefore remedied extremely quickly or eliminated with an updated software version in what is a steep learning curve. And Volkswagen has achieved this successfully with the newly implemented project house for software development.

Smart software for all models. With the ID.3, ID.4 and ID.4 GTX[1], Volkswagen has launched a completely new, all-electric product family on

the market in less than one year. It will be offered in future in parallel to the highly efficient product lines with petrol, diesel, mild hybrid and plug-in hybrid drives – a range of drive systems with which Volkswagen covers all mobility scenarios of this decade. This was all made possible with smart software.

The new Volkswagen electronic architecture E³

High levels of integration with ICAS servers. The electronic and software architecture with the highest current development level is used in the new ID. family. It is called E³, which stands for end-to-end electronic architecture. It has two high-performance computers at its heart: ICAS1 and ICAS3, where ICAS stands for In Car Application Server. In conventional cars, the tasks performed by ICAS1 and ICAS3 were and still are distributed among a large number of smaller computers – the local control units. The ICAS modules raise the performance capability of the hardware and software to a level that opens up a completely new spectrum of possibilities.

The new Volkswagen operating system for the ID. models

ID. software 2.1. A new software is responsible for the system's intelligence: the ID. software. The ID.3 was launched with the ID. software 1.0 not long after its market introduction, and version 2.0 followed at the end of 2020. All ID. models are currently being delivered with the ID. software 2.1. The ID.3 models that were produced very early on received the latest software version by means of a workshop flash.

Over-the-air-updates of firmware

Paradigm shift for software updates. The future over-the-air updates will reflect a paradigm shift in the automotive world: The vehicles download

the latest update to the vehicle via a mobile data link. All ID. versions thus always have update-to-date software. What's more: even new functions can be installed by way of over-the-air updates.

Future over-the-air updates for the ICAS computers. The planned next-generation over-the-air updates will make it possible for Volkswagen to update the software architecture via a mobile data connection for the first time. This is because the updates will be installed directly to the ICAS1 and ICAS3 high-performance computers and will update their operating system and firmware.

As easy as a smartphone update. As soon as new software is available, the driver will be notified with a message in the ID. Cockpit. The driver will only get this message when the download has been completed and the software loaded in the background. It has not yet been installed at this point. Installation of the new software can be started only when the ID.3, ID.4 or ID.4 GTX[1] has been parked. If they wish, the driver can have information on the current update displayed. For safety reasons, it is not possible to start the car during the update. As soon as installation has been completed, the driver must briefly actively end the update by pressing the OK button on the multifunction steering wheel – and the ID.3, ID.4 or ID.4 GTX[1] is now ready to be driven with the new software.

The vision of an accident-free future

Local hazard warnings via Car2X. Thanks to the use of smart software and electronics, Volkswagen is also raising the safety of its models to a new level. An example for this is the standard Car2X communication launched with the latest Golf. This new system is also on board in the new ID. models. Car2X communication uses the information provided by other vehicles (with the Car2X function) within a radius of up to 800 metres in addition to signals from the traffic infrastructure to warn drivers about hazards much earlier than was previously possible, and to forward these

warnings to other correspondingly equipped models. Volkswagen is acting as a pioneer here – with a technology that uses the swarm intelligence principle. In other words, the more participants there are, the better it becomes. The vision of an accident-free future therefore comes an important step closer.

Innovative software conquers all Volkswagen segments

Democratisation of progress. In future, Volkswagen – and this is also typically pioneering for the brand – will integrate highly innovative software and the associated functions and services in all vehicle classes. Buyers of the relevant models and the company will benefit from the Group's large economies of scale. Because these make the most progressive systems affordable – this is the democratisation of progress in a new form.

The start of a new era. A future highlight of this democratisation of progress will be the all-electric volume model Trinity[2], which is planned from 2026. With this completely new high-tech electric saloon, Volkswagen aims to make automated driving accessible to a wide clientele.

IQ.DRIVE – the present. Volkswagen currently brings together assist systems for partly automated driving under the umbrella brand IQ.DRIVE; these are functions that can be activated by the driver. Conventional "manual" driving will therefore remain the starting scenario in personal transportation. Thanks to the current Travel Assist – available in the Polo (new model), ID.3, Golf, ID.4, Tiguan, Passat, Arteon and Touareg product lines – journeys at level 2 with automated lateral and longitudinal guidance are already part of everyday driving in Volkswagen vehicles. At level 2, the driver must continuously monitor the systems.

Levels 3 and 4 – the future. In the medium term, Volkswagen will continue to drive forward automation with vehicle projects like the Trinity[2]. Over the course of the years, the scale will range here from level 3 (highly

automated driving; the driver no longer has to monitor continuously but must be potentially able to intervene) up to level 4 (fully automated driving; no driver is needed in the specific application). In the long term, automated driving level 5 (from start to destination without a driver) will be implemented – Volkswagen provided a preview of this with the avant-garde Gran Turismo concept car, the ID.VIZZION[2]. As one of the first volume manufacturers worldwide, Volkswagen has already laid the digital foundation for this new age – with its latest electronic and software architecture.

Software as a factor in differentiation and value creation

Volkswagen will undergo a radical transformation. It will stand like no other brand for climate-friendly electric mobility, exciting digital customer experiences, new business models and autonomous driving. It has already shown for many years that it builds outstanding cars with the MQB technology matrix. The company is now proving its electric competence with the ID. models based on the MEB. And in future, Volkswagen will demonstrate its full competence in the area of software development.

Software is a key factor when it comes to competitive differentiation in the automotive market of the 21st century – a way in which Volkswagen sets itself apart from other manufacturers. An intelligent and future-oriented software architecture is a major selling point for a car – and a factor that will become increasingly important in the light of continuing digitalisation and automation.

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software-based features that the customer can add as needed, and with automated driving.