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Hardware and software, alone and in combination:

Bosch has everything it takes

for the mobility of the future

Dr. Stefan Hartung,

chairman of the board of management, Robert Bosch GmbH,

and Dr. Markus Heyn,

chairman of the Mobility business sector,

at the IAA press conference on September 4, 2023

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Ladies and gentlemen,

As the video just showed, the way we drive in the future will be different. Together with our customers and associates, but also with policymakers and the general public, we want to shape the future of mobility. This is summed up in the motto: “Let’s shape the new era of mobility, together.” Yet we are fully aware that the focus of interest at this year’s IAA is not just cars, but also protests against driving. We have no problem with criticism of the automotive industry. But that criticism should be fair. Electromobility is becoming a core business for us. We want sustainable mobility, and above all we want to make it affordable – this is the only way it will succeed in the market.

The transformation of our business is no simple task, but we are devoting all our energy to tackling it, with the interests of our customers in mind. What this also means is that we are positioning ourselves more than ever before as a software company for mobility – in addition to our strengths in hardware. You could say that the vehicles of the future will be as much at home in the cloud as on the roads. In this context, not only hardware will be vital, but also the smooth interaction of software from various sources. And this is precisely why, in our reorganized Mobility business sector, we are strengthening cross-divisional collaboration. We are also assigning horizontal responsibility for software, vehicle computers, and semiconductors. All this is making good progress. The ultimate objective is an ambitious one: we want to use Bosch technology to bring about the software-defined vehicle. Even now, we offer solutions across all the domains of automotive software engineering, from control units to the cloud. We will hear more about this later from my colleague Markus Heyn. But before that, I would like to outline the current market situation. What we can see

here is that Bosch is growing rapidly, but also investing heavily in the future of mobility.

Business situation:
Rapid growth coupled with substantial upfront investments

However, we are witnessing volatile market developments in 2023 as well. While automotive production grew slightly in the first half of the year, these gains are now fading. The consequences of the war will accompany us for some time yet, especially the uncertainty as concerns energy and raw materials. In addition, inflation is placing a burden on purchasing power, especially in Europe and the United States. Our Mobility business sector is not immune to these developments, even if it is growing faster than the industry. Adjusted for exchange-rate effects, we expect it to grow by roughly 10 percent in 2023. And while this also includes price effects, we are above all posting strong increases in volume as a result of rollouts, such as the new generation of our ESP anti-skid system.

This year and beyond, we are making heavy upfront investments in the transformation of mobility – in areas such as software, electric driving, and automated driving. On the whole, the transformation of our industry presents us – just like other companies – with a dual task:

- On the one hand, we have to find viable prospects for our workforce and give them the skills they need. On this subject, the works agreement we recently concluded for our German locations is a good start.
- On the other hand, we have to remain at the cutting edge of technology. This applies above all to our efforts to create the software-defined vehicle.

En route to tomorrow's mobility:
thinking through the implications of the software-defined vehicle

However, Bosch software is not only changing the way we drive, but also how we manufacture vehicles. We are more than an automotive supplier. With our industrial technology, we can support the automotive industry along the entire value chain. So before we turn to the car itself, let's look at three examples.

- First, we secure automotive supply chains. Our track and trace solution allows us to pinpoint the position and condition of transport crates in real time. We are now equipping 260,000 transport carriers at BMW with this solution, so that important powertrain components can be reliably and securely tracked.
- Second, we are digitally connecting automotive production. For example, battery-cell factories still have a scrappage rate of between 10 and 15 percent. Our Nexeed Industry 4.0 software helps significantly reduce this wastage. In the future, it will be deployed in VW cell factories.
- Third, we are applying artificial intelligence to automotive production, where it can detect anomalies and defects at an early stage. At Bosch, our MAS manufacturing analytics solution is already in use in 50 plants. At our location in Bursa, Turkey, for example, AI has helped lower manufacturing costs significantly.

But now for the software-defined vehicle itself. This requires a new, centralized IT and electronic architecture. Bosch is one of the few companies that is developing such an architecture – from the cloud, to core onboard computers, to chips.

- We are the foremost company in the automotive industry that makes semiconductors itself. Moreover, we produce a large share of these chips in collaboration with partners. Together with TSMC, Infineon, and NXP, we only very recently announced that we will be investing in a joint venture in Dresden. Our common objective is a new factory to meet the growing demand for chips in the car of the future.
- We are posting rapid growth in our business with onboard computers. As early as 2026, we expect computers for driver assistance and infotainment to generate sales of more than 3 billion euros.
- And we know how to control the interaction between automotive electronics and the internet of things. Connectivity will be a standard feature of the next vehicle generation, which will debut in the market in the second half of this decade. In this context, we foresee not only a tripling of software applications, but also a tenfold increase in the number of applications accessing the cloud.

In this future form of mobility, Bosch no longer sees itself solely as a supplier of systems and components. More than ever, we will also be automakers' software partner. For this purpose, our Mobility business sector alone employs 38,000 software engineers – the biggest team of its kind in the industry.

In our approach to the software-defined vehicle, we go further than others. This sets us apart from many tech players, who hardwire computer cores from consumer electronics with automotive software functions. This creates technological dependencies that, if at all possible, we want to avoid in the interest of the industry. This is why, for the most part, Bosch software is hardware-agnostic, and runs on chips made by different manufacturers. One way we make this possible is through our new middleware solution for driver assistance and automated driving systems, which helps disengage software applications from their underlying hardware.

In addition, it is more important than ever to integrate software from diverse sources. Here as well, Bosch can contribute specialist expertise. Take infotainment systems, where the share of third-party software is in the region of 90 percent. Here, Bosch makes it possible for software packages to interact flexibly, regardless of their origin. And it does so on time for customers such as a globally operating automaker that has to manage 200 new rollouts each year. We are currently growing 25 percent annually with infotainment systems – twice as fast as the market.

We also want to use our experience to accelerate software development along the automotive industry value chain. For this purpose, we are now setting up a collaborative platform that developers from various companies can use to continuously test and integrate function changes. This is already a standard feature in the IT industry – our solution is the first time it has been used in the automotive industry. We are already using the platform to work with other suppliers, and are also offering automakers the opportunity to do so.

Fundamentally speaking, the software-defined vehicle will mean that new functions, such as those for driver assistance, appear on our roads faster. They will arrive via software updates, independently of hardware development. As a result, vehicles will be just like new, even after many years. Yet even software is “Invented for life,” as we say at Bosch. After all, in very concrete terms, it makes mobility safer and more sustainable. And that is my cue to hand over to my colleague Markus Heyn...

Electromobility:
Bosch offers solutions for every stage of value creation

... Many thanks, Stefan. I’d like to start with a very concrete manifestation of sustainable mobility – electromobility. We are doing everything in our power to ramp it up, also with new software solutions. Generally speaking, our electromobility business is doing well – I could also say: it’s charged up. We’re well on track to achieving our target of 6 billion euros sales revenue by 2026. Even last year, we were able to increase our output of components for electric driving by some 50 percent. This year, production of electric motors alone will double. As early as the fall, we will be starting volume production of a new 800-volt powertrain and inverter – a system in which the battery can be recharged twice as fast as before. Whether in technology or business, Bosch wants to be a frontrunner in electromobility as well.

In this context, software is the key to further enhancing convenience and sustainability. In the electric car itself, it aids connected energy and thermal management that predictively gets the battery up to the right temperature when it needs charging. Through this measure alone, the time taken to recharge is cut by as much as 20 percent. One new feature is the efficient distribution of electrical and thermal energy

between the battery, the powertrain, and the air conditioning system during driving.

For drivers, it not just convenience that is important, but also security when recharging. Together with the startup Fetch AI, Bosch is developing a digital passport for the electric car – independent of central data platforms. This software package means data privacy when accessing the charging network. It also makes new services possible, such as an AI-assisted traffic forecast to make the search for a charge point even simpler.

Above all, what will really make electromobility sustainable is when raw materials such as lithium and cobalt can be recovered. Here as well, Bosch software can play a part. In automated recycling systems, it can identify not only the origin and condition of the batteries, but also control the process steps. In this way, the battery packs can be dismantled quickly and safely. The demand for such circular-economy solutions is growing. By 2030, the annual recycling capacity for battery materials will have risen from 50 to 420 kilotons.

This is just another example of how Bosch is active along the entire electromobility value chain. In fact, our diversity here is unmatched by any other automotive supplier – with technology ranging from chips to e-axles, from e-bikes to trucks, for batteries and fuel cells. And Bosch's role in all this is a dual one, as a supplier of both hardware and software. The one begets the other.

Automated driving:
Bosch is launching video software that runs on any chip

Our accident protection systems offer an even better example of how hardware and software engineering are becoming separated, yet are also mutually beneficial. Our new ESP generation is a particularly striking case in point. It is more than a modified piece of hardware. The real innovation is to be found in the software, in the shape of Vehicle Dynamics Control 2.0. This is a new control concept that can intervene not only in the braking system, but also in the electrical powertrain and the electric steering. This will give drivers even more safety, with less countersteering and shorter braking distances. What is significant for automakers is that it can be used flexibly in the electronic architectures of the future: the new control system can be integrated in both a central vehicle computer and the ESP control unit, and will in the future be available as a discrete software package. It will be part of vehicle motion management, a software that coordinates all aspects of vehicle motion by centrally controlling the brakes, steering, powertrain, and chassis.

Not least, this takes us one step closer to automated driving. Bosch was quick to recognize the technological and business opportunities offered along the journey to this goal. With driver assistance systems, we will again post double-digit growth this year. And over the past five years, we have more than doubled our engineering capacity for assisted and automated driving. The innovations we are presenting at this year's IAA are evidence of the flexible customization of hardware and software.

- For example, our new generation of radar sensors works with artificial intelligence. This allows the sensors to detect and classify obstacles even more precisely and distinctly, including smaller objects such as motorbikes, whose reflection is only weak.
- One of the video sensors we offer is new camera heads whose intelligence can be reassigned to central vehicle computers. And with video perception, we are premiering a purely software solution. It allows a vehicle's surround sensing to be designed flexibly – whether to the front of the vehicle or with a 360-degree belt. In this way, regardless of the hardware they use, automakers will be able to implement new safety and convenience functions faster.
- Finally, in the shape of the ADAS integration platform, we are launching a vehicle computer that acts as the "brain" of automated driving and parking functions. The platform can be regarded as a modular kit that is compatible with proprietary and third-party hardware and software. Above all, because it can integrate systems on chips from various manufacturers, it is flexible. Once again, the decisive factor here is that Bosch software runs on any chip.

Bosch services for mobility service providers:
making the operation of vehicle fleets even more efficient

The examples I have given show how rapidly automotive engineering is changing – and Bosch is one of the drivers of this development, always with the interests of its customers firmly in its sights. But when we speak about software-defined mobility, we see more than just individual vehicles. Our new RideCare Connected Rent cloud solution allows mobility service providers to operate their fleets even more efficiently. Once they have rented out their vehicles, they automatically receive information about things such as battery status and also damage, for which the fault can then be unequivocally apportioned.

This offers two main advantages: more efficiency for service providers, and more transparency for users. The new solution is already being trialed by rental companies. Initial experience suggests that it saves up to 150 euros per month and vehicle. By the end of the decade, Bosch wants to equip more than 2 million vehicles with it.

Here as well, it becomes clear that, in the mobility of the future, Bosch will be a byword for both hardware and software solutions. And whenever we speak of software, we always also mean services that help people get from A to B more easily. As we embark on a journey into a new era of mobility, we can contribute our wide-ranging expertise. To quote our introductory video: “Let’s move like a Bosch!”