Professor Dressler uses communicating robot cars today to analyze the potentials of cooperating vehicles of tomorrow.

"We might be surprised to see the capabilities that cooperating vehicles will have."

Professor Falko Dressler is researching the future of inter-vehicle communication

The dSPACE-sponsored research group for Distributed Embedded Systems is working on one of the most promising topics at the Department of Computer Sciences at the University of Paderborn. In an interview for dSPACE Magazine, the group´s leader, Prof. Falko Dressler, not only looks back at three exciting years. He also looks ahead to the future challenges for the automotive industry.

Prof. Dressler, you have coordinated the team for Distributed Embedded Systems since 2014. What were the team's most important milestones of the three years?

We were able to reach our first milestone as early as December 2014, in the founding year of our team. We successfully convinced the internationally renowned Vehicular Networking Conference (IEEE VNC) to take place in Germany for the first time, and in a relatively small city at that – after it took place in major cities like Amsterdam, Boston, and Kyoto. It was not just a good start for me, but a great effort that made the entire team proud. Only two years later, we hosted the International Symposium on Mobile ad-hoc Networking and Computing (ACM MobiHoc), an international technical conference with world-class speakers. The conference also brought Paderborn into the focus of many high-level researchers in mobile wireless communication. Last but not least, I also consider our cooperation with dSPACE an important milestone. It has continuously intensified over the last three years.

Distributed Embedded Systems – In the age of the Internet of Things, this sounds like a very broad field of research that already touches on many parts of our everyday lives. What are the focal points of your work?

Our field of research is indeed very broad. We therefore focus on two main areas. The first is driven quite strongly by the Internet of Things, where a growing number of the devices we use every day are interconnected. Here, we are working on miniaturizing the sensor technology for embedded systems. The sensors have to be very compact, be very versatile, and have a low energy consumption. Today, we can equip bats with radio sensors that only weigh 1.8 g, including the battery, and continuously monitor their social interactions in the network for up to two weeks.

The second main part of our work is inter-vehicle communication. In contrast to the Internet of Things, this area focuses mainly on criteria such as reaching ultrashort communication latencies and a high robustness of wireless networks, because human lives might depend on them.

Your inaugural lecture already addressed the challenges of this type of vehicle network. How do you view these challenges now that many automobile manufacturers are plan-

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ning to have their vehicles communicate with each other and the infrastructure?

We are currently focusing specifically on cooperative autonomous driving. This includes much more than today's environment perception of modern vehicles: Vehicles that interact with each other will also be able to detect dangerous situations that are outside of their own sensor perception range, for example, by being able to literally see through obstacles with the help of their partner vehicles. Even though the semi-autonomous cars of today are already impressive, I think it will be intriguing to see what a high number of interacting vehicles will be able to do. However, another great challenge will be to efficiently manage the resources of the required communication channels so that safety-relevant messages are always transferred, even when road traffic is very dense.

And how will it be possible to master these challenges in the future? What can the automotive industry do to prepare the ground for a stronger interconnection of their products? And what can university research do to support the industry?

In my opinion, one key to the solution will be choosing and standardizing a suitable transfer technology for the wireless communication between vehicles and the infrastructure. So far, I have had the impression that each OEM is doing it their own way. For example, some use mobile communications standards of the fourth generation (4G), whose coverage is still insufficient in many countries. Others push for networking via WLAN (IEEE 802.11p) but are facing enormous challenges in reaching a minimum penetration rate. Here, the longer-term research of universities can support the industry's research, which often runs for only a few years and aims at a quick return on investment. The support

Adaptive wireless communication is one of Professor Dressler's main research areas.

can be a type of "technology radar", for example. However, what I find most important is that companies consider the cooperation with universities a double win.

What does your cooperation with dSPACE look like, the company that sponsored your research group by means of a foundation? And in what areas do you cooperate?
To my mind, our cooperation with dSPACE is a good example for such a double win. One reason, of course, is that the professorship would not have been possible without the foundation. I think the company has also clearly recognized the long-term benefits of university research. dSPACE not only benefits from our work. It also openly shares the results with us, which is not a given in industry-financed research projects at universities. The many liberties we have in using our insights lay the foundation for more exciting topics and questions of the future. Our cooperation is also successful in terms of bachelor's and master's theses, and in terms of the hardware that the company provides us. We benefit from the cooperation because it lets us offer practical seminars. In turn, our students start working with dSPACE products very early on. It is not surprising that many of our graduates start their professional career in this company.

> "It is particularly important for me that companies consider the cooperation with universities a double win situation. In my opinion, dSPACE has a clear understanding of this."
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> *Professor Falko Dressler*

For your HY-NETS project, you also work closely with dSPACE and other partners with the aim of simulating complex traffic flows and making hybrid drives even more efficient with assistance systems. How is this project coming along?
HY-NETS not only gives us a vivid example for our good cooperation with dSPACE and partners from the industry. It also presents a very interesting use case for vehicles that communicate with each other and the infrastructure, in this case even from an ecological point of view. The traffic flows we simulate for the project, as well as the simulated communication among the vehicles and the infrastructure, can already be combined with the dSPACE models for the immediate traffic environment of the hybrid vehicle to be optimized. This makes it possible to create complex cooperative driving scenarios, which our partners use to test a real hybrid drive on a test bench. The great potential for future improvements in efficiency and fuel consumption is visible even today.

In 2016, you were named Fellow of the Institute of Electrical and Electronics Engineers (IEEE). What does this mean for you personally and for your research?
Personally, the IEEE fellowship is a great honor, but it is not likely to have a direct effect on my research today. In the long term, however, I think it can open up new possibilities and networks for the Distributed Embedded Systems team. First, it improves the image of the professorship, which might be of help when acquiring exciting new research projects. Second, this recognition will also transfer to our graduates. Graduating under an IEEE Fellow can tip the scale for a graduate to be successful on the IT job market.

Professor Dressler, thank you for speaking with us.

Prof. Dr.-Ing. habil. Falko Dressler, born in 1971, has been with the Department of Computer Sciences at the University of Paderborn since April 1, 2014 and heads the research group for Distributed Embedded Systems.