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## **Mobility for metropolises: Bosch's future lies in the smart city**

### **Bosch Mobility Experience 2017 – #BoschME**

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- ▶ Technological solutions for better quality of life in cities
- ▶ Bosch vision for urban mobility: zero emissions, zero stress, zero accidents
- ▶ Already 14 beacon smart-city projects worldwide
- ▶ Bosch Mobility Solutions growing three times faster than the market in 2017

Boxberg, Germany – Bosch is becoming a provider of mobility services for conurbations. In the future, the company will focus more on developing and providing mobility solutions in connected, smart cities. The demand for smart mobility concepts for the urban environment is rising rapidly worldwide. Megacities across the globe are full to bursting point. In many places, there is a threat of total gridlock. More and more people are returning to cities, or will live there in the future. By 2050, there will be more than six billion people living in megacities, twice as many as now. By then, urban traffic will have tripled. With roughly two-thirds of the global population living in conurbations in 2050, and the growth in urbanization this will involve, there will also be a growing number of problems.

More and more people in a limited amount of space will also mean more traffic, and thus more pollution, less green space, more noise, and more time wasted sitting in traffic. “With technological solutions, Bosch can help improve quality of life in megacities and conurbations. The main means to this end is emissions-free, stress-free, and accident-free mobility,” says Dr. Rolf Bulander, member of the board of management of Robert Bosch GmbH and chairman of the Mobility Solutions business sector. In business terms as well, smart cities are a growth area for the supplier of technology and services. In the period up to 2020 alone, the smart-city market will grow 19 percent each year, reaching a volume of 700 billion euros. In its cross-selling projects, Bosch has already doubled its sales in this sector over the past two years.

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### **Today: congested roads and polluted air**

Ages spent looking for somewhere to park, inefficient final-mile delivery, roads chockablock with private cars – all these are already common mobility problems in many large cities. “For city-dwellers, it’s the same old story – congested roads. There’s no sign of progress. It’s high time the opportunities offered by connectivity were used to make urban traffic smart,” Bulander says. In the future, no megacity will work without smart traffic, and a new model for mobility. “We are moving away from the car-centric city to an idea of mobility that is both smart and multimodal,” he adds.

### **Tomorrow: emissions-free, stress-free, and accident-free mobility**

At the Bosch Mobility Experience in Boxberg, Bosch is demonstrating how the company is shaping urban mobility: “Our efforts to help create an urban environment that is free of emissions, stress, and accidents are tied to three technological developments: automation, electrification, and connectivity”, says Bulander. For Bosch, the focus here is on getting from A to B without stress. To achieve this even in a bustling metropolis, public transportation, cars, self-driving shared and delivery vehicles, and other means of transport – in short: all the means of transport in the city – will have to be seamlessly connected with each other. “Multimodal mobility services that users can reserve with just a few mouse-clicks will play a major role in reducing congestion.”

The increasing automation of urban traffic will also result in greater safety and fewer accidents. Even now, Bosch’s motorcycle stability control MSC provides a kind of ESP for motorbikes. And the ABS for e-bikes that was recently premiered may also be an important lifesaver. “Connecting cars, two-wheelers, other road users, and infrastructure may help reduce accidents, and thus save lives. Especially in emerging markets, road users such as riders of two-wheelers are at risk,” Bulander says. One of the solutions Bosch has developed for this is a digital shield for motorcyclists. And in emergencies, the eCall developed specifically for motorbikes can save lives.

### **Electromobility and combustion engines for better air quality**

Especially in conurbations, air quality will remain an important issue. For this reason, Bosch is pursuing the goal of low-emission traffic. “In the cities of the future, both electromobility and combustion engines will be part of the solution,” Bulander says. Even now, Bosch’s e-bike business makes it the market leader for drive units for the world’s most successful electric vehicle. More than 200 million e-scooters are on the road in China, and Bosch powertrains play a role here as well. For light two-, three- and four-wheel electric vehicles, Bosch has

developed a compact powertrain system that can power two-wheelers such as the E-Schwalbe and small four-wheel vehicles such as the e.Go. Moreover, parcel deliveries in large cities are becoming increasingly electrified. The German company Deutsche Post DHL is already leading the way here with its Streetscooter, which also features Bosch powertrain components. Apart from driving forward the development of electromobility in all vehicle classes and segments, the company is working to further improve the combustion engine. Bosch spends roughly half its R&D budget on environmental protection and resource conservation. All in all, this is a sum of roughly 3.5 billion euros.

### **Full-liner for smart cities**

Even now, Bosch is pursuing 14 beacon projects relating to smart cities. They include urban projects in Singapore, San Francisco, Berlin, and Hamburg. Seven projects include urban mobility solutions. Apart from connected parking and fleet management, these solutions also involve electromobility and multimodal transport. Bosch's latest collaboration agreement in the area is with the Chinese city of Tianjin. The aim of this alliance is to make this port into a smart city.

### **Growing three times faster than the market**

In its transformation into a provider of urban mobility, the company is benefiting both from its technological expertise as the world's leading automotive supplier and from its economic clout: the Mobility Solutions business sector's 227,000 associates worldwide generated sales of 43.9 billion euros in 2016. This year, the Bosch Group's mobility business is expected to grow by some 7 percent. This is nearly three times as fast as global automotive production. "We are growing faster than the market and, as an automotive systems supplier, will remain a strong and above all innovative partner of the automotive industry. Moreover, we are evolving into a provider of services for every road user," Bulander says. This also means that Bosch will be reinforcing the Mobility Solutions business sector's research and development efforts over the course of the year. By the end of 2017, the business sector will employ 48,000 R&D associates, roughly 4,000 more than at the start of the year.

### **Further information:**

[A smart city in China: Bosch to make Tianjin intelligent](#)

[Good start to the year: Bosch improves sales in all business sectors and regions](#)

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*Mobility Solutions is the largest Bosch Group business sector. In 2016, its sales came to 43.9 billion euros, or 60 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 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 390,000 associates worldwide (as of December 31, 2016). The company generated sales of 73.1 billion euros in 2016. 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 440 subsidiaries and regional companies in some 60 countries. Including sales and service partners, Bosch's global manufacturing and sales network covers nearly every country in the world. The basis for the company's future growth is its innovative strength. At 120 locations across the globe, Bosch employs some 59,000 associates in research and development.*

*Additional information is available online at [www.bosch.com](http://www.bosch.com), [www.iot.bosch.com](http://www.iot.bosch.com), [www.bosch-press.com](http://www.bosch-press.com), [www.twitter.com/BoschPresse](https://www.twitter.com/BoschPresse).*



**BOSCH**

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**Stress-free urban mobility:  
from vision to reality**

Dr. Rolf Bulander,  
chairman of the Mobility Solutions business sector of  
Robert Bosch GmbH,  
at the Bosch Mobility Experience  
in Boxberg, July 4, 2017

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Ladies and gentlemen,

The film you have just seen shows all too clearly that new, bold traffic planning is needed for the world's megacities. Traffic has to be as close to zero-emissions as possible, as well as accident-free and, not least, stress-free. These wishes are still visions, but they are visions that determine the path our development efforts will take. This is what we want to show you at this Bosch Mobility Experience, to which I would like to offer you a very warm welcome. To explain what is driving us, I would refer to our strategic imperative: more than ever, it is technology "Invented for life" that is needed in our urban environment – an environment in which more and more people will be on the move. By de-congesting and improving urban traffic, we want to make it easier for those people to get around – this is the biggest challenge for mobility providers worldwide.

By 2050 at the latest, there will be more than six billion people living in megacities, twice as many as now. By then, urban traffic will have tripled – not least because online commerce will continue to generate ever more delivery traffic. It is scarcely conceivable that this growing traffic volume will be on four wheels only, and so we too are focusing on new solutions for transporting people and goods that go beyond the car. This is in line with urban planning around the world, which is moving away from the solely car-centric city to an idea of mobility that is both smart and multimodal. We have to develop a new concept of urban traffic: goods that are delivered from inner-city distribution centers by connected electric vans, people who switch from road to rail, and from four to two wheels, depending on congestion and need. Moreover, this changeover from cars to trains or bikes has to be managed smoothly, with a minimum of searching and waiting. And this in turn presupposes seamless connectivity – that all means of transport in the city are connected with each other. This shift has already begun. In Europe, London is becoming a smart city, just as Singapore is in Asia. As early as 2025, 80 of the world's metropolises will be smart cities, and even now,

Bosch is pursuing 14 beacon projects in this field, half of them concerned with urban mobility. Here, we are also opening up a future field of business.

### **Vision #1: stress-free mobility is connected mobility**

Let's first take a closer look at the transformation of urban mobility. The major metropolises are suffering from congestion, air pollution, and a lack of parking. For this reason, their priorities are threefold: to avoid, to shift, and to improve traffic flows. The first implication of this is that industrial and residential areas will, over the long term, have to be mixed to reduce the need for getting from A to B. The second is that people will drive less with their own vehicles. And the third is that, if cars still need to be driven, this will have to be as ecofriendly and safe as possible. City-dwellers have the same aims. However, the one thing they want more than anything else is to get from A to B without stress. This can only work if they can plan their journeys flexibly. For the city traffic of the future, the motto is that it doesn't always have to be your own car. Four wheels, two wheels, rail – this is the new, pragmatic approach to mobility. That said, our job is to ensure that switching from a vehicle of one's own to other means of transport is as effortless as possible. To give you a concrete example: it will have to be possible to reserve parking spaces near rail or bike stations online, at the push of a button. In other words, the commuting city-dwellers of the future will always have cloud services with them, their own personal mobility assistants. Especially from the point of view of megacity-dwellers, stress-free travel can only be connected travel.

Over the course of our event today, you will be able to see how Bosch is making connectivity possible in and beyond the car. Let me give you a preview of what's on show. Our vehicles and workshops will give you the chance to experience today's state of the art in urban mobility, as well as its future.



- We already offer mobility services for large cities. Our e-scooter sharing service Coup is one example. After debuting in Berlin, it has now been launched in Paris. Bosch has put 1,600 scooters on the road, and more are on the way – one of them can be seen in our exhibits.
- Next year, we will be launching the Bosch Automotive Cloud Suite, a software platform that is practically the centerpiece of connected mobility. Accessing online parking and your smart home while on the road is something you can experience in one of our demo vehicles.
- Step by step, our projects are helping take the stress out of the search for parking. At present, this search accounts for one-third of urban traffic. Our solutions for connected and automated parking save time and fuel, and spare people's nerves – in our workshop, you can find out more.
- We are also forming alliances for connected driving with international partners. Before this decade is out we will have managed to create a high-definition digital map that also contains the readings from our radar sensors. We are working on this together with TomTom, as well as with the Chinese providers AutoNavi, Baidu, and NavInfo. This radar signature will enable self-driving cars to determine their location with precision.
- In the years ahead, we will also be connecting and automating freight traffic. We are currently developing novel logistics services. In one instance, integrated micromechanical sensors monitor the freight. Our aim here is to reduce costs, improve logistical efficiency, and relieve the infrastructure. Want to know how will we do this? Then I advise you to have a look at our connected truck exhibit.
- In the next decade, connectivity will go hand in hand with a transformation of the car itself. It will become a third living environment, alongside homes and workplaces. In the future, simple gestures will be all it takes to shop online or reserve an e-bike from behind the wheel. You can experience this for yourself in our concept car.

## **Vision #2: accident-free mobility is automated mobility**

Just like connected driving, automated driving reduces stress on the roads. But above all, it significantly improves safety. Our vision is clear: to reduce accidents on city streets to an absolute minimum. More than 1.2 million people are still killed every year on the world's roads. That's 2.3 a minute, or more than 20 since I started my presentation. If we look at our cities, we see significant differences between those in advanced and emerging economies. In Stockholm, Tokyo, and Berlin, for example, we see 3 to 5 deaths per 100,000 road users. In Jaipur, Guadalajara, and Curitiba, the figure is 15 to 35. Obviously, the more modern the infrastructure and the better vehicles are equipped, the safer road traffic becomes. The fact that electronic guardian angels are mandatory in most advanced economies is clearly reflected in the accident statistics. But still nine out of ten accidents are caused by human error. For this reason alone, automated driving will save further lives. It is a perfect illustration of what "Invented for life" means. Our accident researchers estimate that it can reduce accident numbers by a further one-third in Germany alone. In this context, the contours of a major economic shift are beginning to emerge: the more automated or indeed driverless vehicles there are, the lower the share of vehicles that are privately owned. By 2030, every tenth car may be a shared vehicle. In fact, metropolises such as London, Singapore, and Paris are backing autonomous shuttles – called "pods" or "robocabs" – as a mobility solution.

We also want to look more closely at this development over the course of the day. My colleague Mr. Hoheisel will sketch out the path from driver assistance to automated driving in more detail. And for your part, you can accompany us on this journey into the future in our workshops, vehicles, and exhibits:

- To start at the beginning: it was Bosch that made it possible for vehicles to drive automatically in emergencies. The electronic guardian angels ABS and ESP are pioneering achievements of our company. There's no

longer any need to show you these systems. Without doubt, however, they have protected all of us from a collision at some time or other by automatically taking control of braking or steering for a split second.

- What we want to show you instead is the current dramatic development of our driver assistance systems – both technologically and economically. We are growing rapidly with these systems, also in the wake of ever stricter safety rating criteria for new vehicles. A workshop will give you more information.
- Finally, we want to look at developments up to the start of the next decade. By then, in collaboration with Daimler, we want to have made urban automated driving possible. This is currently one of our most ambitious engineering projects, a veritable revolution in urban mobility. And looking even further ahead, it will also be the basis for the robocabs of the more distant future. Worldwide, we are making automated driving a priority. For example, we are supplying sensors for the Chinese “Apollo” project – Baidu’s open platform for the development of self-driving cars. You are welcome to join us in a workshop for a sneak preview of this future development.

### **Vision #3: many paths lead to emissions-free mobility**

Whatever we do – it is worthless without clean air. It is precisely for this reason that we’re stubbornly pursuing the goal of emissions-free mobility, especially in cities. Clean air is an absolute priority – and this not only in Stuttgart, where we have our headquarters, but also in the world’s conurbations. When thousands of schools in Beijing and New Delhi have to be closed because of smog alerts, as happened in 2016, something is clearly amiss. But what is amiss when Paris, Madrid, Athens, and Mexico City decide to ban diesel vehicles from their streets from 2025? In our view, this is ecologically misguided – or at best environmental protection from a blinkered perspective. Blinkered if only because such driving bans ignore diesel’s outstanding efficiency, which is still needed to limit global warming. But also blinkered because it underestimates the potential still latent in this

technology, since emissions from diesel and gasoline engines can be cut even further – further than any legislation currently requires. Politicians should not restrict our engineers’ creativity by favoring or disadvantaging a certain technology. Bosch spends half its impressive seven-billion-euro annual R&D budget on environmental protection and resource conservation. We invest a lot in making all powertrains fit for the future.

So if I’m asked whether the urban mobility of the future will be more electric than ever, I can answer in the affirmative. But I would also like to add that combustion engines and electric motors will coexist for many years to come. Above all, we will not be able to achieve our very ambitious CO<sub>2</sub> targets solely on the basis of electric vehicles. We have to pull out all our engineering stops, which means that we still have to improve diesel and gasoline engines. This is not to say we are ignoring the air pollution in many cities – this pollution is also one of the reasons we are optimizing our technology. Last not least, the combustion engine itself may become an alternative powertrain if it runs on synthetic fuel produced using renewable energy. This would make it resource-conserving and CO<sub>2</sub>-neutral. Many paths lead to emissions-free mobility, and Bosch is exploring them all.

The progress we are making toward the grand ambition of clean air in our cities is also demonstrated by the vehicles we’re showcasing. You can drive them yourselves on our proving ground. Once again, I will conclude this section with an outline of our solutions for this decade and the next. Here again, the future has already begun, as our many ongoing projects show:

- This year alone will see the first-time certification of diesel models that comply with the Euro 6 emissions standards in real driving conditions – also with the help of our technology. We are currently involved in some 300 RDE projects with our customers. Moving beyond this year, our aim is clear: we want to support automakers in their efforts to make nitrogen oxide driving emissions from diesel vehicles even lower than at the test bay – and this without substantially more effort. We have already shown

this is possible in urban test drives. Here in Boxberg, all I can say to you is: see for yourself!

- You can also try out some modern gasoline-powered vehicles on our test track. Here too, I can make a clear technical promise: In Europe, we will no longer do any engineering work for spark-ignition engines that are not fitted with a particulate filter. Since these particulate filters were introduced, the diesel has not had a particulate problem, and we aim to achieve the same result for gasoline engines. We take air quality seriously, regardless of the powertrain used.
- The 48-volt onboard network is suitable for entry-level hybrids. Here, we are a systems supplier, from the electric motor to the battery. And even after the planned sale of Robert Bosch Starter Motors Generators Holding GmbH, we will be able to draw on this tried and tested portfolio. Our business with this system is doing well. For example, in China alone, we won five major orders for our 48-volt battery technology in 2016. We have organized a workshop that describes the next technical steps in this field.
- All-electric 48-volt powertrain systems will feature in the very small and very light new vehicles for personal urban mobility. We are also equipping these vehicles, whether the two-wheel E-Schwalbe or the four-wheel e.Go. My colleague Mr. Heyn will speak later about Bosch's role in this light electromobility. And of course, you will have the opportunity to try out these electric vehicles of the future for yourselves.
- To make larger vehicles capable of driving electrically as well, we are driving forward the development of our high-voltage systems. On the one hand, there is the battery. By the end of the decade, we want to more than double its energy density and halve its cost. On the other hand, there is the electric axle, a motor, power electronics, and transmission integrated in one housing – highly efficient and simple to standardize. For the first time, we can show you a prototype of the new axle in one of our exhibits. The upshot of all these various new developments is that Bosch electrical powertrain components are already to be found in half a million vehicles around the world.

- Indeed, Bosch electromobility is already in evidence in our urban delivery traffic. For example, we supply the powertrain system for the German company Deutsche Post DHL Streetscooters. This is Europe's largest electric-vehicle fleet. Here in Boxberg, you can test drive a Streetscooter.

### **Business situation: growth this year and beyond**

As you can see, ladies and gentlemen, we're full of plans. And Bosch has the economic clout to make solutions for tomorrow's urban mobility reality. Only very recently, we announced we will be building a new wafer fab in Dresden, a total investment of a billion euros. We also need this new fab to cover the increasing demand for chips in the cars of the future. Our Mobility Solutions business sector's 227,000 associates worldwide generated sales of 43.9 billion euros in 2016. It has made a good start to the current year, and is likely to grow 7 percent in 2017, nearly three times as fast as global automotive production. Over the course of the year, we will also be strengthening our "team future." By the end of 2017, we will have more than 48,000 research and development associates working on mobility solutions – some 4,000 more than at the beginning of the year. They are the source of the creative power that will also allow us to open up the urban mobility business.

We expect this business to experience a boost over the next few years. The challenges for urban traffic I have sketched out are considerable, as is the pressure on local authorities to deal with them. Our solutions offer them support, regardless of whether they are looking for parking apps or ways of keeping their air clean. Nine out of ten of the world's megacities see the need for investments in multimodal mobility. This form of mobility depends crucially on connectivity. It is the mobility of a connected, or smart, city. As I already mentioned, Bosch is also supporting these developments with a series of projects, from San Francisco in the U.S. to Tianjin in China. Between now and 2020, the smart-city market will grow 19 percent each year, reaching a volume of 700 billion euros. We will be a part of that, not least because our

diversified portfolio includes energy, building, and industrial technology, but also in the shape of our own IoT cloud. But there can be no smart cities without smart traffic. The more fluid the traffic, the smarter the city – the one is the key to the other. This challenge is the rationale behind the diversification of our mobility solutions. We will remain an automotive systems supplier, a strong and above all innovative partner of the automotive industry. But on top of this, we are evolving into a provider of services for road users. To come up with new concepts for mobility, we are also revising our conception of Bosch.



**BOSCH**

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## **Bosch is putting artificial intelligence into cars**

Presentation by Dr. Dirk Hoheisel,  
member of the board of management of  
Robert Bosch GmbH,  
at the Bosch Mobility Experience  
in Boxberg, July 4, 2017

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It's a scene many of you may remember from your lessons at driving school: a ball rolls onto the street from between two parked cars. What's the most likely thing that will happen next? All of us, expecting a child to run out from between the cars a few seconds later, would reduce our speed as a precaution. Up to now, cars have been driven by people who react similarly in such situations – by reducing speed. But what if it's a computer driving the car? A self-driving car has to be capable of doing everything people do at the wheel. Automated vehicles can react faster than any human, they are constantly alert, and they never get tired – of that there can be no doubt. But how good are they at anticipating events?

A self-driving vehicle has to be able to do two things. First, it has to be capable of identifying pedestrians, cyclists, scooters, traffic signs, and – of course – other cars as well. Technically, many of today's production models are already capable of this. Second, it also has to be able to interpret traffic situations in order to make predictions about the behavior of other road users. Artificial intelligence (AI) will make this possible. A car equipped with artificial intelligence will not only react faster than any human, but will also drive more defensively. This benefits us all, since it makes the roads in our urban areas safer – for pedestrians, cyclists, and, not least, for the occupants of vehicles. Our development goal, therefore, is clear: Bosch wants to help make cars smart.

For many years now, our engineers have been working hard on automated driving. Nearly 3,000 of them are striving to make automated driving reality. Only recently, moreover, we started an alliance with Daimler to put self-driving cars onto our city streets. As the basis for automated driving, driver assistance systems are a fast growing area of business for Bosch. It was only in 2016 that our sales in this area first passed the billion-euro mark – while orders last year were worth 3.5 billion euros. Unit sales of our radar sensors alone will grow 60 percent this year, and those of video sensors by 80 percent.

But now we're moving beyond sensor technology, and extending our expertise in the area of artificial intelligence. To achieve this, we will be investing 300 million euros in the Bosch Center for Artificial Intelligence over the next five years. This center will employ some 100 experts at locations in India, the U.S., and Germany.

As Mr. Bulander already said, our goal is to reduce accidents to zero. Automated driving helps save lives, since it makes our roads safer, and artificial intelligence is the key to making it work. But we have a lot of ground to cover before a computer on wheels can anticipate and interpret events at least as well as a human driver. Fundamentally speaking, this work involves three crucial steps.

The first of these is understanding: the car has to know what its sensors are detecting. Like a human being, a computer with artificial intelligence first has to learn. In this context, experts speak about deep learning. But while a small child only needs to see a few trucks before it is able to recognize any truck as such, computers in the laboratory have to see millions of commercial vehicles before they can identify a truck. To be viable in road traffic, artificial intelligence has to sift millions of images and reliably identify cars, trucks, pedestrians, cyclists, trees, and other objects – including the ball I mentioned earlier.

The second one is enabling the car to make decisions. Again, a comparison with human learning makes sense. Cars have to be capable of more than perceiving and understanding their surroundings. They also have to learn to anticipate, to guess what is most likely going to happen in the next few seconds. The range of sensor data creates the basis on which artificial intelligence can make decisions. When radar and video data are merged, the image of the car's surroundings becomes more detailed, allowing pedestrians and their direction of movement to be identified. On this basis, the AI system computes the probability of someone moving onto the road ahead, and initiates braking in good time.

The third step toward self-driving cars is high-resolution maps. We are working on this together with TomTom, the Dutch provider of maps and traffic information, as well as with the Chinese companies AutoNavi, Baidu, and NavInfo. Our vision for the future is that vehicles should use sensor data to keep the cloud-based digital map constantly up to date. We want to create an open standard for this. After all, the empirical knowledge we have gathered suggests that keeping a high-resolution map up to date for freeways in Europe, North America, and Asia Pacific will require vehicle fleets of around one million vehicles each. We have already reached one milestone. To find their way through a city, automated vehicles need to have a high-definition map to know precisely where they are at all times. In this area, we and TomTom have premiered our “road radar signature,” which is based on data from our radar sensors. As cars drive along, billions of radar reflection points are entered into the high-definition map, replicating the course of the road. Automated vehicles can use this signature to determine their exact location – both in their lane and in a wider geographical context – down to a few centimeters, and this even at night and when visibility is poor.

It should be clear from what I have said that data play a crucial role in automated driving. A self-driving car generates huge quantities of data – as much as one gigabyte a second. Processing such huge quantities of data calls for more than classic control units. Instead, a car equipped with artificial intelligence also needs a brain. And in the future, this brain for self-driving cars will come from Bosch. Our AI onboard computer is expected to go into production by the beginning of the next decade at the latest.

This computer for artificial intelligence will guide self-driving cars through even complex traffic situations, or ones that are new to the car. To do so, it will be capable of up to 30 trillion floating-point operations per second – three times as many as a human brain. And with every new situation it encounters on the road, artificial intelligence will learn more. In artificial neural networks, our computer will store whatever it learns while the car is moving. In the laboratory, experts will check that what has been learned is correct. Following

further testing on the road, it will be possible to transmit the artificially generated knowledge structures to any number of other AI onboard computers in an update.

To sum up, our objective is accident-free driving. We will achieve this objective with the help of automated driving. Even now, vehicles can react faster than any human being, but they also have to be able to anticipate better than us. The key to achieving this is our AI onboard computer – it will help make the roads in our megacities significantly safer.

If you want to know more about how automated driving will find its way onto our city streets at the start of the next decade, I invite you to visit our “automated” station.

July 4, 2017  
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## **Bosch is putting small electric vehicles on city streets**

Presentation by Dr. Markus Heyn,  
member of the board of management of  
Robert Bosch GmbH,  
at the Bosch Mobility Experience  
in Boxberg, July 4, 2017

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Whether transporting goods or making the daily commute in a crowded metropolis: small electric vehicles are the backbone of mobility in the Asian conurbations, as well as the number one form of mass transportation. Over the past decade, electric scooters have taken Asia's urban roads by storm: in 1998, a modest 58,000 were sold. Now, more than 30 million of them are sold each year. Some 200 million such scooters are already purring along China's roads alone.

For the local population, they are usually the only chance of making any headway in the congested cities – past cars and buses stuck in traffic jams. Nonetheless, there is no denying that it is not only in small vehicles such as e-scooters that e-mobility is on the march on the streets of the world's conurbations. Electric SUVs are also an ever more frequent sight there. Indeed, especially in China, there are even long-wheelbase versions of electric vehicles sold in Europe.

Nonetheless, we firmly believe that urban electromobility is not solely about the quest for greater size and range. In cities, neither are absolutely necessary. How? The distances traveled in cities are only short, usually no more than 40 kilometers a day. In addition, small vehicles make it easier to weave quickly through traffic, as well as to park in the smallest available space.

We can currently see a new wave of pragmatism among city-dwellers. Their rallying cry is back to basics, with mobility having to offer one thing above all: it has to get them reliably and as quickly as possible from A to B. Especially city-dwellers want a simple and affordable alternative, without stress and emissions. Mr. Bulander talked about this earlier.

But can this form of electromobility that depends on small vehicles such as e-scooters also work outside countries such as China, Taiwan, and Vietnam? At Bosch, our answer is clear: yes, it can. Small electric vehicles have a bright future, worldwide. We believe that it is especially in this segment that urban

electromobility will take off. According to estimates, some 100 million light electric vehicles will be produced worldwide by 2020 – these include scooters and small four-wheeled cars roughly the same size as a Smart.

We have brought along two prototypes of this new urban mobility with us today. The small e.GO four-seater, and the electric makeover of the Schwalbe scooter. Both are powered by a Bosch solution. Especially for urban mobility, we have developed an integrated system including motor, control unit, battery, charger, display, and app – for two-, three-, and four-wheelers.

- The powerful 48-volt drive unit converts the energy from the battery into maximum boost.
- The control unit is the powertrain's brain, and ensures perfect handling.
- The lithium-ion rechargeable battery provides high energy density.
- The charger enables fast recharging at regular household power sockets.
- The display clearly presents all information about the system. There is a choice of different driving modes.
- In addition, the system allows communication between the vehicle and the driver via a Bluetooth interface and an app.

One further advantage is that these small vehicles not only reduce emissions, but noise as well. All these elements mean that the system isn't just about efficient mobility in cities. Rapid acceleration from a standstill makes for a "wow" factor. We expect that this 48-volt system will generate annual internal growth of well over 100 percent.

As the system is made up of off-the-shelf automotive components, manufacturers will have the benefit of production-tested parts and minimal development expense. This gives both established OEMs and new players in the market the opportunity to launch vehicles within a very short timeframe of 12 to 18 months. Thanks to simple scalability, multiples of the system's components can be combined, depending on vehicle class and the desired

level of power. Adding a second battery pack, for example, doubles the vehicle's range. This reduces complexity, variants, and cost – for manufacturers and thus also for anyone who wants to drive electrically through their city.

In order to get around more flexibly in a small electric vehicle in urban traffic, people no longer have any absolute need to have a vehicle of their own parked outside the house. Sharing is the new trend. With Coup, our e-scooter sharing service, we are making urban mobility simpler and less stressful. In addition, as a sharing service provider, we receive direct feedback from our customers, both about the service itself and the technologies used. This gives us an opportunity to constantly improve and launch new developments, since we now know what people expect of sharing services.

To sum up, we firmly believe that electromobility will take off much more rapidly in small-vehicle segments. And with our modular 48-volt system and our Coup e-scooter sharing service, we have the right solutions.





## **Bosch solutions for urban mobility**

July 2017

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- ▶ From sharing to parking: solutions for stress-free mobility
- ▶ From ABS to robocab: solutions for accident-free mobility
- ▶ From synfuels to e-scooters: solutions for emissions-free mobility

### **Solutions for stress-free mobility**

COUP: Bosch already offers mobility services for large cities. The e-scooter sharing service COUP is one example. After debuting in Berlin, it has now been launched in Paris. Bosch has put 1,600 scooters on the road, and more are on the way.

Automotive Cloud Suite: Next year, Bosch will be launching its Automotive Cloud Suite, a software platform that is practically the centerpiece of connected mobility. It allows drivers to access online parking and their smart homes while on the road.

Intermodal: In July 2017 Bosch starts the trial period for a mobility assistant that finds the fastest way through the city by seamlessly using connections between existing mobility services on the basis of real-time data. Thanks to the new app commuters reach their target more efficiently, cities can better tackle their traffic volume, and mobility providers improve utilization of public transport.

Connected parking: Step by step, Bosch projects are helping take the stress out of the search for parking. At present, this search accounts for one-third of urban traffic. Whether community-based parking, active parking lot management, or automated valet parking – Bosch solutions for connected and automated parking save time and fuel, and spare people's nerves.

HD map: Before this decade is out, Bosch will have managed to create a high-definition digital map that also contains the readings from radar sensors. Bosch is working on this together with the Dutch company TomTom, as well as with the Chinese providers AutoNavi, Baidu, and NavInfo.

Connected logistics: In the years ahead, Bosch will also be connecting and automating freight traffic. The company is currently developing novel logistics services. In one instance, integrated micromechanical sensors monitor the freight. The aim here is to reduce costs, improve logistical efficiency, and relieve the infrastructure.

Connected cars: In the next decade, connectivity will go hand in hand with a transformation of the car itself. It will become a third living environment, alongside homes and workplaces. In the future, simple gestures will be all it takes to shop online or reserve an e-bike from behind the wheel, as Bosch's connected showcar demonstrates.

### **Solutions for accident-free mobility**

ABS and ESP: The electronic guardian angels ABS and ESP are pioneering achievements of Bosch. At some time or other, they have protected millions of people from a collision by automatically taking control of braking or steering for a split second.

E-bike ABS: It is now becoming even safer to ride a pedelec. Bosch is launching the first production-ready antilock braking system for e-bikes. This new development prevents the front wheel from locking up and the rear wheel from lifting. In this way, braking distance can be reduced and the risk of flying over the handlebars or falling off the bike minimized.

Motorbike ABS: The Bosch ABS10 for motorcycles is small and light. Compared with the ABS 9, Bosch engineers have managed to reduce the weight of the antilock braking system by roughly 30 percent and the size by some 45 percent. As well as optimizing size and weight, the focus was on reducing costs. As a result, the system is now also suitable for use in small motorcycles with up to 250cc displacement – a segment that is both price-sensitive and popular in emerging markets.

MSC motorcycle stability control: MSC motorcycle stability control is a type of ESP for motorcycles. By monitoring two-wheeler parameters such as lean angle, the system can instantaneously adjust its electronic braking and acceleration interventions to suit the current riding status. In this way, the Bosch system can prevent the bike from lowsiding or righting itself when braking in bends, which is where the majority of motorcycle accidents occur.

Digital shield: Bosch accident researchers estimate that motorcycle-to-car communication could prevent nearly every third motorcycle accident. Up to ten times a second, vehicles within a radius of several hundred meters exchange

information about vehicle type, speed, position, and direction of travel. In other words, long before a motorcycle comes into view, this technology warns drivers and the sensors in their vehicles that a motorcycle is approaching. This allows them to drive better and more defensively.

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.

Automated driving: By the start of the next decade, in collaboration with Daimler, Bosch wants to have made urban fully automated driving (SAE level 4) and driverless mobility (SAE level 5) possible. Their objectives include the development and start of production of an autonomous driving system for robocabs.

eCall for motorcycles: On the basis of intelligent crash algorithms, eCall detects when a motorcyclist is involved in a crash, automatically transmits an emergency call, and informs the emergency services about the type of vehicle and its position.

### **Solutions on the path to emissions-free mobility**

RDE: This year will see the first-time certification of diesel models that comply with the Euro 6 standards for real driving emissions, or RDE. Bosch is currently pursuing some 300 RDE projects with its customers. The company wants to support automakers in their efforts to make nitrogen oxide driving emissions from diesel vehicles even lower. In urban test drives, Bosch has already shown this is possible.

Particulate filters: In Europe, Bosch will no longer be carrying out engineering work for spark-ignition engines that are not fitted with a particulate filter. Since the particulate filter was introduced, the diesel has not had a particulate problem, and the aim is to achieve the same result for gasoline engines.

48-volt technology: The 48-volt on-board network is suitable for entry-level hybrid powertrains. Here again, Bosch is a systems supplier, from the electric motor to the battery. The company is doing good business with this technology. In China alone, for example, Bosch won five major orders for its 48-volt battery technology in 2016.

Light electric mobility: All-electric 48-volt powertrain systems will feature in the very small and very light new vehicles for personal urban mobility. Bosch is also equipping these vehicles, whether the two-wheel E-Schwalbe or the four-wheel e.Go.

E-axle: To make larger vehicles capable of driving electrically as well, Bosch is working on the development of high-voltage systems. One example of this is the electric axle – a motor, power electronics, and transmission integrated in one housing. It is highly efficient and simple to standardize.

Final mile: Bosch electromobility is already in evidence in German urban delivery traffic. Bosch supplies the powertrain system for the German company Deutsche Post DHL Streetscooters. This is Europe's largest electric-vehicle fleet.

Synfuels: The combustion engine itself may become an alternative powertrain if it runs on synthetic fuel produced using renewable energy. This would make it resource-conserving and CO<sub>2</sub>-neutral. Many paths lead to emissions-free mobility, and Bosch is exploring them all.

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## Urban mobility worldwide

### Driving bans in Europe, lottery in Asia, three-wheelers in India

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- ▶ By 2050, at least 70 percent of the global population will be living in cities<sup>1</sup>
- ▶ The rural population will shrink to 2.8 billion people by 2050<sup>2</sup>
- ▶ By 2030, the world will have 41 megacities<sup>3</sup>

#### Europe: Cars should remain outside city limits

The cost of traffic jams: In 2025, traffic jams in major European cities will result in annual costs of some 208 billion euros.<sup>4</sup> That figure could go even higher, as by 2050, more than 82 percent of Europeans will be living in cities.<sup>5</sup>

Cycling first: Amsterdam residents travel two million kilometers by bicycle every day. That corresponds to 60 percent of all journeys in the downtown area.<sup>6</sup> In Copenhagen, too, bicycles are a means of mass transport: there, 45 percent of the population cycles to work or university every day.<sup>7</sup>

Entry restrictions: Emission stickers in Germany, congestion charges in London and Milan, driving bans on older vehicles in Paris – dozens of European metropolises are limiting vehicle traffic in their central zones.

#### North America: Traffic jams cost over 120 billion dollars

More cars than drivers: In 2003, for the first time, registered vehicles in the U.S. outnumbered people with a driver's license.<sup>8</sup>

The cost of traffic jams: In the U.S., drivers in the ten cities with the most traffic spend some 42 hours a year in traffic jams, losing 121 billion dollars in time and fuel.<sup>9</sup>

Carpooling: To reduce the amount of traffic, the U.S. created the first carpool lanes in 1961. Today, the network covers some 5,000 kilometers.<sup>10</sup> Also called high-occupancy vehicle (HOV) lanes, carpool lanes can be used only if there are two, three, or more people in the car.

### **Japan: First the parking space, then the car**

A snail's pace: Cars in Tokyo drive at an average speed of 15 kilometers per hour.<sup>11</sup> Although the city's road network covers more than 22,000 kilometers and bicycles make up 14 percent of its traffic, Tokyo has only 11.6 kilometers of bike paths or lanes.<sup>12</sup>

Parking problems: Japan has 61 million vehicles and far, far too few parking spaces.<sup>13</sup> Cities such as Tokyo permit people to buy cars only if they can prove they have a place to park it.

Minicars: To get traffic under control, one idea called for a whole new class of vehicle: Kei cars. These cars are under 3.4 meters long and have an engine with less than 0.66 liters displacement.

### **China: The license plate lottery**

Traffic congestion: At the end of 2015, there were a total of 279 million vehicles on China's roads, of which 172 million were cars.<sup>14</sup>

Rails: The Chinese government provides heavy subsidies for traveling by tram. In Beijing, these carry 10 million passengers a day, or 44 percent of all travelers.

Lottery: Every month, Shanghai grants just 9,000 new vehicle licenses.<sup>15</sup> Depending on the district, license plates can cost up to 8,000 yuan, or more than 10,000 euros.<sup>16</sup> Oftentimes they are even auctioned off to the highest bidder.

### **India: Heading for modern mobility on two or three wheels**

Growth: Over 40 cities in India already have more than a million residents.<sup>17</sup> With annual population growth of 15 million people, India has the world's fastest growth rate.<sup>18</sup>

Two-wheelers: There are some 125 million two-wheelers on India's roads, representing 70 percent of all the country's vehicles.<sup>19</sup>

Pioneers: The city of Ahmedabad has succeeded in scaling back its motorized traffic by improving and investing in its transportation infrastructure. Today, 58 percent of journeys are made with public or non-motorized modes of transportation.<sup>20</sup>

## **Latin America: Cable cars, not highways**

Cable car (1): In the chaotic megacities of South America, the urban cable car boom shows no signs of weakening. Not only do (aerial) cable cars take up less space, but they also cost ten times less than a subway or highway.

Cable car (2): Mexico inaugurated its first urban cable car in 2016. The aerial gondolas replaced several thousand minibuses. Prior to Mexico's initiative, Colombia, Bolivia, Brazil, and Venezuela had already implemented a "street in the air" concept.

Cable car (3): Ten kilometers – that's the length of the world's longest urban cable car, stretching from La Paz, the Bolivian capital, to the neighboring city of El Alto. This cuts up to an hour off passengers' travel time and strikes a blow against pollution. There are plans to expand the cable-car network to 30 kilometers by 2019.

### **Further information:**

[www.bosch-urban-mobility.com](http://www.bosch-urban-mobility.com)

**Press photos:** #1138642, #1138649, #1133972, #1138645, #1138647, #1138648, #1138644, #1084018

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