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IAA 2019: Bosch wins electromobility orders amounting to 13 billion euros

September 10, 2019
PI 11001 BBM ts/Bär

Mobility business is again growing faster than the market

- ▶ Bosch CEO Dr. Volkmar Denner: “Bosch is making mobility climate-friendly and affordable.”
- ▶ Business figures: mobility business holding its own in a difficult environment
- ▶ Key to the mobility of the future: Bosch invests nearly 3 billion euros annually in software expertise
- ▶ From combustion engines to fuel cells: Bosch is further refining powertrains of all kinds
- ▶ Stepping stone to automated driving: permission granted for automated valet parking

Stuttgart and Frankfurt, Germany – When it comes to electromobility, Bosch is driving in the fast lane. No other company has as much expertise in this domain. And this is paying off: since the beginning of 2018, Bosch has won electromobility orders worth roughly 13 billion euros, including production projects for electrical powertrains for passenger cars and light trucks. Thanks to these successful orders and its innovative strength, Bosch is holding its own in the currently difficult environment. The Mobility Solutions business sector is again developing better than global automotive production in 2019. Despite the market’s current significant downward trend, the sector’s sales from operations will come in at just under the previous year’s level. “The transformation of mobility entails challenges, but also opportunities. We want to grasp them,” says Dr. Volkmar Denner, chairman of the Bosch board of management. Technologically, Bosch is approaching the mobility of the future with an open mind. It is both further refining conventional powertrains and fast-tracking electrification. In addition, the company is working to make mobility automated, connected, and personalized. One key to this lies in electronics and software. The company’s mobility operations currently employ some 14,000 software engineers, and annual expenditure on software expertise comes to 3 billion

euros. The objective is to keep people mobile in an eco-friendly way and to ensure that mobility is accessible to everyone. “Bosch is making mobility climate-friendly and affordable,” Denner says.

Efficient powertrains: from combustion engines to fuel cells

Bosch is leading the way in climate action, and this not only by making all its locations worldwide carbon neutral from next year. “We are also devoting ourselves to developing mobility solutions that have no appreciable impact on global warming and air quality,” Denner adds. Each year, the company invests some 400 million euros in emissions-free mobility. When it comes to electromobility, Bosch has a broader footprint than other companies – from bikes to trucks, and from mild 48-volt hybridization to the fully electrical powertrain. Bosch is aiming to achieve a leading position in the market with its 48-volt battery, and has concluded a long-term cooperation agreement with the Chinese company Contemporary Amperex Technology Co. Limited (CATL) for the production of battery cells. At the start of the year, Bosch forecast sales of 5 billion euros by 2025 with electromobility components and systems for passenger cars and light trucks. Now it expects to exceed that figure. “Whatever the technology that brings about emissions-free mobility, we have to get the market to accept it. We will only manage that with affordable solutions. If we don’t offer them, we won’t help stop global warming,” Denner says. On its path to becoming the market leader in electromobility, Bosch also wants to create a mass market for fuel cells and is taking them into production. Here, economies of scale will also help make the manufacture of this still expensive technology more cost-effective. “Bosch is making alternative powertrains affordable,” Denner says.

New technology: less particulate matter, less brake dust

In 2030, however, three-quarters of new vehicles will still have a conventional engine under the hood, some of them with electrical support from a 48-volt system or a plug-in hybrid. For this reason, Bosch is making not only the diesel engine but also the gasoline engine more efficient. Its most recent advance uses modifications to the engine and modern exhaust-gas treatment to bring particulate emissions from gasoline engines down to a level as much as 70 percent below the Euro 6d standard, even in real driving conditions. Bosch also wants to minimize particulate emissions from braking. Developments here include the iDisc, which generates as little as 10 percent of the brake dust produced by a conventional brake disc, and the regenerative braking system, which can cut brake dust by over 95 percent in electric vehicles.

Milestone: first level 4 system approved

Bosch is also posting substantial business success in automated driving. Driver assistance systems form the basis for this. In this area, Bosch will generate

12 percent growth this year, and sales of 2 billion euros. For the next levels of automated driving, Bosch will invest 4 billion euros up to 2022. For the U.S. and Asian markets, Bosch is currently developing level 2 systems that allow drivers to take their hands off the wheel on the freeway. In Germany, Bosch and Daimler were recently granted the world's first approval for a level 4 system – automated valet parking in the parking garage of the Mercedes-Benz Museum in Stuttgart. This automated valet parking service has thus progressed beyond the prototype stage. By the end of 2021, it is expected that a dozen other parking garages will be equipped with automated valet parking.

Customized mobility: shuttle services and rolling chassis

The transition in the mobility industry is giving rise to new market players. Bosch is also entering into business with these players. For example, the company is working with DiDi, Lyft, and Uber – the three biggest ride-hailing providers, who already arrange more than 50 million rides a day worldwide. DiDi, which is the leading Chinese provider of mobility services, is using Bosch's cloud-based battery services to help increase the service life of their vehicle batteries.

In the future, mobility service providers such as these will increasingly use shuttles to offer customized on-demand mobility. By 2025, it is expected that more than 2.5 million shuttles will be driving on the world's roads. With its solutions for electrification, automation, connectivity, and personalization, Bosch wants to help these providers offer ride-hailing services featuring maximum comfort and security. The undercarriage of such shuttles could be a rolling chassis – a ready-to-drive, modular platform that serves as a flexible basis for various bodywork designs. In this area, Bosch entered into an alliance with the chassis and automotive specialist Benteler at the start of the year. Automobil Pininfarina will be the first customer to use the rolling chassis for its own vehicles, and will also act as a reseller for the chassis.

Press photograph: #2725587, #2725588, #2725589, #2725590, #1728556, ##2068019, #2725720, #1147921, #2725592, #1852121, #2725719, #2068017

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Mobility Solutions is the largest Bosch Group business sector. In 2018, its sales came to 47.6 billion euros, or 61 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. The Mobility Solutions business sector pursues a vision of mobility that is accident-free, emissions-free, and fascinating, and combines the group's expertise in the domains of automation, electrification, and connectivity. For its customers, the outcome is integrated mobility solutions. The business sector's main areas of activity are injection technology and powertrain peripherals for internal-combustion engines, diverse solutions for powertrain electrification, vehicle safety systems, driver-assistance and automated functions, technology for user-friendly infotainment as well as vehicle-to-vehicle and vehicle-to-infrastructure communication, repair-shop concepts, and technology and services for the automotive aftermarket. Bosch is synonymous with important automotive innovations, such as electronic engine management, the ESP anti-skid system, and common-rail diesel technology.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 410,000 associates worldwide (as of December 31, 2018). The company generated sales of 78.5 billion euros in 2018. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life." The Bosch Group comprises Robert Bosch GmbH and its roughly 460 subsidiary and regional companies in over 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world. The basis for the company's future growth is its innovative strength. At nearly 130 locations across the globe, Bosch employs some 68,700 associates in research and development.

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BOSCH

September 10, 2019
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**Emissions-free mobility is coming –
provided the solutions are affordable and fascinating**

Dr. Volkmar Denner
chairman of the Bosch board of management,
at the IAA press conference
in Frankfurt
on September 10, 2019

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This year's IAA, ladies and gentlemen, is a catalyst –

energizing not only the automotive industry and its customers, but also kindling debate and demonstrations. And more than ever, society is faced with critical questions: What could eco-friendly mobility look like? How can the technological progress we need be achieved economically? And how, finally, can we handle the social consequences of climate-friendly transport policy? We will have to find a new position that harmonizes the interests of ecology, economy, and society. There are no simple solutions, and no one person exclusively holds the key. We will have to hammer out a solution in an open debate. We're here at a motor show, yet questions such as these are just as much on people's minds as the latest models on four wheels. Our response to them has two parts.

- First, we want mobility that helps keep our planet healthy and the air in our cities clean. Bosch will be the first industrial enterprise to make all its locations worldwide carbon neutral within one year. And we're applying the same determination to deliver efficient powertrains, from combustion engines to fuel cells.
- Second, what is ecologically correct must not be socially and economically incorrect. Emissions-free mobility is possible – if it remains affordable for people and its benefits capture their imagination. Only in this way can we make it a market success.

That said, for some time now we've regarded mobility as much more than people driving their own cars. As we see it, tomorrow's mobility will not only be electrified and automated, but also connected and personalized. And it is above all this personalized form that will be about much more than driving. For us, it means services that find the best way for each individual to get to their destination, whether on two or four wheels, by road or by rail. Supporting multimodal mobility is also a response to the critical issues surrounding road traffic.

Key to the future: three billion euros annually for software

But first, we're developing the technological foundations for the mobility of the future. Our open sesame for all this is our profound expertise in electronics and software. Even now, our Mobility Solutions business sector employs some 14,000 software developers, and its annual software engineering expenditure comes to nearly 3 billion euros.

The upshot is significantly more powerful vehicle electronics and software architecture, which is important for connected driving as well as automated and electrified driving. Computing power will increase by a factor of at least 1,000 at the start of the next decade. What we will be seeing is high-performance vehicle control units of the kind Bosch is already creating for the integration of infotainment systems and driver assistance functions. With computers such as these, vehicles will increasingly act as players on the internet of things.

Growth at last: electromobility is turning the corner

But how will they drive on tomorrow's roads? We foresee a gradual transformation of the automotive powertrain. First of all, there's still some mileage left in the combustion engine. In 2030, three-quarters of all new vehicles will feature a diesel or gasoline engine, whether with or without a hybrid option. For this reason alone, further refining these engines is environmentally expedient. Thanks to Bosch's new exhaust technology, diesel engines' NO_x emissions have been almost completely eliminated, as independent tests have already shown. Our solution is already in production, and features in a number of vehicles being presented at this show. Our next goal is the reduction of particulates from gasoline engines. More specifically, this means 70 percent less particulate matter than permitted by the current Euro 6d standard – both on the road and at the test bench. But that's not all. We can also reduce brake dust by more than 90 percent, whether with regenerative braking systems or with our iDisc brake disc. We are coming ever closer to our goal of road traffic that no longer pollutes the air in our cities.

The electromobility market is also gaining speed at last. It is becoming ever more obvious that the electrical powertrain will be Bosch's next success story. Both technologically and commercially, we lead the way. We lead the way in the efficiency of our components, and have a broader footprint than other suppliers – from bikes to trucks. And growth is on its way. In 2018, we acquired orders for 30 electromobility projects worth 8 billion euros, and the first half of 2019 has already seen a series of further orders worth 5 billion euros. The total value of the electromobility orders we have won in the last 18 months thus amounts to 13 billion euros. As early as 2020, our sales in this area will pass the one-billion-euro mark. For 2025, we have set ourselves a sales target of 5 billion euros – a target which we will surpass. Our products are finding a market, and our upfront investments are paying off.

At the same time, we are commercializing the fuel-cell powertrain. To achieve this, we are preparing to manufacture a Bosch stack. More specifically, we are further refining the stack made by our partner Powercell, which already offers the highest power density in the market. The task now is to manufacture it cost-effectively. We will do this not only through economies of scale, but also through simultaneous engineering of the product and the manufacturing process. This is one of Bosch's strengths. And one of the ways we will exploit this strength is by deploying engineers experienced in mass-production diesel projects to work on this new technology. We made common rail affordable, and we will do the same for alternative powertrains such as the fuel cell.

It starts with parking: automated driving becomes everyday reality

We're also in the lead on the path to automated driving. In this endeavor, we will generate 12 percent growth with driver assistance systems this year, with sales rising to 2 billion euros. Sales of radar sensors alone will grow 20 percent in 2019, and those of video sensors by 30 percent. For the next levels of automated driving, we will invest 4 billion euros up to 2022. The next step is

freeway assistants that allow drivers to take their hands off the wheel. We are currently developing such level 2 hands-off systems for the Asian and U.S. markets. At present, it is only there that such systems are legally permissible. We need them to be approved for exactly the same purpose in Europe, so that the next stage of automation can also happen on our roads.

After all, we were given approval for the world's first driverless parking system right here in Germany – for our joint project with Daimler in Stuttgart's Mercedes-Benz Museum. The project is no longer a prototype, but is going into regular operation. I've brought along a film clip to show you how the automated valeting and parking service works.

And of course, that's not the end of the story. Here as well, we will work on costs. One way of doing so is by deploying the video cameras we use in our building technology. By the end of 2021, we will have set up automated valet parking in a dozen further parking garages, and by 2025, we aim to have it available at over one hundred more. But with this first approval, we can say that everyday automated driving starts with parking.

Equipped for disruptive trends: projects with new market players

Technologically, we are the innovation leader – but how do we foresee new business ideas in our rapidly changing industry? Bosch is deliberately entering into business with new market players that may also be antennae for disruptive trends. For example, we're working with DiDi, Lyft, and Uber – the three biggest ride-hailing providers, who already arrange more than 50 million rides a day in total worldwide. For DiDi, we are using a cloud service to prolong batteries' service lives. To give you an idea of the new approaches we're taking in our collaboration with new providers, as well as of the visions we have for web-based mobility, I'll now hand over to Stefan Hartung.



Bosch and CATL collaborate on battery cells Aim is a leading position in 48-volt batteries

September 5, 2019
PI 11014 BBM joe/BT

- ▶ Stefan Hartung: “The 48-volt hybridization is sure to be the minimum standard in tomorrow’s automotive market.”
- ▶ As early as 2025, nearly 20 percent of new cars will feature a 48-volt system.
- ▶ Production of the Bosch 48-volt battery started at Wuxi in late 2018.

Stuttgart, Germany: Bosch and Contemporary Amperex Technology Co. Limited (CATL) have concluded a long-term strategic cooperation agreement. The partners are going to jointly specify high-performance battery cells. CATL will then design, develop, and manufacture these cells in accordance with Bosch requirements. The cells are to be used in the 48-volt battery developed by Bosch. This battery is the core element of 48-volt hybrid powertrain systems, whose efficiency is making them globally ever more important. In joining this alliance, the supplier of technology and services is also securing its long-term sourcing for battery cells. “We have to understand battery cells, but we do not have to make them ourselves,” says Dr. Stefan Hartung, member of the board of management and chairman of the Mobility Solutions business sector. “With CATL, we have brought an established cell specialist for lithium-ion batteries on board as a partner. In combination with our systems know-how and expertise in battery management, we will extend our strong position in the 48-volt battery market.” CATL, one of the world's leading experts of lithium-ion battery is currently building a battery factory in Erfurt, Germany. For Bosch, this alliance is another step on the path to market leadership in electromobility. Numerous global automakers already use Bosch’s 48-volt battery.

48-volt system destined to be the minimum standard in tomorrow’s automotive market

Bosch’s portfolio for 48-volt systems extends beyond the 48-volt battery to encompass other system components such as DC/DC converters and electrical machines. With this technology, Bosch aims to gear up all classes of vehicles for

future emissions requirements and offer affordable hybridization. Its 48-volt electrification augments the combustion engine with an electric motor. This motor is powered by the 48-volt battery, which in turn is charged by recovering energy expended during braking. This can cut fuel consumption by as much as 15 percent. If we want to improve efficiency, we can no longer afford to let brake energy dissipate unused,” Hartung says. “This 48-volt hybridization is sure to be the minimum standard in tomorrow’s automotive market.” The market for 48-volt solutions is growing worldwide. Bosch expects that by 2025, nearly 20 percent of new cars sold annually around the globe will have a 48-volt system and matching battery on board. Demand for 48-volt systems is rising, especially in Europe and China.

Cost-effective and easy to integrate – the Bosch 48-volt battery

The Bosch plant in Wuxi, China, started making the first generation of the 48-volt battery late last year. The USP of the latest version of this product is that the battery is compact and cooled passively. This means automakers can simply integrate it into their vehicle models, and do not require any additional cooling units. In addition, they can dispense with the long and costly effort of proprietary engineering work. “We are confident that our 48-volt battery will achieve a leading position in the market, and make the 48-volt hybrid affordable for the mass market,” Hartung says.

Expertise across the e-mobility ecosystem

Bosch is more broadly positioned in e-mobility than any other company. It aims to take the lead in the mass e-mobility market that will emerge in 2020 and beyond. The company is planning to increase its sales in this area more than tenfold by 2025, to five billion euros. Bosch electrical powertrain components already feature in more than a million vehicles around the world. The supplier of technology and services has carried out powertrain projects for 50 electric-vehicle platforms. It is the market leader in China, the world’s biggest and fastest-growing electric-vehicle market. Bosch technology can be found in practically every class of vehicle, from electric baby buggies, bicycles, and scooters to passenger cars and commercial vehicles. The company’s expertise thus extends across the entire e-mobility ecosystem. Bosch is partnering with various automakers to give e-vehicle drivers app-based access to some 40,000 charge spots in eight European countries.

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From the wind tunnel to the sidewalk: Bosch is bringing smart electrical drives to strollers e-stroller system revolutionizes comfort and safety

August 2019

PI 10983 BBM ts/as

- ▶ Bosch management board member Dr. Stefan Hartung: “The Bosch e-stroller system incorporates know-how from across the company.”
- ▶ Intelligent sensors regulate electrical drive and automatic braking function.
- ▶ Nine out of ten parents look at a stroller’s comfort and safety.
- ▶ Smartphone app gives the Bosch e-stroller system connectivity via Bluetooth.

Bühl, Germany – Measuring a seven on the Beaufort scale, the air in the wind tunnel blasts the stroller at a speed of 60 kph. Its hood may be flapping wildly, but the stroller doesn’t budge. This isn’t because its parking brake is on, or because someone is holding it still. It’s all thanks to the new Bosch e-stroller system. This is much more than an electrical drive – it is an assistance system for strollers with a comprehensive range of comfort and safety features: in addition to offering push support and an automatic braking function, this includes connectivity via a smartphone app, an alarm function, and a variety of high-tech sensors. This new system marks Bosch’s entry into a new market. “The e-stroller system incorporates know-how from across the company. We’ve applied the same rigorous technology and quality standards here as we do in the automotive sector, including wind tunnel tests,” says Dr. Stefan Hartung, member of the board of management and chairman of the Mobility Solutions business sector. The variable Bosch system is equally suitable for single, twin, or sibling strollers. It will have its market launch in early 2020 with the Swedish stroller manufacturer Emmaljunga. Collaboration with additional manufacturers is planned.

Two electric motors help with acceleration and braking

Demand for electric assistance for strollers is growing. Comfort and safety are the key criteria for nine out of ten parents when buying a stroller. This is the result of a representative Bosch survey of women and men with a child aged 0 to 4 years old as well as expectant parents. “Bosch wants its mobility solutions to

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offer help even before a child can walk, bringing intelligent mobility to all areas of life,” Hartung says. The system’s drive unit comprises two low-noise electric motors on the rear axle along with a Bluetooth module and a smart sensor system. The sensors, which are also employed in smartphones, measure things like the stroller’s speed and acceleration while assessing the road surface it is moving over. Using algorithms, they can calculate in fractions of a second what mom or dad wants to do next. On an uphill path, the motors automatically help push the stroller, as they do on an e-bike. When on a downhill slope, they step in to help brake. If the parents let go of the stroller, the motor brake prevents it from rolling away unchecked, and the electromechanical lock engages the parking brake. In line with Bosch’s typical approach of combining the highest technical standards with user-friendly operation, the e-stroller system has no need for additional switches or buttons on the push handle.

The electric assistance not only increases comfort and safety, but also improves the stroller’s ergonomics. Bosch user testing showed that the e-stroller system can greatly improve parents’ posture, since it takes a lot less effort to push the stroller uphill, over uneven terrain, or into a headwind. Meanwhile, the self-braking electrical drive noticeably eases back strain when heading downhill. The system’s steering support also brings clear benefits when pushing with just one hand. Among other things, this makes bends easier to manage. What’s more, the drive system helps keep the stroller on course when on a laterally sloping path. After all, parents often push a stroller with one hand, for instance when holding their child’s older sibling with the other hand.

Smartphone connectivity via Bluetooth

Users can choose from three levels of electric assistance using the associated smartphone app (available for Android and iOS). The app communicates with the e-stroller system via Bluetooth. It also displays the charge level of the detachable battery and warns users in good time that power is running out. The stroller’s handy, lightweight 18-volt lithium-ion battery is housed in a lockable compartment. This is the same battery used in standard Bosch power tools such as cordless screwdrivers, which means that the stroller battery can be used to power other devices and vice-versa, whenever a spare battery is needed. With a charging time of some two and a half hours, the fully charged battery offers a range of up to 15 kilometers, depending on the level of assistance selected and the weight of the stroller. Parents can also charge their smartphone using the system’s USB port. The app can be used to activate the alarm function, too, for instance when parents leave the stroller parked outside a café. Provided a Bluetooth connection has been established with a parent’s smartphone, a warning will appear if anyone tries to push the stroller away. In addition, an alarm will sound from the stroller’s integrated loudspeaker and the parking brake will

automatically reengage. Should the battery run out on the move after all, the stroller can still be used like a normal stroller – with no perceptible motor resistance.

Press photographs: #2718966, #2718967, #2718968

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Better than a pair of eyes: Bosch camera with AI for driver assistance and automated driving Bosch aims to be market leader for camera technology

August 30, 2019
PI 11000 CC joe/BT

- ▶ Harald Kroeger: "We want to make cars better drivers than people."
- ▶ For reliable object recognition, Bosch camera takes unique multi-path approach.
- ▶ AI designed by Bosch: camera improves legacy driver assistance systems and extends their application range.

Stuttgart, Germany, and Yokohama, Japan – Automated driving technology is gradually providing more and more assistance to the driver – with the future aim of the car being able to take complete control. But there is more to it than that: "We want to make cars better drivers than people, and in this way to increase road safety. In other words, technology has to work more reliably than people," says the Bosch management board member Harald Kroeger. That presents a major challenge, particularly in terms of surround sensing. Only if it knows exactly, and at all times, what is going on around it can an automated vehicle choose the right, and above all safe, driving strategy. Bosch uses various technologies for surround sensing, including ultrasound, radar, and video. When it comes to structure and function, cameras come closest to the human eye, which is why they will be such invaluable assets for automated driving, and indeed why they already play a key role in driver assistance. Bosch has now succeeded in taking automotive camera technology to a new level. This new Bosch technology is set to debut in vehicles in 2019. The combination of its unique multi-path approach and artificial intelligence (AI) for object recognition will make surround sensing far more reliable, and road traffic safer. Bosch aims to be the market leader, and the measure of all things in camera technology.

Human drivers: looking but failing to see

Cars with driver assistance, automatic emergency braking systems, and automated driving capability must be able to see all objects in their surroundings. On top of that, they must be able to detect in a flash if an object is relevant for their driving strategy. And just as quickly, they have to determine what their

reaction to relevant objects should be. Should they brake, swerve, or continue on their path? Unlike the human eye, the new Bosch MPC3 mono video camera has been optimized to handle such decisions. For humans, looking is one thing, but actually recognizing what our eyes see is another matter. Our eyes may be marvels of nature, but we have our weaknesses when it comes to visual perception. Just because we see something does not mean that we recognize and understand it. Many drivers who are involved in accidents say that they had been looking in the right direction but failed to spot the other party. It is estimated that up to 50 percent of road traffic collisions are attributable to this phenomenon. The new Bosch camera is superior to the human eye in this respect, not least because it never gets tired, and works just as well after hours of driving as during the first kilometer.

Bosch technology makes new and improved driver assistance systems possible

The new technology's great strength lies in its robust object recognition, enabled by Bosch's multi-path approach. This also makes use of artificial intelligence. For example, Bosch engineers have taught the camera to reliably detect if the edge of the road is passable, even in the absence of road markings. This camera intelligence is based on Bosch know-how and integrated into a chip, known as V3H, made by the Japanese company Renesas. It can also improve legacy driver assistance systems and extend their application range. For instance, it could enhance automatic emergency braking systems to prevent vehicles hitting various types of animals. It could also make emergency braking more reliable, since the camera can recognize pedestrians even when they are partially concealed. The Bosch innovation also improves road-sign recognition. The new Bosch camera features optical character recognition that reliably reads text and numbers on road signs, and presents this information to the driver on a dashboard display.

The camera with AI won an award in a company-internal innovation contest.

Press photos: #2719170, #2719173

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New dimension: Bosch is paving the way for 3D displays in vehicles

Next milestone in digital displays

August 2019

PI 10982 BBM ts/af

- ▶ Dr. Steffen Berns, president of Bosch Car Multimedia: “Displays are increasingly becoming interactive systems.”
- ▶ Safer: 3D effect means visual information can be understood faster.
- ▶ More efficient: Bosch has combined all control functions in a central processing unit.

Hildesheim, Germany – Bigger, more visually attractive, and with more and more features, digital displays are becoming a key feature of vehicle cockpits. Neither drivers nor passengers want to be without the display and control features they now enjoy on devices such as smartphones and televisions. But there is more to it than that: in the cockpits of the future, digital displays will play a key role in the interaction between drivers and their vehicles. With its new 3D display products, Bosch is responding to this trend. The products use passive 3D technology to generate a realistic three-dimensional effect that allows visual information to be grasped faster than when displayed on conventional screens. “Displays are increasingly becoming interactive systems that can better anticipate drivers’ individual needs,” says Dr. Steffen Berns, president of Bosch Car Multimedia. “There is huge business potential for Bosch here.” Forecasts suggest that the global vehicle display market will double from 15 billion dollars (13.4 billion euros) to 30 billion dollars (26.7 billion euros) by 2025 (source: Global Market Insights). Whether curved, equipped with organic LEDs (OLEDs), or freely configurable – Bosch regularly sets the benchmark for vehicle displays.

3D effect in the cockpit

3D displays are the latest trend for vehicle cockpits. On the movie screen, a 3D effect serves primarily to enhance a film’s entertainment value. But in a vehicle, it’s a different case. “The display’s depth of field means drivers can grasp important visual information faster, whether from an assistance system or a

traffic-jam alert,” Berns says. “Alerts that seem to jump out of the display are much more obvious and urgent.” When parking, moreover, the rear-view camera image is more realistic, allowing obstacles to be detected earlier. And drivers can get an even better idea of how much space they have left between the rear fender and, say, a parking garage wall. When navigating street canyons, this 3D effect also plays a decisive role, as the spatial depth of the map display makes it immediately clear which building marks the next turn. For its new display, Bosch makes use of a passive 3D technology, which works completely without additional features such as eye tracking or 3D glasses.

Innovative and interactive

The eyes are responsible for 90 percent of all human sensory perception. Simply showing information on a car display instrument is old hat. The future is all about interaction between users and displays. And Bosch is ready for this. Its portfolio includes applications of all kinds – from small and flat to large and curved, and sometimes in unusual shapes such as round or with trimmed corners. On top of this, interaction can take the form of voice or touch control – the latter also with haptic feedback. “Bosch is developing infotainment to suit any customer,” Berns says. And especially when the drivers of the future let their autopilot do the driving, the human-machine interface (HMI) will be crucially significant for the interaction between the car and its driver.

Back-end makes all the difference

As displays grow in size, become more multi-purpose and intelligent, and feature voice and touch control, more and more computing power is needed. This could mean many more control units. Even now, as many as 15 back-end processing units control the display and operating systems. Bosch uses just one cockpit computer to coordinate the entire HMI, and delegates all control functions to one central control unit. “We are putting intelligence into the cockpit,” Berns says. Fewer control units also means less weight, and vehicle development times are also reduced. Thanks to over-the-air updates, moreover, the infotainment system can be kept up to date just as simply as a smartphone.

Safety first

Vehicle displays are subject to rigorous safety standards. Especially when it comes to temperature fluctuations and vibrations, these standards are far higher than for consumer electronics. For example, car displays have to work perfectly whether the temperature is minus 40 or plus 120 degrees Celsius, and this over the vehicle’s entire service life. Even in the event of partial failure, drivers have to be able to rely on a minimum amount of vital information at all times. Bosch operating systems are tested thoroughly to make them fit for vehicle use.

Since the 1980s, the company has repeatedly set milestones for vehicle display instruments, such as the world's first digital display, featured in the cockpit of the Audi Quattro. It was also thanks to Bosch that the [first freely programmable display](#) went into production in the Audi TT some five years ago. And Bosch is also behind the [world's first curved instrument cluster](#) in the Innovision cockpit of the latest VW Touareg. The company also applies its digital innovations to display instruments for motorcycles and e-bikes.

Press photos: #2715345, #1515914, #2715346, #1289439, #1289576, #2716453

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Emissions-free, safe, fascinating: Bosch is shaping present and future mobility

These are the highlights at the IAA 2019

July 2019

PI 10942 BBM CS/af

- ▶ Diesel, gasoline, synfuel, electricity, and hydrogen: modern powertrains are making vehicles more efficient and helping the environment.
- ▶ Cities, freeways, parking garages: automated driving is making traffic safer and more convenient.
- ▶ Apps, data, cloud: connectivity is turning the car into a smart device on wheels and enhancing driving enjoyment and safety.

Stuttgart and Frankfurt, Germany – Bosch wants to make mobility as emissions-free, safe, and fascinating as possible. At the IAA 2019, the technology and services company is showcasing its latest solutions for personalized, automated, connected, and electrified mobility. You will find Bosch in hall 8, booth C 02 as well as at the Agora exhibition space.

Shuttle concept and technology showpiece at the Bosch booth

Bosch IoT Shuttle – vehicles for the future of urban mobility:

In the future, driverless shuttles will be a common sight on city streets around the world – whether they are transporting goods or people. Thanks to their electrical powertrains, the shuttles will glide through city centers and be seamlessly connected with their surroundings. Bosch technology for automating, electrifying, personalizing, and connecting can be used in these sorts of [shuttles](#).

Rolling chassis – electromobility platform:

Electrical powertrains, steering systems, brakes – Bosch has all the building blocks of electromobility in its portfolio. As part of a development partnership with the chassis and automotive technology expert Benteler, the company is demonstrating how all Bosch products for electric vehicles can be integrated with one another. The rolling chassis showpiece is, among other things, helping Bosch to strategically refine products to meet such requirements.

Gasoline, electricity, and stacks – Bosch technology for all powertrain types

Bosch wants to make mobility energy-efficient and eco-friendly whatever the application, so it offers solutions for all powertrain types – including efficient internal-combustion engines, fuel-cell powertrains, and various stages of electrification.

Fuel-cell system – e-mobility for the long haul:

Mobile fuel cells offer long ranges, short refueling times, and – with hydrogen produced using renewable energy – emissions-free vehicle operation. Together with the Swedish company Powercell, Bosch plans to commercialize a fuel-cell stack. In addition to the stack, which converts hydrogen into electrical energy, Bosch is developing all the essential system components to a production-ready stage.

48-volt systems – lower consumption and CO₂ emissions:

Bosch 48-volt systems offer entry-level hybridization for all vehicle classes by providing an auxiliary motor to assist the internal-combustion engine. The technology stores braking energy from recuperation and makes it available during acceleration. This reduces fuel consumption and CO₂ emissions by up to 15 percent. Bosch offers all the system's major components.

High-voltage solutions – greater range for hybrid and electric vehicles:

Electric vehicles and plug-in hybrids make mobility possible with zero local emissions. Bosch helps vehicle manufacturers design these kinds of powertrains and supplies the necessary systems. The e-axle combines the power electronics, electric motor, and transmission into a single unit. The efficiency of this compact module has been further optimized for greater range.

Thermal management – setting the right temperature in electric cars and hybrids:

Bosch uses intelligent thermal management to increase the range of electric and hybrid vehicles. Precise distribution of heat and cold improves the efficiency of the battery and ensures that all components are working within their optimum temperature range. The thermal-management system also delivers a pleasant temperature inside the vehicle.

Flexible air-pollution measurement system – better air quality in cities:

Air monitoring stations are big and expensive and they measure air quality only at a few selected points. Bosch's air-pollution measurement system consists of compact boxes which can be flexibly distributed around cities. They measure particulate matter and nitrogen dioxide as well as temperature, pressure, and

humidity in real time. Bosch creates an air-quality map on the basis of these measurements and uses it to advise cities on traffic planning and management.

eMountain bike – making light work of tough terrain on two wheels:

Electrified mountain bikes are currently the strongest-growing segment of the eBike market. The new [Bosch Performance Line CX drive system](#) is optimized for sporty cycling and features a compact profile. Its freewheel clutch makes riding feel natural even without motor assistance.

Assistance systems and automation – Bosch is teaching cars to drive

Safety, efficiency, traffic flow, time – automation is one of the keys to many challenges of tomorrow's mobility. Not only does Bosch have a broad portfolio of driver assistance systems, but the company also systematically develops its systems, components, and services further with a view to partial, highly, and fully automated driving.

Automated valet parking – green light for driverless parking:

Bosch and Daimler have installed the automated valet parking system in the Mercedes-Benz Museum parking garage in Stuttgart. [It is the world's first driverless \(SAE Level 4\) parking function to be officially approved.](#) The automated valet parking service is activated via a smartphone app. As if guided by an invisible hand, the car parks itself without a safety driver.

Front camera – image processing with algorithms and AI:

The front camera combines image-processing algorithms with AI methods. In congested urban traffic, it can for example recognize and classify partially obscured or crossing vehicles, pedestrians, and cyclists quickly and reliably. This allows the vehicle to trigger a warning or emergency braking.

Radar sensors – surround sensors for complex driving situations:

The latest generation of Bosch radar sensors are even better at capturing the vehicle's surroundings – including in bad weather or poor light conditions. Their greater detection range, wide aperture, and high angular resolution mean automatic emergency braking systems can react more reliably.

Vehicle motion and position sensor – precise localization for vehicles:

Bosch has developed a sensor that allows automated vehicles to precisely determine their position: the [VMPS vehicle motion and position sensor](#). This enables automated vehicles to determine their exact position in the lane while driving. The VMPS uses global navigation satellite system (GNSS) signals supplemented with data from a correction service as well as from steering-angle and wheel-speed sensors.

Connected horizon – even more precise and up to date:

Bosch is continuing to refine the connected horizon. Automated driving requires ever more precise information in real time about the road ahead – for instance danger spots, tunnels, or the angle of bends. The connected horizon uses highly accurate map data to provide the vehicle with this kind of information safely and reliably.

Electric steering systems – key to automated driving:

Electric power steering is one of the keys for increasingly automated driving. Thanks to its multiple redundancies, Bosch's electric steering system offers additional safety. In the rare event of an error, it can still maintain at least 50 percent of the electric steering functionality in conventional and autonomous vehicles.

Communication between vehicles, their surroundings, and users – Bosch is bringing seamless connectivity to mobility

Vehicles that warn each other of dangers or need no ignition key: Bosch connected mobility makes life easier for road users while increasing safety, convenience, and driving enjoyment. Operation is simple thanks to intuitive human-machine interface (HMI) solutions. A range of services tailor mobility to individual needs.

3D display – instrument display with deep-view effect:

Bosch's new 3D display creates a convincing three-dimensional effect in the vehicle cockpit that both drivers and passengers can see. This improves visualization to assistance systems, for example the reversing camera. Drivers enjoy an even clearer overview of relevant information, such as the distance to obstacles or vehicles.

Perfectly keyless – smartphones instead of keys:

The [Bosch keyless access system](#) works with a virtual key stored on a smartphone. The system enables drivers to automatically unlock their vehicle, start the engine, and lock the car again. Sensors installed in the car recognize the owner's smartphone as securely as a fingerprint and open the vehicle only for them.

Semiconductors – building blocks of connected mobility:

Without semiconductors, modern vehicles would simply grind to a halt – and Bosch is the leading supplier of chips to the automotive industry. Bosch chips

help navigation systems when the GPS signal is interrupted, for instance, and they keep driving behavior steady. These chips also turn off the power in electric cars in the event of an accident to protect occupants and enable the emergency services to do their job safely.

V2X communication – data exchange between vehicles and their surroundings:

Connected and automated driving is possible only if vehicles communicate with each other and with their surroundings. However, no uniform global technical basis for vehicle-to-everything (V2X) data exchange has yet emerged. Bosch's hybrid V2X connectivity control unit is technology-neutral and can communicate via Wi-Fi as well as cellular networks. This means vehicles can warn each other of hazardous situations.

Vehicle computer – next-generation electronics architecture:

Increasing electrification, automation, and connectivity are placing ever higher demands on automotive electronics. Bosch is developing the necessary secure, powerful control units, known as vehicle computers, and putting them to work for the powertrain, in automation, and for infotainment.

Battery in the cloud – services for longer battery life:

Bosch's new [cloud services](#) increase the service life of batteries in electric cars. Smart software functions analyze the status of the battery based on real-time data from the vehicle and its surroundings. It recognizes stress factors for the battery, among them high-speed charging and multiple charge cycles. On the basis of the data collected, the software then calculates measures to counter cell aging, such as optimized recharging processes.

Predictive road-condition services – anticipating potential hazards:

Rain, snow, and ice change the road's surface grip, or friction coefficient. To let automated vehicles know how they need to adapt their driving behavior to current conditions, Bosch has developed its [cloud-based road-condition services](#). Information about weather, road-surface characteristics, and surroundings as well as the expected friction coefficients are passed on to connected vehicles via the cloud in real time.

Interior camera – observer for more safety:

Microsleep, distractions, or a forgotten seatbelt: what happens inside a vehicle can have far-reaching consequences. The Bosch interior monitoring system, which is optionally available in both single- and multi-camera configurations, recognizes critical situations in a matter of seconds and warns the driver. This means increased safety.

Press photos: #1728556, #1156595, #1849989, #2658357, #1147919, #1709802, #694337, #1713652, #2068019, #1156702, #2715345

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World first: Bosch and Daimler obtain approval for driverless parking without human supervision

July 23, 2019

PI 10970 BBM Fi/af

- ▶ Automated valet parking is the world's first fully automated driverless (SAE Level 4)¹ parking function to be approved by the authorities.
- ▶ System to be in daily use in the Mercedes-Benz Museum parking garage in Stuttgart.
- ▶ Automated parking system collects and returns the vehicle completely independently.
- ▶ Bosch supplies the infrastructure; Daimler the vehicle technology.
- ▶ Special permit issued by Stuttgart regional administrative authority in close cooperation with Baden-Württemberg state transportation ministry following assessment by TÜV Rheinland.

Stuttgart, Germany – Bosch and Daimler have reached a milestone on the way to automated driving: the two companies have now obtained approval from the relevant authorities in Baden-Württemberg for their automated parking system in the Mercedes-Benz Museum parking garage in Stuttgart. The automated valet parking service is accessed via a smartphone app and requires no safety driver. This makes it the world's first fully automated driverless SAE Level 4¹ parking function to be officially approved for everyday use.

“This decision by the authorities shows that innovations like automated valet parking are possible in Germany first,” says Dr. Markus Heyn, member of the board of management of Robert Bosch GmbH. “Driverless driving and parking are important building blocks for tomorrow's mobility. The automated parking system shows just how far we have already progressed along this development path.”

¹ SAE Level 4: Driverless driving in a geographically discrete area, as defined by the Society of Automotive Engineers (SAE) in its recommended practice J 3016

“This approval from the Baden-Württemberg authorities sets a precedent for obtaining approval in the future for the parking service in parking garages around the world,” says Dr. Michael Hafner, the head of drive technologies and automated driving at Daimler AG. “As a pioneer in automated driving, our project paves the way for automated valet parking to go into mass production in the future.”

Playing it safe: two partners with a common objective

From the very beginning, Bosch and Daimler’s top priority for the driverless parking service was safety. Since there is as yet no official approval process for automated driving functions that do not require a driver, the local authorities – the Stuttgart regional administrative authority and the state of Baden-Württemberg’s transportation ministry – oversaw the project along with experts from the German technical inspection service TÜV Rheinland from the outset. Their aim was to assess the operating safety of the automotive and parking-garage technology.

The result is a comprehensive safety concept with appropriate testing and approval criteria that can be applied beyond this pilot project. In the concept, the developers defined how the driverless vehicle detects pedestrians and other cars in its path and reliably comes to a halt when it encounters an obstacle. They also set up secure communications between all system components and took steps to ensure the reliable activation of the parking maneuver.

The technology behind driverless parking

Drive in to the parking garage, get out, and send the car to a parking space just by tapping on a smartphone screen – automated valet parking has no need for a driver. Once the driver has left the parking garage to go about their business, the car drives itself to an assigned space and parks. Later, the car returns to the drop-off point in exactly the same way. This process relies on the interplay between the intelligent parking garage infrastructure supplied by Bosch and Mercedes-Benz automotive technology. Bosch sensors in the parking garage monitor the driving corridor and its surroundings and provide the information needed to guide the vehicle. The technology in the car converts the commands from the infrastructure into driving maneuvers. This way, cars can even drive themselves up and down ramps to move between stories in the parking garage. If the infrastructure sensors detect an obstacle, the vehicle stops immediately.

Project milestones

Bosch and Daimler started developing fully automated driverless parking in 2015, and in the summer of 2017, their pilot solution in the Mercedes-Benz Museum parking garage in Stuttgart reached an important milestone: automated valet parking in real conditions, with and without drivers at the wheel, was presented to the public for the first time. This premiere was followed by an intensive testing and start-up phase. Starting in 2018, museum visitors could use the parking service live, accompanied by trained safety personnel, and share their experience. One aspect of the pilot project involved testing lighting concepts on the vehicles. Turquoise lighting indicates that a vehicle is in automated driving mode and informs passers-by and other road users that the vehicle is driving itself. The insights from these tests are reflected in the recently issued SAE standard 3134. Obtaining final approval from the authorities is a further major milestone for Bosch and Daimler: soon, interested parties will be able to experience the innovative valet parking service live in daily operation in the Mercedes-Benz Museum parking garage without additional supervision from a safety driver.

Press photos: #1147919, #1147921, #1147922, #1150597, #2658330, #2658331, #2658332, #2658333

Additional information:

[Bosch and Daimler demonstrate driverless parking in real-life conditions](#)

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Bosch extends the service life of electric-vehicle batteries

July 2019

PI 10934 BBM Fi/Bär

Cloud-based swarm intelligence helps batteries maintain performance for longer

- ▶ Markus Heyn: “Bosch is connecting electric-vehicle batteries with the cloud, and substantially improving performance and service life.”
- ▶ Smart algorithms recognize battery stress factors and optimize the recharging process.
- ▶ Mobility services provider DiDi is the first company to use the Bosch battery services.

Stuttgart, Germany – Stress makes cells age faster. Something that geneticists have long since demonstrated for the human body is also true for electric-vehicle battery cells. The older the batteries get, the lower their performance and capacity, and the shorter the range of the vehicle. To help batteries last longer, Bosch is developing new cloud services that supplement the individual vehicles’ battery-management systems. “Bosch is connecting electric-vehicle batteries with the cloud. Its data-based services mean we can substantially improve batteries’ performance and extend their service life,” says Dr. Markus Heyn, member of the board of management of Robert Bosch GmbH. Smart software functions in the cloud continually analyze the battery status and take appropriate action to prevent or slow down cell aging. These measures can reduce the wear and tear on the battery, the most expensive component of an electric vehicle, by as much as 20 percent. Real-time data gathered from the vehicle and its surroundings plays a key role here. The cloud services utilize this data to optimize every single recharging process and to provide drivers with tailored driving tips on how to conserve battery power via the dash display. Didi Chuxing, a globally leading mobility platform based in China, is working with Bosch to introduce Battery in the Cloud across DiDi’s electric vehicle fleet. The aim is to optimize battery performance, thus benefiting both drivers and fleet operators within DiDi’s ecosystem.

Precise real-time analysis

According to experts, the average service life of today's lithium-ion batteries is 8-10 years or between 500 and 1,000 charge cycles. Battery makers usually guarantee mileage of between 100,000 and 160,000 kilometers. But rapid battery charging, high numbers of charge cycles, an overly sporty driving style, and extremely high or low ambient temperatures are all sources of stress for batteries, which makes them age faster. Bosch's cloud-based services are designed to recognize – and counter – these stress triggers. All battery-relevant data – e.g. current ambient temperature and charging habits – is first transmitted in real time to the cloud, where machine-learning algorithms evaluate the data. With these services, Bosch is not only offering a window into the battery's current status at all times, but enabling a reliable forecast of a battery's remaining service life and performance to be made for the first time. Previously, it was not possible to make any accurate forecast of how quickly an electric-vehicle battery would wear out. "Powerful batteries with long services lives will make electromobility more viable," said Heyn. Another feature of the smart software functions is their use of the swarm principle: the algorithms used for analysis evaluate data gathered from an entire fleet, not just from individual vehicles. Swarm intelligence is the key to identifying more of the stress factors for vehicle batteries, and to identifying them more quickly.

Protecting cells against aging

The new insights gained into a battery's current status enable Bosch to also actively protect it against aging. To give one example: fully-charged batteries age more quickly at particularly high or low ambient temperatures. Bosch's cloud services thus ensure that batteries are not charged to 100 percent when conditions are too hot or too cold. By reducing the battery charge by only a few percentage points, the battery is protected against inadvertent wear and tear. Data in the cloud will also help improve battery maintenance and repair. As soon as a battery fault or defect is identified, for example, the driver or fleet operator can be notified. This increases the chances that a battery can be repaired before it becomes irrevocably damaged or stops working altogether. Finally, the cloud services also optimize the recharging process itself. The recharging process – which, by the way, is one of the biggest obstacles to creating a mass market for electromobility – harbors the danger that the battery cells permanently lose some of their performance and capacity. Smart software in the cloud can calculate an individual charge curve for each recharging process, regardless of whether it takes place at home or elsewhere. This means the battery is recharged to the optimum level, helping conserve the cells. Whereas existing apps with charge timers merely allow drivers to time the recharging process so that it is carried out when demand for electricity is low, the Bosch solution goes much further, offering a specially developed recharging process as part of the company's new battery

services. They optimize both fast and slow charging and control electricity and voltage levels during the recharging process, thus prolonging battery life.

Q&A

What is the difference between Bosch cloud services and conventional battery-management systems?

The battery-management systems currently integrated in electric vehicles monitor and manage the battery cells, and ensure both reliable operations and uniform recharging of the battery cells. But a battery's performance and service life depend on numerous factors, such as the frequency with which it is recharged and discharged, the type of recharging process used, the driving style, and external factors such as the ambient temperature. That is why Bosch has developed cloud services that supplement the conventional battery-management systems installed in electric vehicles.

Why is Bosch developing its own recharging strategies?

Up to now, different recharging processes have been programmed into electric vehicles. Going forward, Bosch will offer automakers innovative recharging strategies that complement the processes available. When, for example, drivers want to recharge their batteries faster, a rapid recharge process automatically shortens the time required without damaging the battery. Another strategy optimizes the more leisurely standard recharging process, which can take several hours. The Bosch process is especially gentle on the battery, enhancing both its capacity and service life.

Press photographs: #2068017, #2068018, #2068019, #2236620

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EXPERIENCE BOSCH AT THE IAA 2019 in Frankfurt: Rethinking mobility and making it as accident-free, emissions-free, and fascinating as possible – this is the goal Bosch has set itself. On a technological level, the supplier of technology and services wants to achieve these aims through personalization, automation, connectivity, and electrification. At the IAA 2019, Bosch will be presenting its latest solutions for making driving safer and more efficient, for making mobility available on demand, and for turning cars into personal assistants.

BOSCH PRESS CONFERENCE: On Tuesday, September 10, 2019, with [Dr. Volkmar Denner, chairman of the board of management of Robert Bosch GmbH](#) and [Dr. Stefan Hartung, chairman of the Mobility Solutions business sector](#), at the Bosch booth in Hall 8.

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