

A researcher on the road: Anja Feldmann loves her work and travels a great deal. However, she sometimes takes a break and plays a computer game to clear her head.



# A tour de force on data highways

Today, the Internet is just as much a part of our everyday life as our refrigerator. Yet researchers are constantly working to develop it further so that it can continue to function despite all the innovations. **Anja Feldmann**, Director at the **Max Planck Institute for Informatics** in Saarbruecken, is one of them. However, there are some problems that she can only solve when she focuses her entire attention on her hobby.



TEXT **KLAUS JACOB**

She knows all the clichés: computer scientists are nerds; they hammer away incessantly on their keyboards in their hoodies and only rarely emerge from their dark basement rooms. They survive almost entirely on fast food, only reach for a comb and soap when they absolutely have to – and, of course, they are male.

Anja Feldmann embodies the opposite of all these prejudices. The 53-year-old computer scientist works in a bright office on the fifth floor with large windows looking out onto a green view. She works long hours and is enthusiastic about her subject, but she's more than just a scientist. In her view, constant work does not necessarily increase productivity. She claims that after taking a break, you see things in another light and can achieve "three times as much." That's why she sometimes gets

intensively involved in a computer game during the course of the day, although she spends most of her free time at an equestrian center.

Her eyes light up as she shows me photos of her three horses on her cellphone. Horse-riding is her way of relaxing "and clearing my head." Besides being at home in the saddle, she sometimes also sits on the seat of her own carriage. This allows her to take visitors who are not able to ride themselves.

### A TASTE DEVELOPED AT SCHOOL

Anja Feldmann has succeeded in forging a career for herself in a male-dominated subject area. However, she doesn't feel that obstacles are placed in women's paths in this field per se. "I personally tended to be treated favorably, since mentors opened doors for me," she says. It is not in her nature to give lengthy an-

swers and to talk a lot about herself. Instead, she always gives brief, precise responses to my questions. Her manner has brought her a long way, and she is now one of the leading researchers in her field worldwide. She has won several prizes, including the Leibniz Prize, which is worth 2.5 million euros, and which is the most important research prize in Germany. She has been Director at the Max Planck Institute for Informatics in Saarbruecken since 2018.

Her career choice is not one that runs in the family. Her father worked as a sales engineer, while her mother was a housewife before working as a shop assistant. A basic course in computer science in senior grade gave her a taste for the subject. However, she also loved chemistry. When deciding what to study, she couldn't make up her mind between the two subjects. She finally decided on computer science since it



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appeared that getting a doctorate was virtually mandatory in the field of chemistry and she did not want to commit herself to doing one right from the start.

As a holder of a scholarship from the Studienstiftung des deutschen Volkes, the “Study foundation of the German People”, she had the opportunity during her course of study to attend summer schools, such as on Lake Constance or in Italy, and to gain her first international experience. She wrote her diploma thesis in Paderborn under the supervision of Thomas Lengauer, whom she would meet again decades later. Lengauer moved to the Max Planck Institute for Informatics, where he worked until about two years ago. It was his post that was recently given to Feldmann.

### **THE INTERNET NEEDS PLANNING, JUST LIKE ROADS**

After her diploma thesis, Feldmann wanted to branch out into something new. She had grown up in Bielefeld and studied in Paderborn. Now, she looked to the U.S. as her next destination. She originally intended to spend a year there, but it turned into ten.

She gained her doctorate at the Carnegie Mellon University in Pittsburgh, Pennsylvania. This elite university is considered one of the most prestigious institutions in the field of information technology. After her doctorate, she was again faced with a decision: to return to Germany or to gain practical experience in the industrial field in the U.S. She was offered a job at AT & T Bell Laboratories, which are renowned worldwide for their outstanding information technology research. It was an offer she couldn't refuse.

It was here in New Jersey that she found the research topic that has been the focus of her work ever since: the Internet. For people who are not specialists, it is probably hard to understand how anyone can spend decades researching nothing but global data flows. After all, there are probably very few people who stop to ask themselves how the Internet actually works. For a long time now, the Internet has been just as much a part of our everyday lives as our refrigerator. However, a great deal of planning and work goes on behind the scenes.

Anja Feldmann likes to compare the data network with road networks: both of them require constant planning since the details change on a daily basis. Sometimes, simply changing the way a traffic light is switched, for example in order to give right of way to a tram, is enough to create a traffic jam. Then a large number of drivers might look for new routes and drive through residential areas, meaning that traffic planners are needed. And this is just one very small planning element in the gigantic road network. In short, the work never ends. The same applies to the Internet, which is subject to constant further development.

As with road traffic, when it comes to the Internet, the aim is to avoid jams. Here, too, the framework conditions are constantly changing, with an ever-increasing number of users, connected devices, and new applications such as Netflix or YouTube, which generate more traffic. Last but not least, Internet users should continue to enjoy wide-ranging freedom. In fact, it's amazing that the Internet continues to function at all. “Originally, it was no more complicated than five supercomputers,” Feldmann explains. Then changes were made and

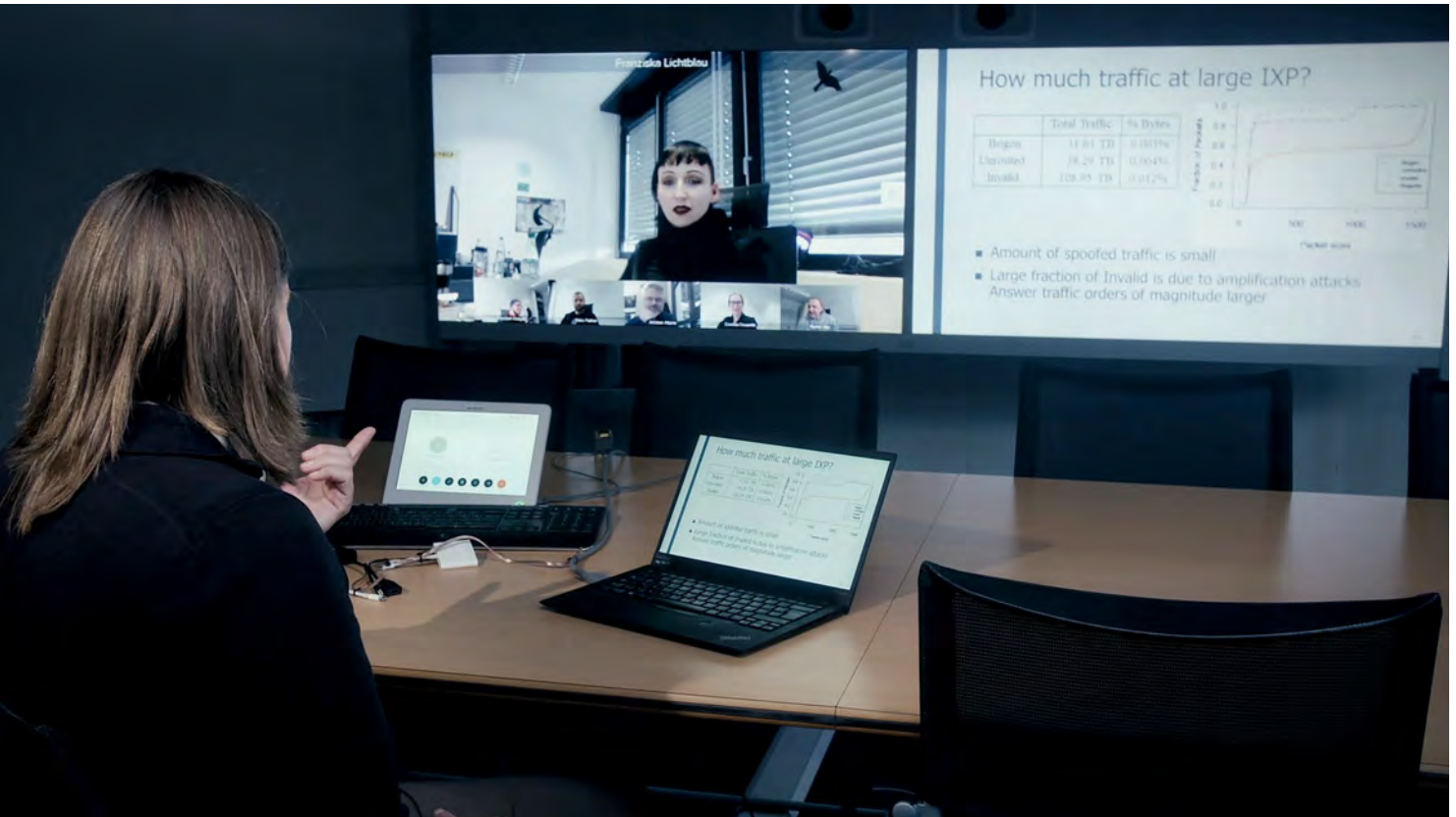
services were expanded and patched in order to retain control over the increasing data flows. This didn't always yield the best results.

If the pioneers had known just how big their creation would become, they might have opted for another concept. Some experts have already thought about how to build up an entirely new network without the flaws of the current system. Feldmann, too, has been involved in such studies, which are an investment in the future. Today, this is almost entirely impracticable, particularly since it would currently be almost impossible to transfer all the data from the old system to the new one in the blink of an eye. However, this level of speed would be necessary in order to avoid complete chaos. That's why for now, we'll have to stick with the old version, which has been repaired many times over. As Feldmann casually puts it, “Never change a running system.”

### **DATA SHOULD NOT TAKE A LONG DETOUR**

However, the network “has become so complex that we can no longer easily understand it, which is why we need to analyze it.” That's why she first looks for bottlenecks, jams and data loss in the data flows in order to find solutions. The purpose of her work is to ensure that data does not need to make long detours. After all, it makes no sense for an email to be sent from Hamburg to China before it finally arrives in Berlin. Every detour enlarges the flow of data and increases the risk of the lines becoming blocked.

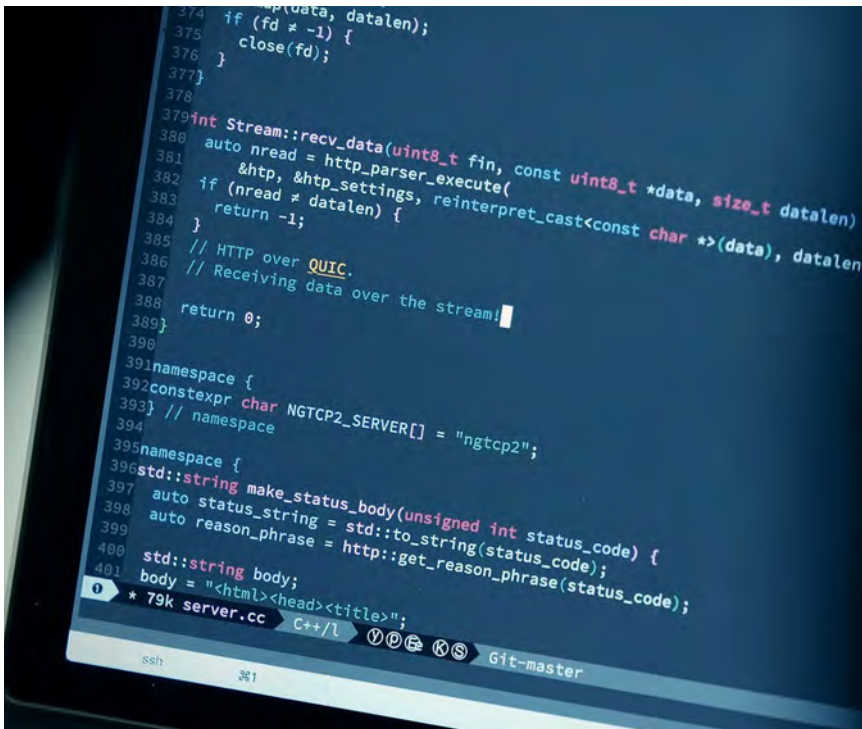
Feldmann's field of research also includes security, which is of considerable importance. After all, the Internet has long since become an essential part of



Traffic planning for the Internet: Anja Feldmann discusses how to prevent data flow traffic jams with colleagues from all over the world. However, the researchers also have to program in order to check whether the concepts really work.

society, just like blood circulation in the human body. By way of clarification, Feldmann asks two simple questions: “Would we still have power without the Internet? Would we still have water?” In fact, hardly anything functions nowadays without the global flow of data. The entire infrastructure would collapse. “We must be aware of the fact that we depend on this system,” she says. And there is a high risk of a crash: “I have no doubt that if certain people wanted to, they could bring down the network tomorrow. And we’re not just talking about state operatives.”

After a decade in the U.S., she returned to Germany, in part because she wanted to be closer to her family and friends, but also because by that time, she had decided that she wanted to obtain a professorship. In fact, she was given one immediately, at the University of Saarbruecken, just a stone’s throw away from where she currently works. However, she stayed there for just two-and-a-half years. She was headhunted by both the Technical University of Munich and the ETH Zurich. Feldmann decided to opt for Munich – “a gut reaction,” in her words. “I want-



Photos: Stills from the film about Anja Feldmann from: Vodafone Stiftung für Forschung



In Munich, Feldmann started to ride. However, the move to Berlin put an end to this chapter in her life for the time being. She threw herself into her work. Overall, she loves working with students and doctoral students from all over the world as well as her research and teaching activities. At some point, her Berlin doctoral students presented her with a rocking horse. It was a subtle hint that she should not neglect her personal life. The hint was taken: Feldmann started to take riding lessons again, and later even bought her own horse.

#### **HORSE-RIDING AS A HOBBY, BUT A SERIOUS ONE**

“I thought, I can’t have pets, since I’m out and about so much,” she says. However, a horse lives in a rented stable and is given all the everyday care it needs, allowing Feldmann to spend a week away without any worries. She now owns three horses: a mare, who is also trained for dressage, and two geldings, which she bought as foals. Giving three animals the care and attention they need is a challenge that Anja Feldmann is happy to take on. When she is not traveling, she spends many of her evenings riding or working in the stables. “I often get impatient at around 6 or 7 in the evening because I want to go and see my horses.”

While the computer scientist rides as a hobby, she takes it very seriously. She wants her horses to have all-round training and to be able to tackle small jumps in the field and master the basics of dressage. They also need to be able to draw a carriage. For her, the fact that very different qualities are needed in horse-riding than at her place of work means that her hobby offers a healthy balance.

“When I’m with my horses, I have no time to think about computer prob-

A healthy distraction: while riding, here on her mare Fontana, Anja Feldmann has to stop thinking about work and focus all her attention on the horse. Afterwards, she can find an even better solution to certain technical problems.

ed to stay in Germany and work in a larger city.” She took over the chair of network architectures.

She enjoyed living in the cosmopolitan Bavarian city, as well as the fruitful collaboration with the Leibniz Supercomputing Center. “I didn’t think that I would leave,” she says. However, Deutsche Telekom then established an endowment professorship at the Technical University Berlin, with excellent facilities. Feldmann was so attracted by the combination of industrial company and university, practice and theory, that she threw her plans overboard. She hoped to gain an even better insight into current network problems by collaborating with the company. She moved to Berlin 13 years ago.

» She also wants to use her enthusiasm to recruit young people to her subject. She aims to awaken pupils' and students' curiosity, particularly since this field is becoming increasingly important.

lems. They demand my full attention.” This becomes clear when you take a carriage ride with her, for example with her gelding Phoenix. At first, she didn't want to buy him at all, but was unable to resist when she actually met him. While driving the coach along the lanes through the fields, she is constantly focused on the horse to make sure that it doesn't just do whatever it wants. This is essential, since she sometimes meets a tractor on the narrow lanes and has to turn the carriage around quickly.

In Berlin, at the “Intelligent Networks and Management” endowment chair, Feldmann worked side by side with Telekom staff members. The focus of her work was also to optimize the company's network infrastructure. “We contributed a large number of useful ideas that saved the company money,” she says. It was then that she came up with the idea of virtualizing home gateways, for example. This makes it possible to use a private router publicly with a second channel. Today, this concept is used by companies such as Telekom, Vodafone and O2.

The endowment chair expired after around seven years. This was the time when everything revolved around apps and nothing else. “A new app, a new app,” she says, shrugging her shoulders a little ironically. She decided to stick with the Internet as the focus of her work and with her professorship at the Technical University Berlin.

By that time, she had already joined the supervisory board of SAP. Once again, the press made her gender the focus of attention, since she was the first woman to join the body on the employer side. She is quite clear about the reasons why. At that time, there was political pressure to break the male dominance of the supervisory boards of the

companies listed on the DAX, the German stock exchange. It was for that reason that the co-founder of SAP and its supervisory board chairman, Hasso Plattner, nominated Anja Feldmann as a member. She has no issues with the subjects discussed on the supervisory board when it meets three times a year. “SAP products and platforms are nothing other than complex systems that have to be programmed while observing the relevant security standards – just like with the Internet.”

Around two years ago, she finally moved to Saarbruecken, to the Max Planck Institute for Informatics, in order to be able to conduct basic research with a good level of basic funding. She also wanted to escape from the excessive bureaucracy at the university and the heavy burden that came with giving lectures – in some cases to over 800 students.

### HANDLING INQUIRIES WITH SURGICAL INSTRUMENTS

Here, too, she continues to conduct big data analyses in order to locate bottlenecks and security problems on the Internet. One example illustrates just how complex her work is. Every so often, hackers bombard a company with a flood of inquiries and bring data traffic to a halt by overloading the server. The experts call this a Distributed Denial of Service Attack (DDoS). For many commercial users, such as Internet traders, an attack of this kind is a disaster because it leads to a breakdown of their basis for working. What's more, the number of such attacks is increasing.

What can be done? Until now, the experts have been taking drastic measures. They shut down the entire computing center that contains the server under attack until the situation calms down. They pull the plug, as it were.

However, in so doing, they deny other users access to the Internet. According to Feldmann, this approach uses “abattoir equipment” rather than surgical instruments. Together with colleagues from the Technical University Berlin and the German Internet node DE-CIX, she is therefore looking for a means of filtering attackers out of the data flow in a targeted way – without incurring major costs.

Her approach is known as “advanced blackholing”. This is like a new traffic sign and will be set up on all Internet routers that transport the data packets used in the attack. It makes it possible to precisely regulate which data packets from specific senders to specific recipients need to be processed. The data that is filtered out can be diverted or, in the case of a DDoS attack, simply deleted. This surgical knife has already proven its worth many times over in practice. However, it also generates a new problem: criminals can use the traffic sign for targeted attacks. They can for example deny certain users access to the network or divert interesting data in order to spy on it.

This example is typical for the Internet, since every change brings new challenges. However, it is precisely this aspect of her work that fascinates Feldmann: “It never gets boring.” She also wants to use her enthusiasm to recruit young people to her subject. She aims to awaken pupils' and students' curiosity, particularly since this field is becoming increasingly important. After all, digitalization is penetrating into more and more areas of life. According to Feldmann, information technology specialists can focus on abstract or practical tasks. “The main thing is that you find something that fascinates you so much that you are willing to put all your energy into it.” ◀