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European Science Stories

Dear Reader

Detlef Günther, Agatha Keller, Sofia Karakostas and Michael Schaepman.

This year, the European Research Council (ERC) is celebrating its 10th anniversary. Within this short period of time, the ERC successfully established several granting schemes, most importantly the Starting, Consolidator and Advanced Grants. Each of these schemes aims to support excellent researchers during different stages of their career by providing attractive funding for their projects. In this issue of the Science Stories, we proudly present three grantees from three different research areas and their projects that are currently funded under the European Framework Programme Horizon 2020.

Silja Häusermann is Professor of Political Science at the University of Zurich and has recently been awarded an ERC Starting Grant. Her research is about the welfare state that is currently under pressure. Austerity and increasing stakeholders and demands make tough choices and even trade-offs necessary. In an interview, she explains her motivation to apply for an ERC Starting Grant, talks about political mechanisms influencing the welfare state, methodological challenges and her concept of priorities.

As a Professor in the Department of Computer Science at ETH Zurich, Srdjan Capkun has a strong interest in collaborating with industrial partners. This facilitates the understanding of each other's concepts and technologies and enables access to industrial infrastructures that are usually not granted to academic institutions. Beside the presented collaborative project on cloud security, he is holder of an ERC Consolidator Grant with the aim to securely measure the distance between two devices – a key issue in security research with far-reaching benefits for society.

Laura Baudis, Professor of Physics at the University of Zurich, has been fascinated by dark matter ever since her student days. Together with her research team, she is trying to directly measure and identify the particles that dark matter is made of. The experiments are conducted within different international collaborations in Italy using special detectors. The multidisciplinary and inter-sectorial nature of these projects is ideally suited for the training of PhD students and technical staff. The aim of her ERC Advanced Grant is generating vital knowledge for enhancing the sensitivity of the next-generation detector.

With its 10th anniversary, the ERC reintroduces the Synergy Grants for small groups of individual researchers. 2017 also marks the anniversary of the EU GrantsAccess office. Since 20 years, the office is supporting researchers from both the University of Zurich and ETH Zurich with regard to European and other International Research Funding Programmes. We trust that this support is facilitating Success Stories like the ones presented in this issue. Enjoy reading.

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Enlightening the dark

Searching for cosmic weaklings

Why Laura Baudis is searching for cosmic weaklings and why these invisible particles might answer the question of whatever holds the world together in its inmost folds.

Her racing bike is leant against the office wall, a construction site helmet is placed on the shelve, and the blackboard is scribbled over completely with formulas. These three items perfectly symbolise the professional life of Laura Baudis. The 47-year-old Professor of Physics at the University of Zurich rides her bike to work because it gets her there twice as fast as the tram would. Time is precious, most people do not have enough of it, she says. Yet, she deals with a stretch of time that is virtually inconceivable for us human beings. The researcher looks back on 14 billion years – all the way to the beginnings of space, time and matter. She is devoted to finding the answer to a mystery that has always been on the minds of humankind. "I wish to find out how the universe was formed and what it is composed of," she says. Alike Goethe's Faust, she is interested in «whatever holds together the world in its inmost folds». Specifically, she is interested in dark matter, that mysterious part of the world that cannot be revealed by any high-tech telescope.

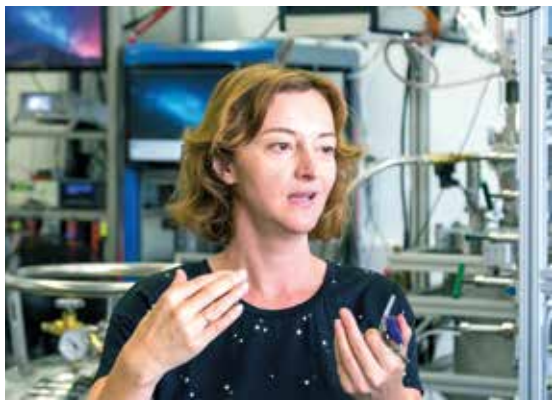
Fascinated by the invisible

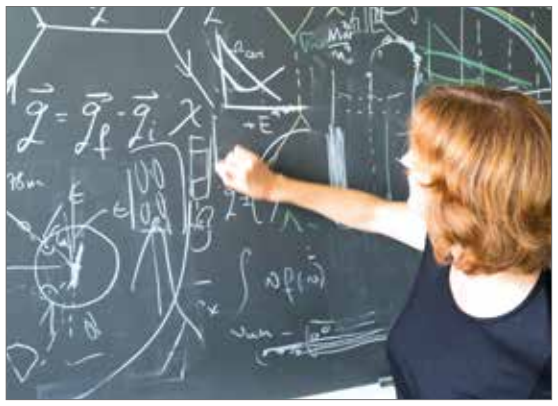
Today, dark matter is a popular topic. However, back when the native Romanian completed her thesis on dark matter at the Heidelberg University 20 years ago, she was given a fatherly advice by one of the professors: "You've had your fun with the dark matter – now on to some real physics." The «real physics» would be the traditional particle physics, dealing with the composition of the visible matter and forces holding it together. Yet, the invisible had already cast its spell over the young researcher; today, the professor is still just as fascinated by dark matter as she had been as a student. «Enlightening the dark» is the title of her project Xenon-1T.

Xenon-1T is the detector located within the Gran Sasso, an Italian mountain massif, deep down below 1,400 meters of rock, so that it is protected against disturbing cosmic radiation. The Latin word detector means revelation. Baudis and her team rely on the xenon detector to reveal those particles that they presume to be a part of the dark matter. Observations suggest that the matter known to us (and of which for example the stars, the Milky Way and other galaxies are composed) represent merely roughly 15 percent of the total matter within the universe. Therefore, the other 85 percent must be made of a different, non-luminous substance.

Searching for WIMPs

Already 84 years ago, the Swiss astrophysicist Fritz Zwicky analysed the mass of the galactic clusters and concluded that the gravitational force alone cannot hold them together. There must be an additional bonding force. Zwicky assumed a large amount of matter running through the galactic clusters and called it «dark matter». "However, we still do not know what it is made of," Baudis regrets. One theory is that it is composed of heavy, neutral particles, interacting only weakly with the matter known to us. Physicists call these particles «weakly interacting massive particles»,





or, in short, simply «WIMPs». A wimp is also another word for weakling. The specialists assume that these particles operate in absolute concealment and neither emit nor absorb light.

However, were the WIMPs to collide with other particles - according to the assumption - energy would be released, causing a brief flash of light. Baudis and her team are trying to catch such collisions by means of their detector in the Gran Sasso underground laboratory. The Xenon-1T detector consists of a tank filled with about three tons of liquid xenon, an inert gas with large atoms. 248 light sensors are attached to the bottom and top part of the cylindrical tank in order to detect the collisions. Nevertheless, such impacts are rare. So far, no WIMPs have been found – but at this point, there are other priorities. For now, the team's main concern is to have a highly light-sensitive detector. According to Baudis, first results have shown that the Xenon-1T is the most sensitive instrument worldwide in search of dark matter today.

Detector with 50 tons of xenon

The formulas on Laura Baudis' blackboard deal with her next Xenon project. The researcher, who is "fascinated by the clarity and simplicity of physical laws", is in the middle of the design phase for an even larger detector by the name of Xenon-nT. Compared to its predecessor, this detector shall impound about three times the amount of liquid xenon and have twice as many light sensors. The team plans to start building the detector in 2018; the project itself will start the year after. What is more, even the project after the Xenon-nT is already in the pipeline. It is called Darwin, which is an abbreviation for «dark matter wimp search with liquid xenon». The Darwin detector, which shall impound 50 tons of xenon and thus 16 times more of the inert gas than the current detector, is supposed to be put into operation by about the year 2025. For the pre-project to Darwin, Xenoscope, Baudis received one of the highly coveted ERC Advanced Grants this year (see box).

> We are looking at an area of the universe that no one has ever looked at before.

Laura Baudis' parents seem to have handed down their enthusiasm for mathematics. Though both of them earned their PhD in literature, they have always loved mathematics and have encouraged their daughter's talent from the very beginning. At the time when Baudis discovered her interest for the dark matter, only a few others were conducting research in that area. The majority of the physicists were dealing with «real physics». "Because our group was so small at the time, we had to collaborate closely, as we continuously had to develop the entire technology for our experiments all by ourselves," Baudis explains. This has not changed over the years. Although by now thousands of researchers all over the world are dealing with dark matter, the many close collaborations have not stopped: For example, the Xenon project consists of an international collaboration of 150 scientists from Europe, Israel and the United States. They all contribute to the construction and operation of the detector as well as the data analysis. The members of this collaboration themselves have to develop and construct the entire technology, the electronic system and the light sensors with which they wish to analyse the composition of dark matter.

EU Programmes allow close collaboration with industrial partners

This is why the European funding programmes are so valuable, for example those of the Framework Programme Horizon 2020. Two of the projects carried out by Baudis and her team are embedded in the Marie Skłodowska-Curie Actions, namely in an ITN and a RISE funding programme. ITN is short for Innovative Training Network, RISE stands for Research and Innovation Staff Exchange. Both projects started last year and deal with cooperation, exchange and networking. RISE focuses on visits and networking between researchers of all hierarchical levels. Baudis, who conducts experimental physics, hereby especially enjoys the exchange with physicists focusing on the theoretical aspects of the field. "These interactions can be mutually beneficial," she says. Both fields of physics are dependent on each other.

The focus of the ITN programme is on the promotion of young talent: During a quarter of a year, PhD students benefit from collaborating with other research groups or industrial partners. "I hereby win additional PhD students and commitment for my projects. In addition, my students have the opportunity to gain new experiences elsewhere," Baudis says. For example, one of her PhD students will join the Japanese Hamamatsu company for a three-month collaboration; this enterprise produces the light sensors for the xenon detectors inside the Gran Sasso laboratory.

Projects funded by Horizon 2020

The group of Laura Baudis is currently involved in two synergetic network projects within the Marie Skłodowska-Curie Actions (MSCA). While the "Elusives" project is an "Innovative Training Network" (ITN), the project "InvisiblesPlus" belongs to the "Research and Innovation Staff Exchange" (RISE) scheme. Typical for both project types is the financial support for training activities as well as for international and inter-sectoral cooperation.

http://www.elusives.eu: The network involves nodes in six European countries and its associated partners extend to seven non-European countries.
Duration: 2016-2020. Horizon 2020 financial contribution: € 3,9 m.

http://www.invisiblesplus.eu: The network involves 13 beneficiaries and 14 partner organisations in Europe and abroad.
Duration: 2016-2020. Horizon 2020 financial contribution: € 2,3 m.

Laura Baudis is also holder of a prestigious ERC Advanced Grant. The project "Xenoscope" (2017-2022) is funded with € 3,3 m from Horizon 2020.

image by naturPHotos.ch

The sensors are custom-built devices, as they have to be as sensitive as possible. Baudis and her team develop the light sensors together with the manufacturing company. Currently, they are refining the idea of silicon sensors the size of a fingernail. Also in terms of technology, the team enters uncharted territory. So they publish papers dealing exclusively with the technical details of the detector and light sensors, which in turn are then exchanged and discussed among scientists. "This is why it is extremely helpful for us that our PhD student can be on site at Hamamatsu thanks to the ITN funding programme," Laura Baudis states. Important questions can thereby be addressed directly with the manufacturer and the student will have gathered new knowledge upon her return. Besides, the physics professor feels very strongly about promoting young talents. According to her, "it is a very beautiful task to collaborate with young people, to see their enthusiasm and to encourage their endeavours." Baudis supervises six PhD students as well as five postdocs. Once, a high school student joined Baudis' team during her summer holidays, as she intended to write her graduation diploma paper on dark matter. Currently, a 70-year-old bachelor student completes the team; he was sent to the Gran Sasso laboratory recently in order to test materials.

Laura Baudis

is a Professor at the Physics Department of the University of Zurich. She dedicates her research to some fundamental questions in particle astrophysics and cosmology. Before moving to Zurich in 2007, she spent one year as a professor at the RWTH Aachen University, three years as an assistant professor at the University of Florida, and three years as a postdoctoral fellow at Stanford University. She is involved in research concerning dark matter, neutrinos and particle detection techniques, which includes the search for particle dark matter with liquid xenon detectors. Prior to moving to California, she spent four years at the Max Planck Institute for Nuclear Physics in Heidelberg. Laura Baudis has two children and her husband Michael Baudis is a Professor at the Institute of Molecular Life Sciences at the University of Zurich.

The Gran Sasso laboratory is her home away from home

The construction site helmet sitting on Laura Baudis' office shelve is needed to move around inside her spacious underground laboratory. The mountain massif is located about 150 kilometres east of Rome near L'Aquila. Here, she spends a great amount of time, especially when a new detector is set up. She laughs when calling the underground laboratory, which is one of the largest and deepest in the world, her "home away from home", as she had participated in smaller projects there already as a student. The Gran Sasso, the Big Rock, serves as a protective shield against disturbing cosmic rays. Inside the mountain, there are several gigantic research halls with additional experimental sites. Laura Baudis has taken her children down to the «cave of wonders». Unsurprisingly, her 18-year-old son and her 14-year-old daughter wish to follow in their mother's footsteps, and study physics.

The smaller everyday laboratories are located just two floors below her office on the Irchel Campus of the University of Zurich. This is where her team assembles the prototype of the detectors, where they test light sensors and electronic devices and perform calibration measurements. The team is under a great deal of pressure, despite the fact that there are still far less physicists devoting themselves to dark matter than to the visible matter. "Researchers in the States and in China are also intensively hunting for the particles that make up dark matter," she says.

"If we find nothing, we will still know more than we did before"

Journalists tend to ask Laura Baudis whether she is disappointed that so far she has not detected any WIMPs and what her plans would look like if she could not verify their existence. By now, the scientist is irritated by these questions. "I consider them irrelevant." In her view, science is above all about gaining insights. "We are conducting these experiments in order to know more than we did before." Should her team not find anything after all, they will still have gained new knowledge and could, for example, rule out a theoretically predicted parameter range. "However, if we are not searching in the first place, we will surely not find anything at all." The Xenon experiments are currently the world's largest and most sensitive in the field of dark matter research. Baudis knows that the outcome is, in fact, uncertain. What is certain, however, is this: "We are looking at an area of the universe that no one has ever looked at before."

● Denise Battaglia

Interview clip:
www.grantsaccess.ethz.ch/en/sciencestories

The welfare state at stake

An interview with Silja Häusermann, Professor of Political Science at the University of Zurich

What the welfare state tells us about power in society, what an ERC Grant can contribute to social reforms and why is it politically crucial to overcome social inequality.

Silja Häusermann, social welfare is one of your favourite research topics. Why is welfare of such great interest to you as a political scientist?

Political science is about power, about understanding how a society structures, controls and executes power. The welfare state is one of the objects where you can study this distribution of power at the core. Many people think social policy is about helping the poor and about solving problems. However, when you study social policy, you realise it is about the distribution of scarce resources and those who organise better, who have superior power resources, get a bigger share. The welfare state is where the biggest chunk of public money is distributed and that is why power plays such an eminent role. Therefore, for me, social policy is the most important area to look at as a political scientist. This is where the big decisions are taken, which very directly affect the distribution of resources

and opportunities among citizens. Additionally, I have always been fascinated by the welfare state as a political achievement. It is a democratic way of dealing with inequality and that is a great achievement of the 20th century.

You published a book on the politics of welfare state reform in Continental Europe. What are the conclusions you draw in this book?*

For my PhD degree, I studied many pension reforms carried out over a period of about 40 years in several European countries. The main conclusion I presented in my thesis and later in this book was that the politics of pension reform are multidimensional. This means that they do not just oppose those who want high pensions versus those who want lower pensions. Rather, there are several conflict lines – between those who want higher occupational pensions versus basic public pensions, those who want better pensions for women versus better pensions for employed men, for the poor or for the middle class, etc., –– and these conflict lines are all cross-cutting. They do not divide political actors in the same way and this multidimensionality of conflicts allows for very flexible coalition building. Those actors who manage to negotiate reforms that play across these conflict lines are able to push through reforms. The idea of multidimensionality is the core idea the book introduced in the field, and it proposed methodological tools to study it empirically.

Thanks to an ERC Grant, you will now extend and deepen your research on the welfare state. What would you wish to achieve?

The main goal is to establish a new perspective in the theory of welfare policy, to move our thinking and conceptualisation away from looking at the opponents and advocates of certain policies to an approach that focuses on priorities and ranking orders of preferences. I think such a new perspective is crucial today. If you look at the preferences of citizens in all European countries, there are less than five percent who want to cut back on social benefits. Nobody wants to cut back on pensions, nobody wants to cut back on education, and yet the current economic and financial context requires tough choices. So I would argue that the conflict in welfare states today is no longer about Yes or No, it is about the ranking order, about how much importance people attribute to specific social needs. First, how much money do you allocate to the welfare state? How much are you willing to extract via taxes? Who do you tax? Consumption, labour, wealth or income? That is a matter of priority.

> The welfare state is a democratic way of dealing with inequality and that is one of the great achievements of the 20th century.

Second, whose needs do you prioritise? The needs of the elderly, the young, the unemployed, the employed? This is the innovative approach I would like to introduce to welfare state theory: To think in terms of conflicts between priorities and to see whether we find different conflicts in different European countries. Once we think about conflicts regarding priorities, we may better understand reforms, for instance by weighing preferences. What we do have right now are data – mostly survey data – on who is in favour of expanding, let's say, childcare infrastructure. Now, what I would like to think through theoretically and measure empirically is how important is expanding childcare to different social groups, different parties, trade unions, etc. Once you know this, you can put a weight on this position and

Silja Häusermann

studied Political Science at the University of Geneva where she received her degree in 2001. From 2001 to 2003, Silja Häusermann completed a master's degree in Public Administration and Public Management at the Swiss Graduate School of Public Administration in Lausanne. From 2003 to 2007, she worked as a PhD student and academic assistant at the Universities of Lausanne and Zurich. In 2006, she was a Visiting Fellow to the Government Department of the Harvard University, Cambridge, USA and in 2007 she received her PhD degree in Political Science at the University of Zurich. Between 2008 and 2009, she was a Max Weber Fellow at the European University Institute in Florence, Italy. After this, she held a position as reader and postdoctoral researcher in Comparative Political Science at the University of Zurich until 2011. From 2011 to 2012, she was a Junior Professor in Comparative Political Economy at the University of Konstanz, Germany. In 2012, Silja Häusermann was nominated Full Professor of Political Science at the University of Zurich. Her key research interest is in comparative political economy with a special focus on the welfare state.

* Häusermann, Silja (2010). The Politics of Welfare State Reform in Continental Europe. Cambridge and New York: Cambridge University Press.

see whether these weighted preferences explain more than the blunt preferences do.

You started the ERC Project in September 2017. What will be the concrete steps in the next five years to reach the goals?

The first phase of the project is about identifying conflicts. What divides citizens and politicians, what creates conflicts, disagreement? The second part will be about the reforms. Once you have mapped the conflicts, the second part asks how we get to reform. What creates political majorities that are strong enough to reform the welfare state and what are the conditions so that citizens are willing to support reforms even if they do not benefit from them directly.

Additionally, there is a methodological goal you would like to achieve by this ERC Grant.

Yes, the project has two goals in terms of innovation. The theoretical one is about priorities. However, there is also a measurement innovation for the field of welfare state research, because so far we do not really have the tools to measure such priorities.

> The most direct practical goal of my ERC Project is to generate knowledge on reform opportunities.

All we have are survey questions that ask people if they are in favour or against certain benefits. That does not take us very far. Hence, I would like to try new methods that are quite established in marketing research, in economics and in sociology. They are generally called conjoint survey experiments or choice set experiments. It is an experimental survey method. In our case, we may show respondents different combinations of policy reforms. Let's say one reform option preserves pension levels and expands education but cuts back on unemployment benefits and you compare that to a second reform strategy that contains different elements. Then you ask respondents to prioritise them: do you like this one better or that one? If you have many of these comparisons of different alternatives, you can estimate the contribution of the individual components to the support of a welfare reform strategy. At the end, we would be able to say for instance how important unemployment benefits are for the support of the welfare state overall, as well as for specific groups, such as the employed, the elderly, the young, the unemployed. It is a new way of measuring these priorities.

Will this research also have an impact on society and policy makers?

Very much, I would say. The most direct practical goal is to generate knowledge on reform opportunities. What works? Which reforms have a chance of receiving a democratic majority among citizens and in parliament? You can have the best scenario, the best economists in the world telling you what to do with the welfare state – it has no impact in a democracy unless you get the required majority. Especially in the second part of the project, we will analyse the different elements or proposals that generate alliances and solidarity between different political groups. These findings could be very useful for policy makers.

Apart from deepening research on welfare state, what other opportunities does this ERC Grant open to you?

The most important benefit of an ERC Grant is the time and freedom it gives you. I will teach slightly less, I can profit from an additional sabbatical, I have this long five-year perspective and I do not have that much pressure of attracting more money immediately. I can really focus on this immense project for quite some time. It also gives me time to do empirical research myself, not just to manage the project as a project leader.I want to design the questionnaire myself together with the team. I want to talk to the survey company myself and I want to do interviews myself. I have not conducted a face-to-face interview myself for ten years! I am looking forward to that. Finally and importantly, an ERC Grant allows you to think big and take risks. Many of these survey methods are new to me and have certainly not been tried in this field. I cannot wait to learn, to develop them further and to see how far they will take us.

You have been Professor of Political Science for five years now. What motivated you to study the subject when you finished high school?

There was always a personal interest in social science – political science, economics, sociology – that I cannot fully explain. Additionally, I was politicised in the 90ies. At that time, there was a heavy economic recession, also in Switzerland, and a major period of deindustrialisation. I grew up in an area in Central Switzerland where the industry, especially the textile industry, was very important, and this industry and the people depending on it faced very hard times over several years. Many people I

knew, including my own family, were affected. So on the one hand I observed this decline year after year, and on the other hand it was a time of educational expansion, new fields, new fancy jobs, etc. This parallel development of deindustrialisation and the boom of a new post-industrial economy and labour market was very visible and impressively tangible. You could feel that society was radically changing, creating winners and losers. That awoke my interest in political science and political economy: how do we distribute the gains and losses in a time of such radical structural change and why?

Many people write a PhD thesis but then their academic career somehow does not pick up pace. You succeeded and became a professor. How did you manage?

I think the key that paved my way into academia was the opportunity to publish my first book – a revised version of the PhD research – with Cambridge University Press. This book quickly became visible in the academic field; it won two prizes, and turned out to be a kind of entry ticket. Once I had the book and well-known international scholars in the field agreed it was important, the door to academia was open. I think you cannot fully plan this, of course. Nevertheless, I would say it is worth to greatly invest in your PhD – to make an impact, a splash when you enter the field. After this, I got a prestigious postdoc position, third-party funding for two new projects, I was invited to join international research projects, and then one thing lead to another…

We live in challenging times. Where will we be in ten years?

I think we find ourselves in a very dangerous period. For the first time since the Second World War, we are facing a real decline in jobs and earnings possibilities for social groups that are politically organised and visible, especially the lower middle class in many countries. It is a relative decline, not poverty, but there is lower growth and growing insecurity for many people who are well organised and who have much to lose. When powerful groups feel that they are losing privileges and status, it is politically quite dangerous. The welfare state can be an answer to this challenge.

It is politically quite dangerous, when powerful groups feel that they are losing privileges and status. The welfare state can be an answer to this challenge.

What it needs to do in such a context of growing inequality is to temporarily support the status of those who lose out. At the same time, in order to allow for peaceful structural change and prepare the society for the future, the welfare state also needs to invest a lot of money in social upward mobility and in education. Balancing these different needs is extremely difficult and controversial.

Where do you think you will be in ten years?

A short answer is: I will be where society takes me. My research agenda is based on these structural changes and how they affect politics, distributive policy and people's opportunities in life. In ten years, different specific questions may be at the forefront, but this overall question will certainly be no less fascinating and important.

● Interview: Rolf Probala

Interview clip:
www.grantsaccess.ethz.ch/en/sciencestories

ERC Starting Grant "WELFAREPRIORITIES"

In times of austerity, the politics of the welfare state involve tough choices and even trade-offs: whose risks should benefit from social solidarity in a context of shrinking resources? Should the welfare state prioritise the needs of the elderly or those of the young? Those of people in the workforce or outside of it? Of natives or of immigrants?

The project is supposed to break new theoretical and methodological ground in comparative welfare state research. It conceptualises and studies both the trade-offs and the potentials for coalitions, which will determine the fate of the European welfare state in the 21st century.

Duration: 2017-2022

Financial contribution from Horizon 2020: € 1,5 m.

Threats from cyberspace

Reducing cyber risks, improving information security

Why expanding connectivity endangers our daily lives, what Srdjan Capkun likes most about information security and how he can protect us from cyber risks.

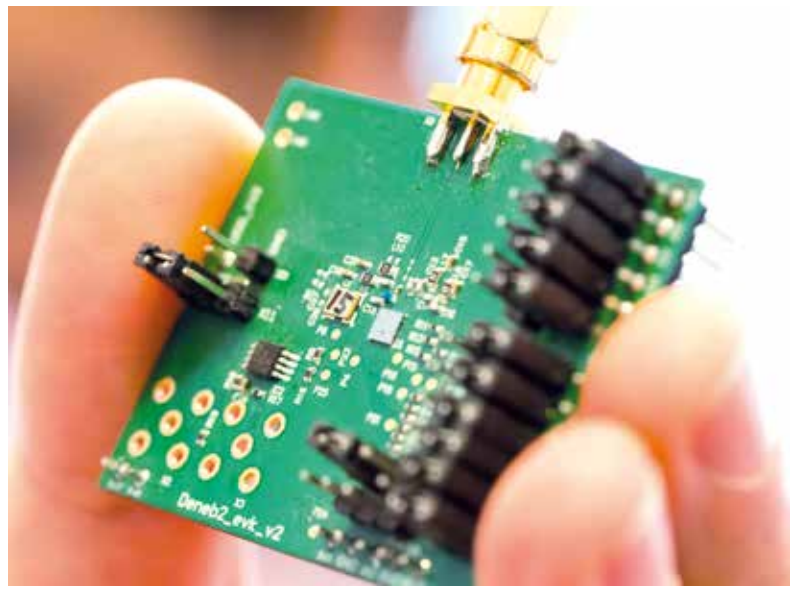
Imagine, you have a pacemaker. Once a year the doctor remotely checks and adapts its proper functioning. But if malware modifies the parameters on your doctor's system, this might cause you significant harm. Imagine, you park your car in front of a supermarket and lock it electronically with your key. When you come back, the car has gone. Someone has spoofed its entry/start system. Imagine a self-driving bus suddenly runs into a crowd of people waiting at the bus stop. Someone has hacked the electronic system and has taken control of the bus. These are just a few examples of threats Srdjan Capkun, Professor of Information Security at ETH Zurich, mentions when we meet him in his office. "Most of the devices today are somehow connected," he explains. "They collect data or have little computers running inside which can be attacked. Connectivity is great but it is definitely something that exposes us to high risks." Digitisation and connectivity are going to make our society extremely vulnerable. We are facing threats at all levels – from financial institutions and public services like banks, power plants and transport systems down to individual devices like mobile phones, computers or smart homes. When Srdjan Capkun started as a PhD student at the EPF Lausanne some 20 years ago, he realised that information security would become a crucial topic in the future; hence, he wrote his PhD thesis on a security topic and specialised in this field.

> Digitisation and connectivity are great but they are going to make our society extremely vulnerable.

"It is a lot of fun to work on these topics where you have to consider someone else's actions, which is hard to predict. If you change something, the other side will try to adapt and you have these games continuously back and forth. And what I also like: security is a cross-layer field and requires a holistic approach because you need to have a broad understanding of an entire system in order to secure it," Srdjan Capkun tells us on the way to his systems security lab just across the corridor. There, his team is currently testing how to measure the distances of two devices securely, for instance the distance of your car and the key in your pocket or how to safely obtain the GPS position of your mobile phone.

Secure positioning

Secure measurement of the distance between two devices or a position of a device is a key issue in security. Attackers try to change the distance measurement and by doing so alter the position of your device to a false place. Your mobile phone believes it is in Berlin while it is actually in Zurich. Once the attackers have faked the position, they can spoof your device and misuse it in many ways – from opening and stealing your car up to controlling a robot. Srdjan Capkun and his team have developed a solution concept for this problem and they have proved already that it works by successfully securing the access to cars. "Currently, we can do this for a distance of about



200 meters, but we need to push the distance as any kind of internet devices are affected," he says. However, there are still many scientific and technical problems to overcome in order to make the concept work under different conditions and to prove that it is secure. To address these difficulties, Srdjan Capkun received an ERC Consolidator Grant in 2016 that came into effect in spring 2017 (Cross-Layer Design of Secure Positioning). "For a long time, I have had this dream to understand the problem fully and to have this security system built and deployed," he tells us while we are heading back from his lab. "So, in five years from now I want to write 50 pages on this topic and say: Now we do understand. We know how to build it, we know what the trade-offs are, what can and what cannot be done."

Secure clouds

Back in his office, he tells us about another key focus of his research – the security of cloud platforms. Cloud providers offering services in data processing and storage to many different companies have to make sure that their systems are secure and robust against any leaks within the system itself as well as against attacks from outside.

> Security is a cross-layer field because you need to have a broad understanding of an entire system in order to secure it.

The provider runs many different companies on the same infrastructure and processes data of different clients on the same machine simultaneously, so it must be guaranteed that these companies do not receive each other's data. This is a matter of isolation. However, security also means ensuring that data a client wants to delete disappears completely according to compliance and regulations. This is very often not as trivial as it looks like. Depending on the software design, data might still remain hidden somewhere within the system.

> It is key to this kind of collaborative projects like TREDISEC to understand each other's concepts and technologies.

Srdjan Capkun and his team have been dealing with challenges of cloud security and secure deletion of data throughout several projects, including TREDISEC, a European collaborative Research and Innovation Action, financed by the European Union. TREDISEC will end by March 2018, presenting prototypes or demonstration models of cloud platforms, which by then will have been built jointly by the project partners. Srdjan Capkun and his team will contribute to the prototypes by implementing security concepts. What is the main benefit for a scientist to participate in such a collaborative project? Srdjan Capkun mentions two fields. "Cloud computing infrastructure is a very complex infrastructure. Some of the participants in this project are leading international companies like SAP, IBM or NEC, with whom we have been collaborating for a long time. It is key to this kind of collaborative projects to understand each other's concepts and technologies. And from a research point of view: the project gives us access to the infrastructure of our partners, so we can test our concepts on their system and obtain the data."

Secure online authentication

Online authentication is another key topic Srdjan Capkun has been working on for quite a long time. We usually use passwords to access our online services but, according to Capkun, this is one of the most insecure ways of authentication: "About 80 percent of passwords employees generate in an average company can be guessed within a couple of days of computation." The reason is that people cannot remember complex passwords, so they tend to choose simple ones. Therefore, Srdjan Capkun and his team have developed an

Srdjan Capkun

is a Full Professor in the Department of Computer Science, ETH Zurich, and Director of the Zurich Information Security and Privacy Center (ZISC). Srdjan Capkun was born in Split, Croatia. He received his Dipl.-Ing. degree in Electrical Engineering/Computer Science from the University of Split in 1998 and his Ph.D. degree in Communication Systems from the EPFL in 2004. Prior to joining ETH Zurich in 2006, he was a postdoctoral researcher in the Networked & Embedded Systems Laboratory (NESL) of the University of California, Los Angeles, and an Assistant Professor in the Department of Informatics and Mathematical Modelling, Technical University of Denmark (DTU). His research interests are in system and network security. One of his main focus areas is wireless security. He is a co-founder of 3db Access, a company focusing on secure distance measurement and proximity-based access control, and of Sound-Proof, a spin-off focusing on usable on-line authentication.

additional system of authentication by the mobile phone called Sound-Proof. Let's say you want to open your email account on your laptop.

> The system of double check by password and mobile phone is the most secure way of authentication so far.

First you enter your password and then your mobile phone communicates automatically with the server to make sure you are allowed to log in. This system of double check by password and mobile phone is the most secure way of authentication so far, because the server accepts your login only if your mobile phone is in the same room that you are. But what about biometric authentication? "Biometrics seemed to be a great solution initially but as most biometrics are static, they can be worse than passwords," Srdjan Capkun tells us. "If you lose your password you can create another one. If someone picks up your biometric authentication, it is gone forever. You cannot change your hand." To catch someone's fingerprint seems to be very easy. With a little bit of powder you can pick it up from a keyboard or a glass. German hackers proved that fingerprints may be obtained even from a photo of a politician waving his or her hand.

Leaving Srdjan Capkun's office after an inspiring morning, we have a look at the cartoon pinned to the door showing two mice pretending to take over the world tonight. "That is for my students," he explains with a laugh. "I want them to aim big.

> Your mobile phone believes it is in Berlin while it is actually in Zurich.

They should pick up a relevant topic and say, for example, 'I want to build the most secure phone in the world. I want to understand all the challenges and complexities involved and I am going to build this phone!' Then you can do this for ten years and eventually build that phone. But in the process of these ten years, you detect so many other topics and solve so many other problems. This is my message to the students and also the guideline for myself – aim big!"

● Rolf Probala

Interview clip:
www.grantsaccess.ethz.ch/en/sciencestories

Projects funded by Horizon 2020

- TREDISEC – Trust-aware, REliable and Distributed Information SEcurity in the Cloud: European collaborative Research and Innovation Action (RIA) that leverages existing or novel cryptographic protocols and system security mechanisms, which offer strong data confidentiality, integrity and availability guarantees while permitting efficient storage and data processing across multiple tenants. The project involves nine academic and industrial partners from Europe and is coordinated by Atos SE, Spain.

  http://www.tredisec.eu/

  Duration: 2015-2018

  Financial contribution from Horizon 2020: € 4,4 m.

- CSP – Cross-Layer Design of Securing Positioning: ERC Consolidator Grant on new approaches to the design of positioning systems that consider security requirements.

  Duration: 2017-2022

  Financial contribution from Horizon 2020: € 2 m.

The art of co-management

If there were an award for co-management, the names of Agatha Keller and Sofia Karakostas would be right on top of the list of nominees. For 16 years, they have been very successfully heading the EU GrantsAccess office, founded in 1997 by merging the respective EU counselling offices of ETH Zurich and the University of Zurich. This is unusual as co-managing often fails due to power struggles and wrangling over competences. "One of the two has to be the boss," is still a very common opinion on co-management. However, the question of who should be in charge has never been raised by Agatha Keller and Sofia Karakostas. They have quite different personalities with varying interests – but they share a common vision regarding EU GrantsAccess. They jointly want to run an office that serves as an efficient, modern service centre, which best supports both young and experienced scientists in applying for funding. Therefore, since the very beginning, the co-managers have been fully committed in building a team of experienced advisers who guide the scientists through every step of the application process – from informing about options and calls up to handling administrative and bureaucratic requirements and filling in forms. Guided by this mission, they have organised their co-management according to their personal abilities and preferences. Sofia is responsible for the communication with the stakeholders at the universities and the EU research administration as well as for marketing, events and human resources. Agatha is in charge of finance, planning, project management and organisational topics. But they can take each other's place easily if one happens to be absent.

Agatha Keller

Since Agatha and Sofia took over in 2001, research funding has become extremely diverse and complex. There are plenty of funding initiatives and programmes within the EU and other funding institutions today, but finding the appropriate source to fund a specific researcher demands special knowledge. Furthermore, the requirements and procedures to receive the money have become even more challenging, also due to new rules of compliance. Therefore, the co-managers have to cope with increasing demands from the funding agencies as well as from the researchers they support. Asking the two managers what they consider the greatest challenge they will face in the near future, they mention two areas: Agatha points to the long-term challenge of discovering the rise of new research topics and changes in funding. "In funding we observe an increasing shift towards big private companies and institutions. We have to be very alert in watching this trend to keep our researchers informed and to adapt our strategy at the right moment," she says. Sofia adds a more short-term challenge that will also strongly impact their work: "Currently, we are doing quite well with Horizon 2020. However, it is an open question if Switzerland will be associated again with the next EU Framework Programme (FP9), starting in 2021." But Agatha Keller and Sofia Karakostas are highly motivated to tackle these challenges as well – in co-management, of course. ● Rolf Probala

Sofia Karakostas

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