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Press release

May 19, 2015
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62nd Bosch International Automotive Press Briefing
Mobility Solutions sector continues strong growth
Sales up 13 percent in the first quarter of 2015

- Sales once again growing significantly faster than the market
- Unit sales of ESP, diesel systems, and gasoline systems each increased 20 percent in 2014
- Driver assistance business growing by one-third annually

The Bosch Group's largest business sector, Mobility Solutions, continues to grow strongly. After adjusting for exchange-rate effects, the sector's sales grew 7 percent in the first quarter of 2015. Nominal sales growth was as high as 13 percent[1)]. "Technologically and internationally, our position is so good that we will again grow significantly faster than the market this year," said Dr. Rolf Bulander, the business sector's chairman, at the Bosch International Automotive Press Briefing in Boxberg, Germany (May 19 - 21, 2015). In 2014, the business volume of Mobility Solutions grew 8.9 percent, and thus more than twice as fast as global automotive production. Unit sales of important systems such as the ESP anti-skid system, gasoline direct injection systems, and diesel direct injection systems each grew by some 20 percent. In the future, Bosch will also increasingly offer solutions that govern the way cars and other means of transport interact. "We are rethinking personal mobility, and moving toward a multimodal concept encompassing bikes, trains, and buses," Bulander said, explaining this new goal. "Bosch as a company is looking beyond the hood."

Electromobility will make diesel and gasoline vehicles even more efficient

On this path to the mobility of the future, Bosch is already achieving success, not just technologically but also commercially. The supplier of technology and services is pursuing three development paths, toward driving that is electric, automated, and connected. "Bosch is making good progress in all three," Bulander said. In his view, the combustion engine will remain the basis for efficient mobility well into the next decade, even if the powertrain is electrified. Over the next five years, Bosch engine-related technology can reduce the

[1] Sales figure assumes that the consolidated group includes Robert Bosch Automotive Steering GmbH.

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consumption of diesel engines by 10 percent, and that of gasoline engines by nearly 20 percent.

In conjunction with electromobility, the combustion engine will become even more efficient. By 2025, 15 percent of all new vehicles will feature at least a hybrid powertrain. For this combination of electric motor and combustion engine, Bosch's wide-ranging expertise means it is is excellently equipped. Of the 30 production orders the company has already carried out relating to powertrain electrification, ten alone are plug-in hybrid powertrains for premium vehicles. Over long distances, these vehicles run on diesel or gasoline, but can run in all-electric mode in city driving. "We have the experience it takes to turn an alternative powertrain into a success story," Bulander said. "It's what we did with diesel, and it's what we want to achieve with the electric powertrain, too."

Automated driving can cut accident figures by up to a third

As the industry moves toward automated driving, the market for driver assistance systems is already expanding. In this market, Bosch is increasing its sales by one-third each year. Last year was the first time that the company sold more than 50 million environment sensors for driver assistance systems. And in 2015, unit sales of radar and video sensors will double, as they did in 2014. Bosch is the global market leader for radar sensors, which are found in systems such as adaptive cruise control. This year, a series of new systems will go into production at the company. These assistance systems help drivers in traffic jams, when taking evasive action, and when parking by remote control. By 2020, the aim is to produce a highway pilot for automated driving on freeways. In the view of the Bosch management board member Dr. Dirk Hoheisel, this is a decisive development step: "With this system, we will make the transition from partly to highly automated driving. Drivers will become passengers. That will mean greater comfort, and above all greater safety." According to forecasts by Bosch accident researchers, increasing automation can significantly reduce accident figures even further – by up to one-third in Germany alone.

Some 2,000 engineers are working on further developing driver assistance systems at Bosch – a good 700 more than two years ago. Following the acquisition of ZF Lenksysteme (now known as Robert Bosch Automotive Steering), the Stuttgart company is in an even better position to take automated driving forward. To quote Bulander: "Bosch technology will enable the cars of the future not only to autonomously accelerate and brake, but also steer."

Connected driving means a growing service business

The internet will play a pivotal role in the development of the mobility of the future. Even now, it provides real-time traffic news, offering information on things such as accidents and construction zones, or about a traffic jam that starts just around the next bend. Such information is an essential condition for highly automated driving functions. Moreover, drivers can find and reserve vacant charge spots, and pay for the electricity, over the internet. “Connectivity is the key to the success of electrified and automated driving,” said the Bosch management board member Dr. Markus Heyn. In addition, connected driving is leading to new, beneficial services. For example, the transmission of ECU data can serve as the basis for preventive maintenance and tips for fuel saving. Services such as these support the fleet management of leasing and insurance companies. On the Bosch Drivelog mobility portal, drivers can also use such services direct. For this, they need a smartphone app and a connector for reading out the ECU data. All in all, it is expected that some 200,000 vehicles will be web-enabled and thus able to access these Bosch services. To quote Bulander: “Connected driving has left the pilot phase. For Bosch, it is becoming a flourishing service business.”

At the same time, Bosch is connecting diverse forms of transport. In Bulander’s words, these mobility solutions are also intended for multimodal transport: “We are offering new products that go beyond the car, such as services for urban mobility.” One example is the software solution that Bosch has developed for the Stuttgart Services project. Thanks to this software, one chip card is all that is needed for car-sharing, bike-sharing, train and bus travel, as well as for admission to amenities such as swimming pools or libraries. For Bulander, this is a “sneak peek at the transportation services of tomorrow.”

Moreover, Bosch already has prototype developments that connect cars and smart homes. In concrete terms, this means that the navigation system instructs the central heating to warm up the house in good time before the vehicle’s arrival. “Whether for houses or for cars, Bosch creates technology that is ‘Invented for life’,” Bulander said. “With the versatility of our expertise, our prospects for developing new mobility solutions are excellent.”

Press photos: 1-UBK-20587, 1-UBK-20782, 1-RB-21099, 1-BBM-21223, 1-BBM-21224, 1-BBM-21225, 1-BBM-21226, 1-BBM-21227, 1-BBM-21228, 1-BBM-21229, 1-BBM-21230, 1-BBM-21231, 1-BBM-21232, 1-BBM-21233, 1-BBM-21234

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Mobility Solutions is the largest Bosch Group business sector. In 2014, its sales came to 33.3 billion euros, or 68 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. The Mobility Solutions business sector combines the group's expertise in three mobility domains – automation, electrification, and connectivity – and offers its customers integrated mobility solutions. Its 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 car-to-car and Car2X communication, repair-shop concepts, and technology and services for the automotive aftermarket. Bosch has been responsible for 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 360,000 associates worldwide (as per April 1, 2015). The company generated sales of 49 billion euros in 2014. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in some 60 countries. Including its sales and service partners, Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. In 2014, Bosch applied for some 4,600 patents worldwide. The Bosch Group's strategic objective is to create solutions 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."*

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May 19, 2015
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Beyond the hood:

how Bosch now sees itself

as a systems supplier

Presentation by Dr. Rolf Bulander,

chairman of the Mobility Solutions business sector

of Robert Bosch GmbH

at the 62nd International Automotive Press Briefing

in Boxberg, May 19, 2015

Check against delivery.

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Ladies and gentlemen,

It doesn't always have to be the engine that gets the most attention at the Bosch automotive press briefing. Allow me to welcome you to the 62nd such event here at the Boxberg proving ground. And indeed, we're giving our attention not just to the technology under the hood, but also to road traffic. Traffic that is regimented according to odd and even days, as in both Paris and Beijing. Traffic that moves at 19 kilometers per hour, as it does in London, or at a staggering five kilometers per hour, as in Mumbai. This suggests that we need to rethink personal mobility, at least in big cities, and move toward a multimodal concept encompassing bikes, trains, and buses. That's exactly why Bosch as a company is looking beyond the hood. We can summarize how the way we see ourselves has changed in two sentences:

- We are a systems supplier – and that already encompasses much more than braking and injection systems.
- And we supply systems for mobility as a whole – including solutions for connecting cars, other modes of transport, and infrastructure.

Against this backdrop, Bosch decided to rename its Automotive Technology business sector Mobility Solutions. The new name says it all. That's the point I'd like to pursue in my opening statement. After a quick overview of our current business situation, I'll sketch out our view of the future of mobility and then show how our technologies are the logical answer to that. We are already making good progress on the necessary solutions – and I'll leave you with some first impressions of them at the end of my presentation. True to our strategic imperative "Invented for life," we want to improve the efficiency not just of engines but also of traffic in general. Only then can we truly see ourselves as a supplier of solutions for the mobility of the future.

The business situation: strong growth continues

First, let's take a look at our current business. Bosch's Mobility Solutions business sector generated sales of 33.3 billion euros in 2014. This was equivalent to 8.9 percent growth – more than double the growth in worldwide vehicle production. Sales of important products such as the ESP electronic stability program, gasoline injection, and diesel direct injection systems each grew by some 20 percent. We experienced particularly strong growth in sales of our clean diesel systems in China – our contribution to making the air in Beijing and Shanghai cleaner.

In 2015, we are continuing on this growth path with Mobility Solutions. As of February, we are also consolidating Bosch Automotive Steering, our steering systems business. On a like-for-like basis, we have already been able to increase real sales growth in the first quarter of this year by 7 percent. As a result of current exchange-rate effects, nominal growth was considerably higher, at 13 percent. Our Mobility Solutions business sector brings together a worldwide network of 126 manufacturing sites and 59 engineering centers. It has a total workforce of some 205,000 associates. Of these, more than 39,500 work in research and development. That's the team that is working on the mobility of tomorrow.

Future mobility: it doesn't always have to be the car

But where are cars and traffic heading in the coming years? At first glance, everything looks positive and the direction clearly set. When it comes to car driving, we see a congruence between societal and technological trends. For example, fuel efficiency is in the interest of climate protection. But forecasts can be quite uncertain – a truth that the economic and financial crisis clearly demonstrated once again a few years ago. It would be negligent to believe that market developments will be linear.

To predict the basic outline of long-term change is only one half of the story. The other half is to prepare for volatility in our markets. How can we do both?

Only by thinking in terms of scenarios. That's why at Bosch we've drawn up a series of pictures of the future. I'll compare two of them here:

- On the one hand, there's the globalization of driving enjoyment. Never mind all the rules and regulations, having your own car is still a lot of fun. So personal mobility will spread further, while the internet will further enhance the driving experience, for instance with music from the cloud. This means that in advanced economies, vehicle demand will be driven by innovations, while in emerging markets it will be driven by the adoption of Western standards of consumerism. In China, there are currently just 50 cars per 1,000 inhabitants, while in the European Union it's a good 500. Under the "fun for everyone" scenario, these numbers would converge.

- On the other hand, there's ecological globalization. This sees the world going green – either because climate protection policies are adopted right around the planet, or because megacities all over the world place limits on personal transport. The result is a further tightening of emissions and efficiency regulations for cars in both advanced economies and emerging markets. We are already seeing countries such as China and India following the European model and tightening their emissions limits. Under the "green world" scenario, personal mobility will not only be regulated more strictly, it will increasingly be complemented by other modes of transport. This is reflected in real planning: for instance, China wants to build 170 new local public transportation systems such as subways and light rail by 2030.

Electrified, automated, connected: complementary developments

These two pictures of the future stand at the two extreme ends of the scale: one an emotive perspective on car driving, the other ecological. And yet the technological answers to both are identical. No matter whether personal mobility continues to grow worldwide or becomes more tightly regulated – either

way, powertrains will be electrified and driving will become automated and connected. The reasons for all three developments are easy to summarize:

- First, electromobility will be promoted with the same legislation that has led to advancements for the combustion engine, namely stricter efficiency and emissions regulations. But this is more than an obligatory piece of green policy, because it also enhances driving enjoyment. For instance, electromobility delivers excellent torque for acceleration even at low engine speeds.

- Second, automated driving makes road traffic more efficient and above all safer. It avoids human mistakes, which are the root cause of nine out of ten accidents today. Yet driver assistance can already relieve the burden on drivers in stop-and-go traffic, in other words, when driving is no fun. And a car with an autopilot provides a whole new driving experience – it becomes your home on the move.

- Third, connected driving, too, can help to find savings. At first glance, we might think the internet's greatest impact would be felt in improving mobile infotainment. But it is also capable of delivering real-time information with which to avoid traffic jams or adjust hybrid vehicles' charging strategy depending on the current state of traffic.

Whether electrification, automation, or connectivity – all three development paths make personal mobility both sustainable and appealing. That means they are also compatible with contrasting pictures of the future – with both the "green world" and "fun for everyone." But more than that: the three paths complement each other. Drivers will be more at ease if they know they can use the internet to find and reserve not only the nearest parking space, but also the nearest charge spot. Driving becomes even safer once automation allows vehicles to warn each other of intersections with limited visibility or congestion ahead. Our developments do more than fit the future, they interconnect with each other in a coherent way.

The road to the future leads to commercial success

But how can we make headway on these roads to the future? Bosch is already achieving success, not just technologically but also commercially. This, too, is something I can point out for you on all three development paths:

- First, electromobility is coming – whatever reservations people may have. This is reflected in the spread of infrastructure as much as by progress in the technology. By 2020 we want to halve battery costs; by then, some three million charge spots will have been installed around the world – ten times as many as in 2013. This gives the market ample room for growth in the next decade. By 2025, 15 percent of all new vehicles will feature an electrified powertrain. But it also means that well into the next decade, the combustion engine will remain the basis for efficient mobility. We will continue to improve this basis, particularly as we are confident we can reduce fuel consumption by a further 10 percent for diesel engines, and by a maximum of 20 percent for gasoline. And in combination with electric motors, the combustion engine has yet to reach the peak of its efficiency. Particularly where this hybridization of the powertrain is concerned, Bosch has broad-based expertise, and this is giving rise to a host of solutions. We have already completed 30 production orders for electrifying driving, ten of them for premium plug-in hybrid vehicles. In the mid-sized segment, we're working on an affordable entry-level hybrid; here we have an order for large-scale volume production. Bosch has the experience to turn an alternative powertrain into a success story. It's what we did with diesel, and it's what we want to achieve with the electric powertrain, too.

- Second, automated driving is coming via a market that is already expanding rapidly: the market for driver assistance systems. Bosch's sales in this market are currently growing by a third each year. Our sales of radar and video sensors will once again double in 2015, as they did in 2014. We are the world leader in radar sensors. Last year was the first time that we sold more than 50 million sensors all told for driver assistance systems. But development doesn't stop there: this year, we're starting production of a

range of new assistance systems covering remote parking, traffic jams, evasive action, and turning against oncoming traffic. By 2020, we want to produce a highway pilot for automated driving on freeways. Some 2,000 developers are working on functions such as these at Bosch – a good 700 more than two years ago. Our acquisition of ZF Lenksysteme has once again improved our prospects. Bosch technology will enable the cars of the future not only to autonomously accelerate and brake, but also steer.

- Third, connected driving has already progressed beyond the pilot-project stage. Collecting and transmitting ECU data and driving profiles and then using these to generate appointments for preventive maintenance or tips for how to use less fuel – by the end of this year, Bosch will have connected some 200,000 vehicles for these functions alone. In this way, we are helping leasing and insurance companies to manage vehicle fleets – as well as supporting services for drivers on our own mobility portal, Drivelog. In addition, we're developing completely new solutions for urban transport. One starting point is the micromechanical sensors that we employ in systems such as ESP. We are web-enabling them and fitting them unobtrusively into parking spaces. There they can detect whether a space is in use – resulting in a real-time online parking map. This will considerably reduce the time spent on looking for parking spaces, which accounts for at least 30 percent of urban driving. At the same time, we're connecting the various modes of transport. Stuttgart Services is a pilot project offering a single chip card that can be used to access car and bike sharing services, trains, and buses, but that also serves as an entry pass for swimming pools or libraries – and we developed the software solution for it. It's a sneak peek at the transportation services of tomorrow.

New customers, new services: Bosch is expanding its business

I would like to close for now by looking at these examples. It is precisely the topic of connectivity that shows how broad a reach our mobility solutions now have.

- On the one hand, new products that go beyond the car, such as urban transportation services.
- On the other, new customers that go beyond the automotive industry; in the future, it could be all road users.

But even within the automotive industry, our customer base has broadened to include the new entrants in California. However cars and transportation are changing, Bosch is playing an agile part in shaping those changes. And we're not going to leave it at that. It is common knowledge that Bosch's versatility goes beyond cars and transportation. That means we can connect vehicles with smart homes – so our car's navigation system can instruct our home's heating system to warm up the living room before our arrival. In short, whether for houses or for cars, Bosch creates technology that is "Invented for life". We can connect them all, and this gives rise to a better quality of life. With the versatility of our expertise, our prospects for the mobility of the future are excellent.

Press release

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The car that thinks and acts
Bosch is creating the technical prerequisites for automated driving

- "Making the transition from partially to highly automated driving is going to be a big step," said Dr. Dirk Hoheisel, member of the Bosch board of management
- Automotive Steering adds electric power steering to the Bosch automated driving portfolio
- Increasing automation can tackle the root causes of 37 percent of the road accidents that happen in Germany alone
- Legal framework must keep pace with technological developments

At Bosch, the development of automated driving is advancing in leaps and bounds, and the engineers have now reached a critical point. "Making the transition from partially to highly automated driving is going to be a big step, in both technological and legal terms," said member of the Bosch board of management Dr. Dirk Hoheisel at the 62nd International Automotive Press Briefing in Boxberg, Germany (May 19–21, 2015). He described how, in highly automated driving, automated systems assume total control of the vehicle for temporary periods. "The driver becomes the passenger," Hoheisel explained. This, he said, calls for fundamental changes. Aside from the vehicle architecture, we are seeing crucial shifts in the way drivers and vehicles communicate with each other. Highly automated vehicles will also be connected to a server. "Only manufacturers and suppliers with in-depth systems expertise will be successful in making headway in this domain," Hoheisel said.

Bosch has all the technologies needed for automated driving

Delegating responsibility for driving entirely to the vehicle places particular demands on safety-critical systems such as the brakes and steering. To ensure maximum system stability in the event of the failure of one of these components, redundancy must be built into the system as a safeguard. Bosch already has

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such a solution for the brakes. In this instance, both the iBooster electromechanical brake booster and ESP brake control system can independently brake the vehicle without the driver having to intervene. This combination of Bosch solutions provides the necessary redundancy; both are indispensable components in any automated vehicle. “Bosch is creating the technical prerequisites for automated driving,” Hoheisel said. All the more so because Bosch has now added electric power steering to the portfolio thanks to its new Automotive Steering division. “Bosch has all the technologies needed for automated driving – not just the powertrain, brakes, and steering, but also sensors, navigation systems, and connectivity solutions,” Hoheisel added.

Highly automated vehicles rely on environmental information – information that goes beyond what sensors can gather. For instance, they need real-time traffic data on congestion and accidents. This can be achieved only by connecting the vehicle to a server. Bosch developed its connected horizon solution to enable exactly this. This system enables a dynamic preview of the upcoming route and corresponding adjustments to driving strategy. “The connected horizon is what allows automated vehicles to think ahead,” Hoheisel said. This is beneficial for the safety and convenience of the driving experience. For instance, connected vehicles are warned in advance of danger spots ahead of a blind bend or hill top and can ease off the accelerator in preparation. Bosch is also giving the provision of real-time traffic data a major boost. When a corresponding app is active, it uses the smartphone’s camera to detect speed limits along the way and sends the information to a server. The data is then verified
before being released to other road users.

People still at the center of automated driving

Whatever the technology, Bosch still places people firmly at the center – and that includes automated driving. “Assistance systems support drivers in critical situations. Automated driving functions relieve them in standard situations, such as freeway driving,” Hoheisel said. He stressed how important it therefore is that drivers trust the system. “Trust builds as long as vehicles keep the driver informed about what they are doing in a way that is easy to understand,” Hoheisel explained. This task falls to the human machine interface (HMI). But when it comes to information supply, less is sometimes more. “Drivers need the right information at the right time,” Hoheisel said, describing the basics of a good HMI.

One crucial aspect of highly automated driving is the transfer of driving responsibility from the driver to the vehicle – and vice versa. In Bosch prototypes, the HMI will notify the driver whenever automated driving is a viable option for a portion of the journey. To activate or deactivate the automated driving mode, the driver has

to simultaneously press and hold two buttons on the steering wheel for a period of three seconds. This eliminates the possibility of accidentally activating the automated driving mode. The HMI also provides information about automated vehicle maneuvers. For instance, it warns drivers in advance that it intends to change lane, so that they can monitor the maneuver based on a virtual bird's eye view. "The HMI adds greatly to the fascination of automated driving technology," Hoheisel said. Managing the various functions and information calls for innovative operating and display concepts. Here, Bosch already offers appealing HMI display solutions with its freely programmable instrument clusters and head-up displays.

Increasing automation makes roads safer

Bosch's motivation for developing automated driving is and remains safety on the roads. The UN estimates that each year some 1.3 million people worldwide are killed in road accidents. In 90 percent of cases, the accident can be attributed to driver error. This means that relieving the driver of control of the vehicle in complex or monotonous situations can save lives. "By increasing automation, we can tackle the root causes of 37 percent of the road accidents that happen in Germany alone," Hoheisel said. This, he said, has been a great motivation for the two Bosch teams working on automated driving since 2011, one in Abstatt near Heilbronn and one in Palo Alto in Silicon Valley. They are supported by some 2,000 Bosch driver assistance developers worldwide.

"Most of the key technical challenges that automated driving presents will have been solved by the end of the decade," Hoheisel predicted. By 2020, vehicles using Bosch technology could drive themselves all the way from the highway on-ramp to the highway off-ramp, as Bosch prototypes have already been doing on freeways in both Germany (A81) and the United States (I280) since the beginning of 2013. This relies, however, on the legal framework keeping pace with technological developments. Currently, there is a legal constraint in the form of the Vienna Convention on Road Traffic of 1968, which dictates that drivers must retain control of their vehicle at all times. In other words, highly automated driving is currently not permitted. Nevertheless, there are signs of impending changes to the regulations that bind Germany and many other countries. One scenario would involve allowing automated driving so long as the driver was able to override or disable it at any time. Hoheisel concluded by saying: "We are optimistic that policymakers and associations will soon take steps in the right direction."

Press photos: 1-CC-21179, 1-UBK-20767, 1-UBK-20782-e, 1-RB-21100

Additional information: www.automated-driving.com

YouTube videos: http://bit.ly/1GfVUrT, http://bit.ly/1osJDai

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Press release

New test vehicles for automated driving
Electric-car twins join the Bosch fleet

May 19, 2015
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- Test vehicles for automated driving are based on Tesla Model S
- Premiere at 2015 International Automotive Press Briefing in Boxberg
- Bosch is developing automated driving for all kinds of production vehicles
- Retrofitting a car requires 50 new Bosch components, 1,300 meters of cable, and 1,400 hours of work
- Highly automated test vehicles are already driving on public roads

Stuttgart – Spotting a test vehicle, equipped as they are with measurement devices, sensors, and instruments, is usually pretty easy. But that's not the case for the new Model S Teslas that recently joined the Bosch fleet. Both these test vehicles are helping engineers further refine automated driving. But at first glance, it's hard to tell them apart from production models. "Bosch is developing automated driving for production vehicles of all kinds," says Dr. Dirk Hoheisel, member of the Bosch board of management. The new test vehicles are evidence of the progress Bosch has already made in integrating the necessary systems and components. Those attending the 62nd International Automotive Press Briefing can see this for themselves in Boxberg, Germany, from May 19 to 21, 2015.

Fit for highly automated driving after 1,400 hours of work

To make the test vehicles ready for automated driving, they first had to be retrofitted. Fifty new Bosch components were installed in each car. They included a stereo video camera (SVC), which the car uses to recognize lanes, traffic signs, and clear spaces. The Bosch SVC is the smallest stereo camera system for automotive applications currently available in the market. Its compact design makes it easy to integrate into vehicles. In addition to the camera, 1,300 meters of cable were laid in each car and fixed in place with 400 cable ties. "After some 1,400 hours of work on each of them, the test vehicles are ready for highly automated driving," Hoheisel says. Thanks to Bosch technology, the two Teslas can now autonomously drive from on-ramp to off-ramp without the driver needing to constantly monitor them.

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This transfer of responsibility from the driver to the vehicle explains why so much time and effort is necessary for the retrofit. Highly automated vehicles must be capable of operating safely even if a component fails. The only way to achieve such operational reliability is by a design strategy that includes redundancy in safety-critical systems such as braking and steering. For example, both test vehicles feature both the iBooster electromechanical brake booster and the ESP braking control system. These Bosch components can brake the car independently of each other, without any need for driver intervention. “For Bosch, the principle here is safety first,” Hoheisel says. Back-up systems are also available for the two test vehicles’ power supply and vital ECUs.

Several thousand test kilometers driven without a hitch

Since 2011, Bosch has had two teams – on two continents – working on automated driving. At the Abstatt location in Germany, Bosch engineers are working on system integration. Their colleagues at Palo Alto in California’s Silicon Valley are driving forward work on function development. The two teams receive support from roughly 2,000 driver-assistance engineers who work for Bosch around the world. To make it as easy as possible for the two teams to share their results, Bosch uses identical test vehicles. Hoheisel explains why Bosch opted for two all-electric Model S vehicles made by the U.S. automaker Tesla: “They combine two automotive industry trends: electrification and automation.” This presents a particular challenge, he says, but one that Bosch relishes.

Bosch started testing automated driving on public roads at the beginning of 2013. So far, it has been using test vehicles based on the BMW 325d Touring. Engineers have successfully driven them for several thousand kilometers on freeways – both the A81 near Stuttgart and the I280 in California. Before the first test drives, the German certification authority TÜV Süd reviewed the safety concept that Bosch had prepared specially for the purpose. And even though the technology on board the vehicles is designed to handle any situation in freeway traffic, the drivers at the wheel have been specially trained. Bosch’s test drivers not only know the safety precautions inside out, but have also completed a multi-day training course.

Press photo: 1-CC-21178

Related link: www.automated-driving.com

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Press release
Bosch Compact

Glossary of Bosch driver assistance systems
From ACC to cross-traffic alert system

May 19, 2015
PI 8924 CC joe/af

Driver assistance systems: These invisible co-pilots help drivers in monotonous or difficult traffic situations. They monitor the car's surroundings with the help of radar, video, and ultrasonic sensors. They help to steer and brake the car when parking, changing lanes, or sitting in traffic. Driver assistance systems can prevent accidents and are precursors to automated driving.

Invisible co-pilots make driving in road traffic safer

Adaptive cruise control: ACC can accelerate and brake a car autonomously. With the help of a radar sensor, the system maintains both the driver's chosen speed and a programmed safe distance to the vehicle in front. This helps drivers reach their destination more relaxed, while the more even driving style saves fuel. In the Stop&Go version, ACC can even stop the car completely and restart the engine once traffic gets moving again after a brief pause.

Evasive steering support: Evasive steering support helps drivers avoid obstacles by way of specific steering interventions. This means the maximum steering angle is reached 25 percent faster. Prior to the maneuver, radar and video sensors detect whether the vehicle's surroundings permit a swerve of any kind.

Automatic emergency braking (rear): It can be difficult to see small children when reversing. Automatic emergency braking (rear) is based on radar and ultrasonic sensors in conjunction with the ESP electronic stability program. At speeds of up to 15 kilometers per hour, the system automatically performs an emergency braking maneuver if it detects a person or an obstacle dangerously close to the rear of the reversing vehicle.

Construction zone assist: The construction zone assist system keeps the car within a narrower lane by way of steering corrections. To do this, the system takes data from video and ultrasonic sensors and calculates a safe distance on either side to vehicles in the neighboring lane as well as to the crash barrier. The video sensor also measures clear spaces ahead of the vehicle. This enables the

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system to provide a timely warning in case the lane in a freeway construction zone is too narrow for the vehicle.

Driver drowsiness recognition: Drowsiness at the wheel causes imprecise steering maneuvers and lots of steering corrections. The drowsiness recognition system constantly analyzes the driver's steering behavior by way of the steering angle sensor, so it can recognize signs that the driver is nodding off before it happens. It also takes into account factors such as the time of day and the length of the journey. Tired drivers are warned optically and acoustically, and are reminded to take a break.

Intelligent headlight control: When driving at night or in a tunnel, this system automatically activates the headlights. Outside of built-up areas, it will also automatically switch on the high beams as long as it does not detect any vehicles ahead or any oncoming traffic via the video sensor. This means the road ahead is always ideally lit.

Left-turn assist: When turning left involves crossing the other side of the road, it is easy to overlook oncoming traffic. The left-turn assist system monitors oncoming traffic using two radar sensors in the front of the vehicle. If the gap in traffic is too small to permit a turn, the system prevents the vehicle from moving forward. If a collision with an oncoming vehicle is imminent, the system will stop the turn in time by performing an automatic emergency braking maneuver.

Lane keeping support: The lane keeping support system helps drivers to keep their vehicle within a traffic lane. It uses a video sensor to detect the lane markings to the right and left of the vehicle. If the vehicle's distance to the lane boundary falls below a defined minimum, the lane keeping support steps in. In vehicles with electric power steering, it steers gently but firmly in the opposite direction in order to keep the vehicle in the lane. In vehicles without electric power steering, it achieves the same effect by utilizing the ESP electronic stability program to brake individual wheels. Drivers can override the function at all times, so they retain control of the vehicle. If they activate the turn signal in order to change lane or turn, the system does not intervene.

Lane-departure warning: The lane-departure warning system alerts drivers to the fact that they are about to unintentionally drift out of the lane by, for example, causing the steering wheel to vibrate. A video sensor detects the lane markings ahead. If the vehicle risks leaving the lane unintentionally, the system sounds a warning. This enables the driver to change course in time. If the driver has activated the turn signal in advance of a lane change, the system sounds no warning.

Lane change assist: Radar sensors fitted in the rear of the vehicle constantly monitor the traffic situation up to 90 meters to the side and behind the vehicle. Prior to a lane change, the function warns the driver, for instance by lighting up a symbol in the exterior rear-view mirrors, if it detects another vehicle either approaching from behind at speed or already in the blind spot.

Traffic jam assist: The traffic jam assist system is based on the sensors and mechanics of ACC Stop&Go and of the lane keeping support. Up to a speed of 60 kilometers per hour, the system automatically follows the vehicle ahead in heavy traffic. Not only does the traffic jam assist accelerate and brake, it also keeps the vehicle in its lane by way of steering interventions. This relieves drivers so they can focus on monitoring the system.

Side view assist: In contrast to the lane change assist with its radar sensors, the side view assist system uses ultrasonic sensors. These permit it to monitor the hard-to-see areas up to four meters to the side and just behind the car. When turning or changing lanes, for instance, the system warns drivers that there is a vehicle in their blind spot by lighting up a symbol in the exterior rear-view mirrors.

Road sign recognition: The road sign recognition system helps drivers to navigate the “road sign jungle.” By way of a video sensor, this system detects all relevant road signs – including speed limits and no-passing warnings – and presents them as information on the cockpit display. This not only ensures drivers are always informed of the current applicable speed limit, it also means they can be warned when they are exceeding it.

Predictive pedestrian protection: Pedestrians are the most vulnerable road users. The proactive pedestrian protection system uses radar or video sensors for early detection of pedestrians who step out into the road without warning and might be hit by the car. The system then reacts faster than any human to automatically perform an emergency braking maneuver. This either avoids an impact or at least reduces the speed of impact and hence the severity of injuries.

Predictive collision warning: This system uses a radar sensor to detect whether there is a risk of collision with an obstacle in the road. It then builds up braking pressure in an instant to prepare the braking system for an emergency braking maneuver. At the same time, it warns the driver of the risk of collision with either an optical or acoustic signal. If the driver then steps on the brakes, maximum braking power is available immediately and the braking distance is much shorter as a result.

Automatic emergency braking: If a radar or video sensor detects a potential obstacle ahead of the car, this system first of all prepares the braking system for an emergency braking maneuver and warns the driver. If the driver doesn't respond, the system performs a partial braking maneuver in order to increase the time available to react. As soon as the driver steps on the brakes, the system helps to avoid an accident by calculating the braking power needed and increasing the braking power applied should the driver brake too gently. If the driver also fails to respond to the partial braking maneuver and the system detects that a collision is unavoidable, it performs an emergency braking maneuver itself. This helps to greatly mitigate the consequences of the accident.

Electronic assistants turn parking into child's play

Smart trailer parking: Maneuvering a car and trailer into a parking space is truly an art. The smart trailer parking system offers a convenient way for drivers to control their vehicle and trailer from the curbside using a smartphone or tablet computer. It is based on electric power steering, the ESP electronic stability program, the electronic gas pedal, and a trailer hitch featuring a trailer angle sensor. Users can select steering angle and vehicle speed with an app. The driver can stand anywhere that offers a good view of the procedure.

Parking aid: Most accidents occur when parking. At speeds of up to ten kilometers per hour during parking maneuvers, ultrasonic sensors integrated into the bumpers constantly monitor the distance to any obstacles in the parking area. Drivers are also warned optically and/or acoustically about other vehicles that are parking. The closer the car gets to an obstacle, the more frequently the acoustic warning is sounded, until it becomes a continuous tone.

Remote park assist: With the remote controlled park assist system, vehicles park themselves as if by magic. All drivers need to do is press and hold a button on their ignition key or smartphone. This tells the vehicle to automatically maneuver itself into the parking space it has previously detected and measured using ultrasonic sensors. However, drivers retain responsibility for the parking maneuver. As soon as they release the button on their ignition key or smartphone, the system immediately stops parking.

Maneuver brake assist: At a speed of up to ten kilometers per hour, ultrasonic sensors monitor the entire area around the vehicle up to a distance of four meters. The system uses this sensor data to detect relevant and non-relevant obstacles and to calculate the path the car should travel. If there is a risk of collision, the driver is warned. If the driver fails to react, the system stops the car itself.

Park steering control: This system uses ultrasonic sensors to detect parallel or perpendicular parking spaces suitable for the vehicle in question and informs the driver. Upon activation, the system then automatically steers the car into the space. The driver remains responsible for accelerating and braking.

Rear cross-traffic alert: When reversing out of a perpendicular parking space, this radar-supported system detects vehicles, bicycles, and pedestrians that are crossing behind the car up to 50 meters away. It then gives the driver an acoustic or optical warning when there is a risk of collision.

Press photos: 1-CC-21158, 1-CC-21159, 1-CC-21160, 1-CC-21161, 1-CC-21162, 1-CC-21163, 1-CC-21164, 1-CC-21165, 1-CC-21166, 1-CC-21167, 1-CC-21168, 1-CC-21169, 1-CC-21170, 1-CC-21171, 1-CC-21172, 1-CC-21173, 1-CC-21174, 1-CC-21175, 1-CC-21176, 1-CC-21177

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Press release

Powertrain of the future

Bosch forecast: electrification will take combustion engines to new heights

May 19, 2015
PI 8903 BBM FF/af

- Some 15 percent of new vehicles to have at least a hybrid powertrain by 2025
- Clean combustion engines for Euro 6, China 4, and U.S. LEV emissions standards
- Dr. Rolf Bulander: “Bits and bytes are making cars more efficient”

Downsizing, hybrids, electric vehicles – in the future anyone taking a look under the hood is likely to find much more than a conventional gasoline or diesel engine. Bosch is demonstrating just that at the 62nd International Automotive Press Briefing in Boxberg, Germany. But while a lot is changing, the internal-combustion (IC) engine will still continue to play a major role over the next decade. In five years’ time, far over 90 percent of new vehicles will still be powered at least partially by fossil fuels. This is particularly true of markets such as China and the United States. “Modern combustion technology is the bedrock of efficient mobility,” says Dr. Rolf Bulander, chairman of the Bosch business sector Mobility Solutions and member of the board of management of Robert Bosch GmbH.

We are also seeing the beginning of a transition toward electromobility: Bosch expects that in 2025 around 15 percent of all new vehicles built worldwide will have at least a hybrid powertrain, while in Europe more than a third of all new cars will be at least partly electrically powered. Bulander is convinced: “Electrification will take combustion engines to new heights.” Vehicles are becoming cleaner and more efficient – and the additional electrical powertrain will provide extra driving enjoyment.

Internal-combustion engine as the bedrock for efficient mobility

Modern IC engines have made significant technical advances in recent years, as a look at Europe clearly shows. Since 2000, the fleet CO_2 emissions for cars in Europe have sunk by a quarter – even though vehicle performance and weight

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increased over the same period. Drivers are noticing this improvement at the pumps: standard fuel consumption for compact cars with a gasoline engine is nowadays often under 7 l/100 km, and less than 5 l/100 km for diesel engines.

Still, it is no longer enough for powertrains simply to be fuel-efficient – they need to become even cleaner as well. One need only look at stringent emission legislation, such as Euro 6, China 4, or LEV in the United States. Making powertrains as clean as they are efficient calls for particularly sophisticated technology. Bosch is showcasing a number of new products designed to achieve this. For gasoline engines, for example, there is gasoline direct injection at a pressure of 350 bar in place of the previous 200 bar. The higher pressure means the fuel is more finely atomized, significantly reducing particulates.

Bosch is also paying particular attention to the ongoing development of the diesel engine. “Diesel is a key technology for achieving fleet CO_2 emission targets. Particularly in Europe, they aren’t achievable without it,” says Bulander. In order to improve the modern clean diesel still further, Bosch is applying a systems approach. One of the vital technologies in this regard is Denoxtronic, which can reduce nitrogen oxide by up to 95 percent in real driving cycles. What is more, systematically combining cleaner combustion, optimized exhaust-gas recirculation, and exhaust-gas treatment significantly reduces emissions.

Hybrids: electrification will take combustion engines to new heights

When it comes to big, heavy vehicles, however, merely optimizing the IC engine is no longer enough. It is Bosch’s belief that the EU’s stringent fleet CO_2 targets for 2021 means that hybrid powertrains will be available for every SUV on the market. That is why Bosch has begun to invest today. Each year, the technology and service provider invests almost 400 million euros in electromobility development. There are currently around 30 vehicle models in production that feature Bosch technology – in the U.S., in China, and at German premium manufacturers. Bosch components can be found in Porsche’s hybrid sports cars, in Mercedes hybrid models, as well as in vehicles such as the BMW i3 with Range Extender. Particularly in hybrids and plug-in-hybrids, Bosch sees considerable future market potential. In 2020, over 9.5 million of them are expected to roll off the production lines.

This goes to show that electrification is not a competitor to the IC engine, but rather complements it. Bosch’s new boost recuperation system is a prime example of this. The entry-level 48-volt hybrid enables a reduction in CO_2 emissions of around 7 percent in the driving cycle for compact vehicles. This is mainly achieved through the recuperation of braking energy. A coasting function that switches off the engine at high speeds by means of the start-stop

mechanism can increase fuel savings even more. The 48-volt hybrid also features a boost function – which goes to show that also in entry-level hybrids, fuel savings go hand in hand with driving enjoyment. When drivers step on the accelerator pedal, the electric motor supports the IC engine with up to 150 newton meters of torque.

Electromobility: electric cars are good but connected electric cars are better

High-voltage solutions are even more dynamic, since electric motors supply the full amount of torque right from the start. Still, if electric cars are to lose their niche status over the coming years, the vehicles must become significantly cheaper. Battery technology is key to this process. “Bosch anticipates that by 2020 batteries will offer twice the energy density for half the present cost,” says Bulander. To research the next generation of lithium-ion batteries, Bosch has partnered with GS Yuasa and Mitsubishi Corporation to establish the Lithium Energy and Power joint venture. Here, the partners are pooling their strengths: GS Yuasa is applying its experience in cell optimization so that a battery with a higher energy density and increased range can be produced. Bosch is contributing its expertise in complex battery management and system integration.

In addition to this, increasing internet connectivity will make electric vehicles a more practicable everyday option: “Electric cars are good but connected electric cars are better,” says Bulander. This belief is underscored by a new smartphone app from Bosch Software Innovations. The Bosch Group’s software and systems unit has developed an app that makes it significantly easier to reserve the charge spots of different providers and pay for the electricity. Up to now, a different customer card was required for each provider. Now all drivers need to recharge anywhere in Germany is a smartphone, the app, and a PayPal account.

Connectivity in electrified powertrains is going even further. After all, only connected vehicles can fully exploit the potential offered by electrification. “Bits and bytes are making cars more efficient,” says Bulander. One example of this is the connected electronic horizon solution, a Bosch technology that will in the future provide essential traffic information about mobile construction sites, traffic jams, and accidents in real time. This will be highly beneficial for internal combustion engines and electric powertrains alike, since the extremely accurate data will serve to improve existing functions, such as start-stop coasting. At the same time, plug-in hybrids can utilize the technology to implement a predictive operating strategy. These are the sorts of technologies that will again reduce CO_2 emissions by a double-digit percentage in powertrains that are already very efficient.

Press photos: 1-BBM-21151, 1-RB-21099, 1-UBE-20209-d, 1-UBK-19636, 1-UBK-19637, 1-GS-19999, 1-GS-20000-e, 1-DS-19451-e, 1-GS-21205-e, 1-GS-21206-e, 1-GS-21207-e, 1-RB-20741, 1-UBK-20832

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Press release

Expertise in innovative drive technology

An electrifying combination: hybrid technology from Porsche and Bosch

May 12, 2015
PI 8928 GS FF/af

Stuttgart - With the 918 Spyder, the Panamera S E-Hybrid and the Cayenne S E-Hybrid, Porsche was the first car manufacturer in the world to offer three plug-in hybrid models. Among the suppliers Porsche relies on for the innovative drive system is Bosch. The possibilities offered by the combination of an internal combustion engine and an electric motor will impressively be demonstrated by the Porsche hybrid vehicles at the 62nd International Automotive Press Briefing at the Boxberg test track, starting May 19.

"We promised to redefine driving pleasure, efficiency and performance with the 918 Spyder. We kept our word, and in so doing repositioned hybrid technology", says Wolfgang Hatz, Member of the Executive Board - Research and Development at Porsche AG. The Porsche 918 Spyder[1)] was the first globally road-legal car to complete the 20.6 kilometre lap of the North Loop of the Nürburgring in less than seven minutes. At exactly six minutes and 57 seconds, this super sports car with plug-in hybrid drive beat the existing record by 14 seconds. Porsche also integrated the knowledge gained from the development of the technology demonstrator into the electrification of the rest of its model range. The Panamera S E-Hybrid[2)] and Cayenne S E-Hybrid[3)] round off the product range and make Porsche the global market leader for hybrid cars in the premium segment.

"Porsche and Bosch have teamed up to bring electrification to electrifying sports cars together. Electricity gives added driving pleasure and efficiency", says Dr. Rolf Bulander, Chairman of the Business Sector Mobility Solutions at Bosch. For the three plug-in models made by Porsche, Bosch supplies the power electronics, the battery pack, the electric motors for the Cayenne and Panamera and the electric motor installed on the front axle of the 918 Spyder.

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918 Spyder: a unique combination of performance and efficiency

The project definition for the 918 Spyder's development team was to build the super sports car for the next decade with a highly efficient and high performance hybrid drive. The completely new development, which logically started from scratch on a blank piece of paper, allows a new concept without having to make any concessions. The whole car was designed around the hybrid drive. The 918 Spyder thus highlights the potential of hybrid drives, i.e. the simultaneous increase in efficiency and performance, without one coming at the expense of the other. Thanks to the SMG 180/120 electric motor developed by Bosch, the Porsche 918 Spyder has an additional 210 kW (286 hp) of driving power. The electric motor on the front axle of the 918 Spyder delivers a torque of 210 Nm right from the start, while the motor on the rear axle delivers 375 Nm. The result is a total system output of 652 kW (887 hp) with a maximum torque of up to 1,280 Nm, allowing the 918 Spyder to accelerate from 0 to 100 km/h in a mere 2.6 seconds. The super sports car's fuel consumption, on the other hand, is an amazing 3.1 litres per 100 km, making it more efficient in the NEDC test than most of today's small cars.

Panamera S E-Hybrid and Cayenne S E-Hybrid: fuel consumption of a small car

The driving experience of a sports car combined with the consumption of a small car – the Porsche Cayenne S E-Hybrid and Panamera S E-Hybrid prove that these two are not contradictory to each other. The world's first plug-in hybrid amongst the premium SUVs with a system output of 306 kW (416 hp) achieves an NEDC fuel consumption of just 3.4 l/100 km. The plug-in hybrid model of the Porsche Gran Turismo, which also has a system output of 306 kW (416 hp) stands out thanks to its weight advantage, rear-wheel drive and low drag, giving it a fuel consumption of just 3.1 l/100 km.

In the plug-in hybrid models of the Porsche Cayenne and Panamera, Bosch's IMG-300 electric motor provides additional electrical propulsion. It gives a boost of up to 310 Nm of additional torque and provides 70 kW (95 hp) of additional power. The central interface between the electric motor and the battery is the INVCON 2.3 module made by Bosch. The power electronics are the control centre of the electric powertrain, because the system converts the direct current stored as energy in the battery into three-phase alternating current for the electric motor and vice versa. The traction battery stores the electricity in the powertrain. It is made up of prismatic cells with an energy capacity of 9.4 kilowatt hours in the Panamera S E-Hybrid and 10.8 kilowatt hours in the Cayenne S E-Hybrid that can be fully charged from a normal household power socket in less than four hours. Using a high current power supply, the charging time is almost halved to a good two hours.

GO

Note: Photographs are available to accredited journalists on the Porsche Press Database at **https://presse.porsche.com**.

[1] Porsche 918 Spyder: combined fuel consumption 3.1 l/100 km; combined CO_2 emissions 72-70 g/km; combined electricity consumption 12.7 kWh/100 km; efficiency class: A+

[2] Porsche Panamera S E-Hybrid: combined fuel consumption 3.1 l/100 km; combined CO_2 emissions 71 g/km; combined electricity consumption 16.2 kWh/100 km; efficiency class: A+

[3] Porsche Cayenne S E-Hybrid: combined fuel consumption 3.4 l/100 km; combined CO_2 emissions 79 g/km; combined electricity consumption 20.8 kWh/100 km; efficiency class: A+

Press photos: 1-GS-21198, 1-GS-21199, 1-GS-21200, 1-GS-21201, 1-GS-21202

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Press release

May 2015
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Bosch at the International Vienna Motor Symposium 2015
Electrification and internet in the car: how Bosch is linking new technologies to gasoline and diesel

- Gasoline engines: 350 bar for direct injection
- Diesel engines: 48-volt hybrid to reduce nitrogen oxide emissions
- Dr. Rolf Bulander: “Bits and bytes are making cars more efficient”

Lawmakers have mandated economical, low-emission vehicles. Car buyers want vehicles that are safe and that offer more convenience and engine performance. At the International Vienna Motor Symposium 2015, Bosch presented numerous innovations that meet all of these requirements. “Bosch technology is making cars more efficient, more convenient, and more fun to drive,” said Dr. Rolf Bulander, member of the board of management of Robert Bosch GmbH and chairman of the Mobility Solutions business sector. All three aspects come together in the Bosch boost recuperation system. In the New European Driving Cycle, the 48-volt hybrid can cut CO_2 emissions by 7 percent (based on compact class). Thanks to its electric-supported coasting, the car offers a smoother ride and can deliver up to 150 Nm more torque on demand.

Connected electronic horizon: efficiency thanks to real-time data
Innovative advances will transform automotive powertrains over the next few years. “Electrification and connectivity will give a further boost to gasoline and diesel engines,” predicted Bulander. “Bits and bytes are making cars more efficient.” Electrified vehicles stand to gain tremendous benefits from connectivity. They are safer, more efficient, and more fun to drive. One example of how this works is the connected electronic horizon. In the future, this Bosch technology will supply essential traffic information about construction sites, traffic jams, and accidents in real time. From this basis, it will be possible to further improve existing functions such as start-stop coasting. At the same time, plug-in hybrids can use the system to implement a predictive operating strategy. Such technologies can cut CO_2 emissions by a double-digit percentage.

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Even after 2020, the vast majority of new cars will be powered by fossil fuels

In his presentation, Bulander reaffirmed that internal-combustion engines will remain the basis of efficient mobility. Even ten years from now, the vast majority of new vehicles worldwide will be powered by fossil fuels. Europe, the U.S., and China will raise the legal requirements for engine efficiency still further over that same period. Starting in 2021, the average new car in the EU will have an emissions cap of 95 g of CO_2 per kilometer. Based on the current situation, advances in engine design should make it possible to achieve these values. The CO_2 emissions for a gasoline engine in the subcompact class can be reduced to 85 g per kilometer, and for a diesel engine, that figure can be even lower than 70 g per kilometer. Enhanced aerodynamics and reduced rolling friction could once again lead to further improvements. Vehicles in the premium class and SUVs will need additional electrification.

Engineering turns its attention to real driving emissions

In addition to current emission regulations, engineers are increasingly focusing on real driving emissions. The European Union is discussing whether to introduce real driving emission tests starting in 2017. This measuring method for diesel cars concentrates primarily on the emissions of nitrogen oxides and carbon monoxide in real-life driving situations. For cars with gasoline direct injection, the focus is on the level of particulates emitted. A number of vehicles currently in production already expel an extremely low amount of emissions – for example, during rapid acceleration or at high speeds. Now it's time to drive the spread of this capability and develop cost-effective technologies that will ensure compliance, whatever the driving conditions. Bosch presented several approaches at the International Vienna Motor Symposium that support this endeavor. Bulander put special emphasis on interlinking the domains of electrification, automation, and connectivity: "Bosch pools these aspects in the vehicle and creates ideal systems," he said.

One example of this approach is the innovative direct injection system with laser-drilled spray holes in gasoline engines. The holes' precise edges swirl the fuel in the combustion chamber in such a way that it burns extremely efficiently. Increasing the injection pressure from 200 to 350 bar cuts particulate emissions to an even greater extent – especially under high load points and dynamic engine operation. Bosch debuted this refined version of its gasoline direct injection system at the Vienna Motor Symposium.

In diesel engines, electrification reduces nitrogen oxide emissions right in the engine, making exhaust gas treatment still more efficient. Bulander demonstrated

this by presenting Bosch's new 48-volt boost recuperation system. Through the judicious application of boosts, the system can markedly reduce untreated nitrogen oxide emissions, especially at high loads or when the car is accelerating. The crucial factor here is that this effect cuts emissions directly at the point of combustion by up to 20 percent. This has the effect of significantly lowering exhaust pipe emissions: Bosch believes the system could allow the storage catalytic converter to reduce nitrogen oxide emissions by up to 80 percent. Electrification will also increase the level of efficiency for urea-based systems as well (SCR catalytic converters). These exhaust gas treatment applications consume much less AdBlue, which means the fluid doesn't need to be refilled as often.

Press photo: 1-BBM-21151, 1-RB-21099, 1-DS-19451

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Press release

Bosch is making the car an active part of the internet **Connectivity as the key to electrification and automation**

May 2015
PI 8905 BBM Ks/af

- Comprehensive connectivity expertise for the car – and beyond
- A wealth of services for business and private customers
- Bosch ensures transparency in data handling
- Connectivity achieves breakthrough for electrified and automated driving

These days, it is hard to imagine life without the internet – and soon that will be true in the car as well, since Bosch is making the car an active part of the internet. "Connectivity is the key to electrified and automated driving," said Dr. Markus Heyn, a member of the Bosch board of management, at the 62nd International Automotive Press Briefing in Boxberg, Germany. Connected vehicles are safer, more comfortable, and more efficient. Online connectivity means, for instance, that drivers have access to information about congestion, black ice, and accidents, as well as where to find available parking spaces and charge spots – which they can reserve and pay for straightaway. Cars are also turning into digital media hubs as Bosch facilitates continuous access to online music services, social networks, and a wide range of smartphone apps.

Connectivity expertise for the car – and beyond

Bosch is a technology and service provider better positioned than almost any other company in the world to exploit the possibilities of the internet of things. "Our connectivity business relies on the 3S's: sensors, software, and services," Heyn explained. The result is connected solutions for smart homes, energy, industry, and of course mobility. This lays the groundwork for innovative functions. In one current test scenario, for instance, engineers use the car's navigation system to automatically turn up the heating at home shortly before the vehicle gets there.

The car of the future is electrified, automated – and connected

Bosch anticipates that around 15 percent of all new vehicles will be electrified as early as 2025. It also expects that by 2020, cars will be able to drive themselves

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from the highway on-ramp to the highway off-ramp. Both trends rely heavily on connected solutions. For instance, drivers of electric cars can conveniently locate and reserve charge spots and pay for the electricity they use. “Apps such as Charge&Pay for Mercedes-Benz allow drivers to enjoy electrified driving without having to worry so much about range,” Heyn said. Rapidly transferred traffic data also enables an extended electronic horizon function, which allows connected vehicles to anticipate what is coming around the next few bends. Electric vehicles can use this system to optimize recuperation and charge levels. The information also contributes to vehicle safety. For instance, if several vehicles report intervention by their ESP at the same location, the system can refer to the weather data and conclude there is black ice present, warning the drivers following on behind. In addition, information on speed limits at temporary construction sites or a warning about congestion ahead allows automated vehicles to anticipate events and ease off the gas in plenty of time. Heyn summed it up in no uncertain terms: “A connected car is always the better car.”

Bosch mySPIN solution brings smartphones and vehicles together

To connect the car to the internet, Bosch pursues two main approaches. First of all, it makes use of the driver’s smartphone: Bosch’s mySPIN integrated solution allows Android and iOS devices to link up to the vehicle’s infotainment system. A wide range of apps can then be conveniently operated from the vehicle’s central display. Second, Bosch offers the connectivity control unit (CCU) as a command center within the vehicle. The CCU communicates via a cellular module equipped with its own SIM card and can determine the vehicle’s position using GPS, if desired. It is available both as an original equipment model and as a retrofit solution, which can be connected to the vehicle’s electrical system via the on-board diagnostics interface.

The CCU sends vehicle operating data to a cloud server, unlocking a variety of potential services. It is here that the Bosch IoT Suite software platform excels. This suite developed by the subsidiary Bosch Software Innovations brings devices, users, and companies together to make it as easy as possible to offer attractive services – including those from Bosch.

Trust is built on safety and security

Vehicle connectivity is already in full swing. Constant growth in the computing power of ECUs, the ongoing spread of high-speed mobile telecommunications worldwide, and the growing possibility to release secured updates over the air will unlock new opportunities for an ever broader range of functions. But technology alone cannot guarantee success. “Only safe and secure functions will win drivers’ trust,” Heyn said, pointing to the three aspects of the security debate. First of all, functional safety ensures the safe operation of the desired application and defines

the procedure for safely deactivating systems if a fault occurs in one of the components. Data security, meanwhile, is about protecting against unauthorized external access. Here, Bosch relies on a multi-tier approach to both hardware and software so that it can maintain the high level of security it offers today in a future of increasingly connected vehicles. In this, Bosch sees a clear need for both technical and process standards, along the lines of the ISO 26262 functional safety standard. Finally, there is data protection as a legal consideration, which is defined in laws and regulations. “What we need is comprehensive European data protection regulation, so that a functioning digital market can establish itself in Europe,” Heyn said, adding that Bosch guarantees transparency in how it handles all data. Outlining Bosch’s basic stance, he emphasized that “customers have to be able to decide for themselves how and to what extent their data is used.”

Services for business customers cut servicing costs and times

Connected fleet management is a service aimed at fleet operators. The solution uses the CCU to securely transmit journey and service data to Bosch servers for analysis. This cuts operating costs and reduces time out of service. Companies can use the processed data to help plan operations, leasing contracts, and service and repair visits with more precision.

In the future, Bosch will put augmented reality to use in workshops, enabling a sort of “x-ray view” under the hood. When a worker takes a tablet computer and holds it under the hood, the tablet’s camera image is overlaid with comprehensive additional information and repair instructions for precisely the area being displayed. The mechatronics technician can manipulate the overlaid objects via the touchscreen and access additional information. This makes poring through service manuals a thing of the past. A Bosch server provides all the detailed data online.

Connected components enable predictive diagnostics

Bosch is increasingly drawing on Industry 4.0 techniques in developing and manufacturing its products. The goal is to connect each component so that it can seamlessly communicate manufacturing, test, and operating data about itself. This can then be used even once the product has left the Bosch plant. To take a current example of preventive diagnostics, it is already possible to use a connectivity control unit to gather operating data from a diesel injector throughout its service life and monitor its operation online from the cloud. If the data indicates signs of wear or a change in operating conditions, a modified version of the operating map can be automatically installed, likewise via the internet. It is also possible to immediately arrange a service visit and order a replacement part, if the customer so desires. Following analysis, the defective diesel injector can be

restored to full working order. This analysis data also provides important information that can be utilized in the development of future product generations and to optimize the manufacturing process.

Press photos: 1-UBK-20489, 1-UBK-20587, 1-CM-21209

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Press release

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Bosch authoring system eases the creation of AR solutions with large volume of data
Bosch banks on Augmented Reality applications for workshops, trainings and sales

- Augmented Reality applications have a great future potential
- Bosch is the world's leading platform provider for the industrialization of Augmented Reality
- Applications for workshops, trainings and sales

Augmented Reality applications (AR) expand the reality in a computer-assisted manner by adding useful additional information. Using a tablet computer or a smart phone, matching explanations, pictures or videos are added to the live image once the user points the device's camera at an area for which Augmented Reality information is available. Market researchers are convinced: Concomitant with the widespread use and growing prevalence of smart phones and tablet computers, Augmented Reality solutions will play a key role in our future lives. Bosch is a pioneer and trendsetter in terms of Augmented Reality applications for the automotive sector. At the same time, it is the first company providing a platform for the industrialization of Augmented Reality.

Software platform eases the creation of AR applications

Bosch developed a platform for the creation of high-performance Augmented Reality applications. In a relatively easy and fast manner, it facilitates the integration of digital and visual contents into, for instance, technical documentations. For this purpose, the Bosch Common Augmented Reality Platform CAP is backed by a comprehensive database of which it extracts the matching contents for the respective Augmented Reality application. Besides written information and explanations in text format, video clips, pictures, safety instructions with audio clips, 3D data, circuit diagrams, technical drawings and markers for the tracking configuration can be added as well. The cross-platform system is independent

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from specific tracking or rendering techniques. The platform is thus designed for the industrialization of AR contents and applications allowing companies to use Augmented Reality for all sectors.

Diverse future Augmented Reality solutions for service, repair and training purposes

Thanks to Augmented Reality applied in automotive workshops, the technician will see, for instance, the location of hidden components or the cable harness behind the dashboard on his tablet computer. Instructions and required special tools will then be displayed at the live image. The next work steps are thus clear and unnecessary disassembly and assembly can be avoided. By means of the touch screen, the displayed objects can be controlled and additional information can be accessed. Sophisticated and time-consuming consultation of service manuals is no longer required. Mistakes and confusion caused by different versions of the same vehicle model can be excluded. Augmented Reality eases repair processes, makes them faster and, at the same time, increases the quality of work. With the help of Augmented Reality used for trainings, sophisticated repairs and the correct handling of state-of-the-art automotive technology can be taught much easier and faster.

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The Automotive Aftermarket division (AA) provides the aftermarket and repair shops worldwide with a complete range of diagnostic and repair shop equipment and a wide range of spare parts – from new and exchange parts to repair solutions – for passenger cars and commercial vehicles. Its product portfolio includes products made as Bosch original equipment, as well as aftermarket products and services developed and manufactured in-house. More than 18,000 associates in 150 countries, as well as a global logistics network, ensure that some 650,000 different spare parts reach customers quickly and on time. In its "Automotive Service Solutions" operations, AA supplies testing and repair-shop technology, diagnostic software, service training, and information services. In addition, the division is responsible for the "Bosch Service" repair-shop franchise, one of the world's largest independent chains of repair-shops, with some 17,000 workshops. In addition, AA is responsible for more than 1,000 "AutoCrew" partners.

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