

HiPEAC

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APRIL 2020

COVID-19
holds
humanity in
its grip

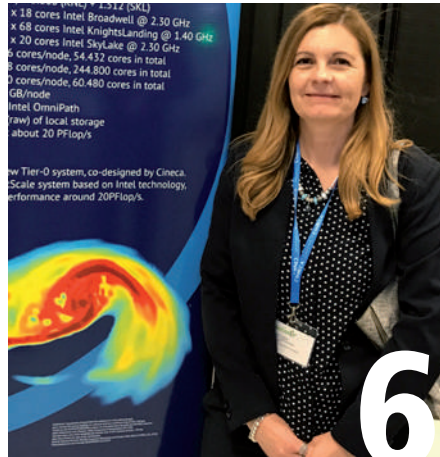
High Performance Computing in the race against the coronavirus

"Around the corner" with Eduardo Quiñones

HiPEAC Member Efforts to Combat COVID-19



Policy Corner by Sandro D’Elia



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“Around the corner” with Eduardo Quiñones

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HiPEAC is the European network on high performance and embedded architecture and compilation.



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An Engine for Health Care Innovation



Innovation Europe



HiPEAC Jobs Career Center



The winter of 2020 will be associated with the outbreak of the coronavirus disease 2019 (COVID-19). Given its global impact, there is no doubt that the outbreak of COVID-19 will end up in the history books as the start of the third millennium, just like 9/11 marked the beginning of the first one. Most governments took unforeseen draconian measures to stop the spread of the virus like locking down entire cities, regions and countries, cancelling all public events, imposing social distancing and self-quarantine, and closing nurseries, schools, universities, and elderly homes, as well as businesses that interact with consumers. These measures would have been unthinkable just a couple of months earlier because they are extremely disruptive for society and for the economy.

This makes me wonder whether there aren't smarter ways to stop a virus than asking people to stay at home until the virus leaves a city. This solution is non-selective, very expensive, and not very effective. It slows down the spreading of the virus, but it does not stop it. I believe that technology could do a better job.

Imagine that every toothbrush had a built-in human virus detector. That toothbrush could make a daily analysis of the viruses one is infected with (from the common cold to the flu and beyond) and could send that information to the person's smartphone, and perhaps warn a local hospital in the case of a dangerous virus. A generalized use of the human virus scanner would allow centers for disease control to identify persons infected with a dangerous virus within 24h, and hopefully take appropriate measures before that person could infect others.

This would not only lead to fewer infected people, less suffering and less spending on curative health care, but also to less severe economic impact. I hope that by 2030, medical schools will teach the next generation of doctors that thanks to cheap human virus scanners, 2020 was the last time governments had to use the medieval practice of locking down whole cities in order to stop the spread of a virus.

In my dreams, this human virus scanner is already being developed somewhere in Europe based on technology developed by HiPEAC members. This is the kind of innovation our community should be working on: one that is impactful, focused on societal needs, globally usable and sustainable.

Koen De Bosschere, HiPEAC coordinator



Cyber-physical systems (CPS) are more and more important in our lives, and will be key elements in both the transition to a sustainable economy and the industrial data economy of the coming years. However, most people have no idea what they are, and why they should care.

Article by Sandro D'Elia

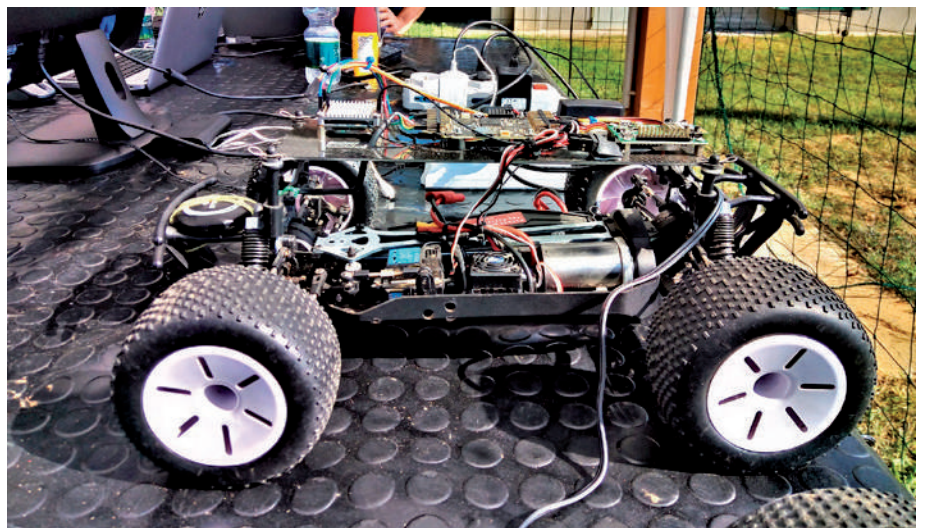
Cyber-what?

I went to a workshop in Brussels. I arrived at the lobby of the office building, and asked the person behind the desk where the event on Cyber-Physical Systems was. The young man smiled and told me: "Sorry, I don't think it is here. I see that today we have only a seminar on CPS."

He was not to blame: the reality is that most people don't know what CPS are, even if in the morning they take a fully-automated metro train, at lunch eat packed food which has never been touched by human hands, and in the evening enjoy the self-parking feature of their car. CPS are a big part of our daily lives, even if we tend to notice them only when they don't work, and their influence is growing quickly: in every sector of the industry we see examples of computers interacting directly with the physical world, and often exhibiting very complex behaviour enabled by Artificial Intelligence (AI).

Over the course of the past few years, we have also realised that CPS are our best friends on the road towards a sustainable economy. For example, making a factory carbon-neutral means controlling very complex industrial processes in real-time and with extreme precision; this is not something that can be done manually, and can work only if the entire factory is a complex CPS capable of taking autonomous decisions quickly and with very high reliability. Of course, manufacturing is not the only sector affected: just consider agriculture, in which reducing the environmental impact of intensive farming means analysing a lot of data to reduce the use of pesticides and water, guarantee optimal yield, and preserve biodiversity. This is simply too difficult for humans; we need computers that can understand the environment in which they operate, and interact with it safely. As in these examples, AI functionalities will be more and more at the core of the CPS designed

"CPS are our best friends on the road towards a sustainable economy"



CPSWARM-rover

in the coming years, but the distinguishing feature of CPS will always be the “system” aspect, that is, the capability to manage complexity while guaranteeing reliability, safety, and the other requirements which are critical when dealing with the physical world.

There is little doubt that to implement the “European Green Deal”, the flagship policy of the European Commission, we will have to push towards a new generation of CPS that can help us deal with global problems like climate change, allowing us to waste less resources and to reduce our footprint on this planet, and this will have an impact on transport, manufacturing, agriculture, and most sectors of economic relevance. The future Horizon Europe and Digital Europe programmes, with their objectives of supporting the development of the best digital technologies and their uptake by the industry, will provide strong support for the future development of CPS.

There is another reason why CPS are becoming even more important: the data economy. The United States and China are the world’s leaders in harvesting and exploiting personal data, and the European Union (EU) must make sure the same thing does not happen when it comes to business-to-business data. This is not my personal opinion: EU Commissioner Thierry Breton, responsible for digital policy, stated this in an interview with a financial newspaper. The fact is that CPS are the main



HERCULES-Lidar

source for many types of industrial data, and represent a sector in which EU industry is very strong. Today, if I break my phone or my laptop is stolen, the cost of the hardware is not my first concern: what is really important is the access to my contacts, photos, documents and whatever makes up my digital world. In the future, we will see the value of CPS defined not only by their complexity or functional capabilities, but primarily by the value of the data that they create and capture. The European strategies for data and AI (published on 19/2/2020 – see <https://europa.eu/!fG74BH>) explain how the European Commission plans to support the creation of a European single market for data, creating space for the growth of the digital economy and of applications

based on AI. From our point of view, this means that we have to start thinking about CPS not only in terms of their physical and digital aspects, but also in terms of how they fit into the European data spaces.

So, CPS may be unknown to most people, but are definitely at the core of the digital strategy of Europe, both for their contribution to the European data space and for their key role in the transition towards a sustainable economy. To be a leader in the industrial data economy of the next decade, Europe must be a leader in CPS.

Too technical a term, “Cyber-Physical Systems” could benefit from re-branding; perhaps we could reach out to its users for a new name!

On a final note, added to this piece at the end of March and in the midst of the COVID-19 pandemic, I have been working from home in Belgium for the past two weeks. While I am anxious about the situation, a CPS has been a steady presence in the hospital system. The intensive-care ventilator, the most critical device in supporting severe cases of COVID-19, is playing a critical role in saving lives. However, it is in short supply. So, let’s remember that CPS are potentially lifesaving and, as such, we should work together to make them safer, more efficient and more reliable.



HERCULES-drone



A conversation with Cristina Silvano

High Performance Computing in the race against the coronavirus

For the past few months, CINECA's supercomputer Marconi has been continuously processing, at the rate of 50 million billion operations per second, to simulate the interactions between the proteins of the new coronavirus SARS-CoV-2 and the molecules of potential therapeutic drugs, in a race against time to identify a therapy to fight the virus effectively. Through the virtual screening of 10,000 drugs already approved for human use, even if for different therapeutic indications, it is possible to select a fairly small number of molecules to be tested in a very short time on humans, allowing a rapid response to the emergency generated by the pandemic. The tool used for the virtual screening is the Exscalate platform, owned by Dompé and developed together with Politecnico di Milano and CINECA.

The activities, which started urgently in February, can now count on three million Euros of the European Commission's emergency call allocated to the Exscalate4CoV (E4C) Consortium. The E4C Consortium is coordinated by Dompé Farmaceutici, and is comprised of eighteen institutions and research centers from seven countries around Europe: Politecnico di Milano, CINECA (Supercomputing Innovation and Applications), Università degli Studi di Milano, Katholieke Universiteit Leuven, International Institute of Molecular and Cell Biology in Warsaw (LIMCB), Elettra-Sincrotrone Trieste, Fraunhofer Institute for Molecular Biology and Applied Ecology, Barcelona Supercomputing Center (BSC), Forschungszentrum Jülich, Università Federico II di Napoli, Università degli Studi di Cagliari, SIB Swiss Institute of Bioinformatics, KTH Royal Institute of Technology, Associazione Big Data, Istituto Nazionale di Fisica Nucleare (INFN), Istituto Nazionale per le Malattie Infettive Lazzaro Spallanzani and Chelonia Applied Science.

Among the partners, there is Politecnico di Milano, which will be engaged in the activity of "accelerating the computational process". This constitutes a key role, given the speed at which

the new coronavirus SARS-CoV-2 spreads. In a brief conversation with HiPEAC member Cristina Silvano, professor of computer architecture at Politecnico di Milano, formerly responsible for the European research project Antarex and currently co-leader with professor Gianluca Palermo of the POLIMI team dedicated to the Exscalate4CoV program, we have a look inside.

What is the potential of the Exscalate platform as a virtual front to fight the coronavirus?

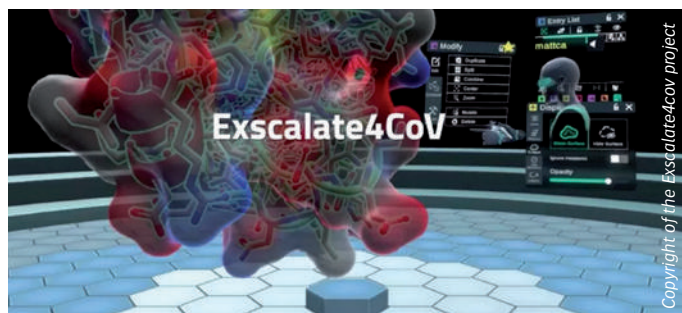
The virtual front represents the first move. As the European Commission also recognized by deciding to finance the project, the Exscalate platform represents a powerful tool to accelerate the initial phase of development of new therapies, called virtual screening. The platform Exscalate (EXaScale smArt pLatform Against paThogEns) is the most performant High Performance Computing (HPC) and structure-based drug design system thanks to its "virtual library" of 500 billion molecules (currently the largest library in the world), capable of evaluating more than three million molecules per second. The state-of-the-art platform consists of a "chemical library" of 138 million molecules on a single target, with a processing capacity of less than two thousand molecules per second (source: Nature, February 6, 2019).

How can the supercomputing technologies be used?

It starts from the structures of the proteins of the virus to be defeated. Then, with smart computational techniques, these proteins are virtually combined with the molecules of the various drugs. We decided to begin by investigating a reduced set of the database, composed of 10,000 drugs already available for human use; if some of them were proven to be potentially effective during the virtual screening, the development of therapies would be much faster. In the second phase, the virtual screening would then be extended to all 500 billion molecules in the database. The most promising interactions would then be studied and validated in the subsequent phases of the drug discovery pipeline. This is a well-known process, which given the global crisis caused by the coronavirus, must be accelerated in order to put an end to the pandemic as soon as possible.

Are you confident about the Exscalate platform's performance?

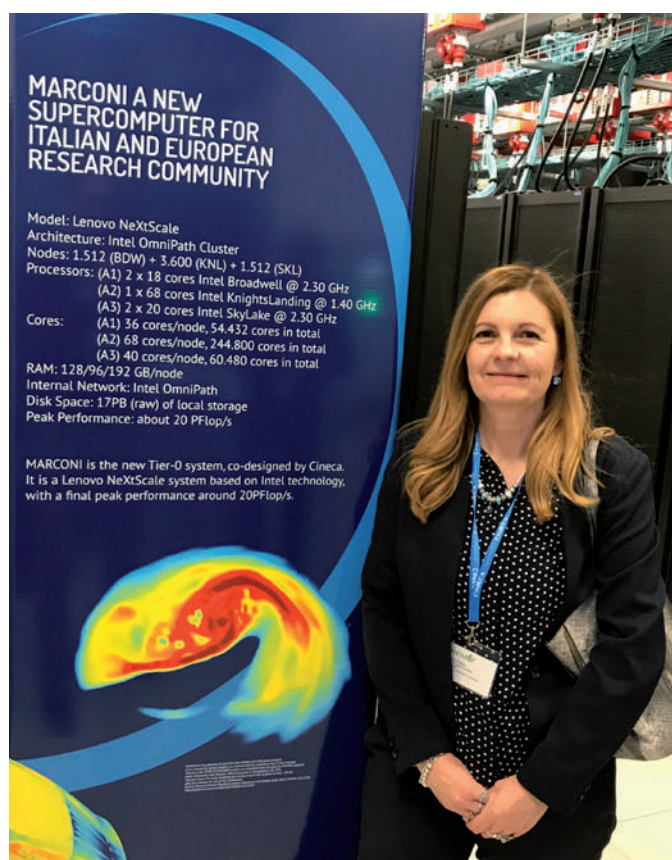
In the context of the European project Antarex, we have already tested the potential of the Exscalate platform to quickly identify drugs against possible viral epidemics. In January 2019, we simulated on the Marconi supercomputer at CINECA an "urgent computing case" to identify possible candidate molecules for



the treatment of the Zika virus, which in 2016 threatened the Rio de Janeiro Olympics. It was the largest virtual screening experiment ever simulated, and ran up to one million parallel threads, with a computing power of 10 petaFLOPS, or 10 million billion operations per second. We managed to identify molecules potentially capable of inhibiting five of the virus's seven viral proteins. At the moment, these molecules are undergoing clinical evaluation in a Brazilian laboratory, the preparatory phase for the release of the therapy.

What can you take from this experience?

The Antarex project is a predecessor of ExScalate4Cov, and allowed for the definition of procedures and the accumulation of useful experiences both for research on the coronavirus and to optimize the computational processes. Today, the Marconi supercomputer, among the 20 most powerful in the world, is already working at an even higher speed: it runs at 50 petaFLOPS. Thanks to recent investments made by Italy and Europe, a further



upgrade is underway, which will be built in Italy. The Leonardo supercomputer, expected to reach 150 petaFLOPS, could place it among the five most powerful supercomputers in the world. We are talking about supercomputers based on heterogeneous system architectures combining the use of general-purpose processors with Graphic Processing Units (GPUs) used as accelerators of the computation.

WHO has classified the COVID-19 spread as a pandemic. Time is of essence.

The Exscalate4CoV project was funded for a period of 18 months. Even if it is difficult to predict the future, our horizon is drawing near, and we hope to be able to share promising results from the virtual screening task much earlier than otherwise would be possible, passing them on to the other research institutes of the Exscalate4CoV consortium for the other phases of the development process, which also require time. Currently, CINECA supercomputers are already processing data at full speed. We will try to do everything to win the race against time. And against the virus.

FOR MORE DETAILS:

<https://www.exscalate.eu/en/>

<https://www.exscalate.eu/en/projects.html#COVID-19>



53rd IEEE/ACM International Symposium on Microarchitecture (MICRO-53)

17-21 October 2020, Athens, Greece

<http://www.microarch.org/micro53/>

The International Symposium on Microarchitecture® (MICRO) is the premier forum for the presentation and discussion of new ideas in microarchitecture, compilers, hardware/software interfaces, and design of advanced computing and communication systems. The goal of MICRO is to bring together researchers in the fields of microarchitecture, compilers, and systems for technical exchange. The MICRO community has enjoyed having close interaction between academic researchers and industrial designers, and we aim to continue and strengthen this longstanding tradition at the 53rd MICRO in Athens, Greece.

The 53rd edition of MICRO is a special one since the symposium comes for the first time to Athens, Greece (and will be only the sixth edition of MICRO held on the European continent). The location is expected to conveniently connect academics, students and industry researchers and practitioners from all around Europe to many colleagues from the West and the East.

The technical program of MICRO-53 will include workshops and tutorials over the weekend of October 17 and 18, followed by the symposium technical program (with keynotes and paper presentations) from Monday, 19 October through Wednesday, 21 October 2020.

For all updated information regarding MICRO-53 in Athens, check the symposium web site <http://www.microarch.org/micro53/>

We are looking forward to welcoming you in Athens next October.

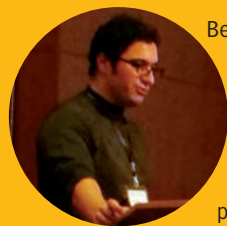
Dimitris Gizopoulos
 General Chair, IEEE/ACM MICRO-53 (www.microarch.org/micro53/)
 Professor, University of Athens, Greece (www.di.uoa.gr/~dgizop)

The 3rd Workshop on Embedded Machine Learning

The 3rd Workshop on Embedded Machine Learning (WEML) took place at Heidelberg University on 13 February 2020, attracting about 60 attendees. This workshop series is jointly organized by Heidelberg University (Holger Fröning), Graz University of Technology (Franz Pernkopf) and Materials Center Leoben (Manfred Mücke), and embraces joint interest in bridging the gap between complex machine learning models and methods to resource-constrained devices like edge devices, embedded devices, and the Internet of Things (IoT). The workshop focuses on invited presentations, with ample time for discussions and other interactions. This time, the program included speakers from Robert Bosch GmbH, XILINX Research, NEC Laboratories Europe, Graz University of Technology, Materials Center Leoben, and Heidelberg University. The workshop started with a focus on tooling, including an overview about resource-efficiency in deep learning, with methods such as pruning, quantization and others, followed by a deep dive into network pruning for specific hardware. Further contributions included an update on code generation for embedded targets, and an overview of machine learning optimization tools for specialized architectures. The following part focused on hardware, with presentations on using neuromorphic hardware for deep learning, and quantization-aware training for field-programmable gate arrays (FPGAs). The last part was dedicated to “Beyond-CNN” models, including Graph-based Neural Networks, Sum-Product Networks, and Capsule Networks. The attendees leveraged the workshop’s philosophy on interactions, and in various discussions a couple of trends were observed. Particularly, the community agrees on an increasing gap between ML application and hardware capability, with convolutional neural networks as a best-case scenario, as “Beyond-CNN” models will substantially push requirements in terms of structure and computational intensity. In this regard, it is also no surprise that ML and its infrastructure is trending, even though the mileage with existing tooling might vary dramatically.



Paper on Dependable Systems and Networks (DSN) by Behzad Salami: an outcome of a HiPEAC Collaboration Grant



Behzad Salami, a post-doctoral researcher at the Barcelona Supercomputing Center (BSC), has recently had a paper accepted to the 50th IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), the product of research partially funded by a HiPEAC collaboration grant. The visit took place between November 2019 and January 2020 at the Computer Science (CS) School of the Institute for Research in Fundamental Sciences (IPM), led by Prof. Hamid Sarbazi-Azad. The paper describes the most recent findings on the aggressive undervolting technique for the field-programmable gate array (FPGA)-based Convolutional Neural Network (CNN) accelerators, specifically from the power and reliability perspectives. The achievement is more than a threefold increase in power efficiency on commodity FPGA fabrics running on CNN applications.

Behzad Salami commented: I believe that our explorations on real FPGAs open new doors for the research and academic community to adopt robust and practical voltage/reliability tradeoff optimizations on CNNs mapped to FPGAs. Indeed, this is not possible with simulators or analytical/theoretical models. I hope that our work influences chip/accelerator manufacturers, including Google, who is producing CNN Application Specific Integrated Circuits (ASICs) to provide multiple voltage rails that will facilitate the application of our approach, as well as FPGA-based enterprise systems like Microsoft Brainwave.

Hamid Sarbazi-Azad (host researcher for the visit) commented: CNN is the choice of the day for solving many problems that affect our daily lives. The computation capacity needed to run such giant learning networks has to be very powerful to speed up the execution of time-consuming CNN-based applications. One way to get such a speed up is to use hardware accelerators based on FPGAs. However, the high utilization of FPGA resources for such resource-hungry applications imposes huge power consumption. In this work, Behzad used an aggressive technique to reduce the power consumption of a FPGA accelerator. He has thoroughly experimented and carefully employed the undervolting technique, and could get a threefold power reduction when employing commodity FPGAs for CNN-based applications.

Osman S. Unsal (Principal Investigator of the LEGaTO project, which is related to the work done) commented: The key aspect in the LEGaTO European Union (EU) project is energy-efficiency for heterogeneous compute fabrics. The work of Behzad is very relevant and important for the project as it explores radical power/energy savings in FPGAs for CNN applications. CNNs are key enablers for moving the

Information Technology (IT) industry forward. The hardware of choice for efficient execution of CNN applications has been the custom ASIC. Examples of such ASICs include the Google TPU and Intel Nervana, Gaudi and Goya. Although ASICs are low-power, they are inflexible. FPGAs, in comparison, are flexible; however, their relatively high power consumption is a concern. Behzad's work attacks the FPGA power problem and solves it through aggressively lowering the voltage. This work has the potential to demonstrate that FPGAs could be close to ASICs in power-efficiency, while providing programmability and re-configurability for CNN applications.

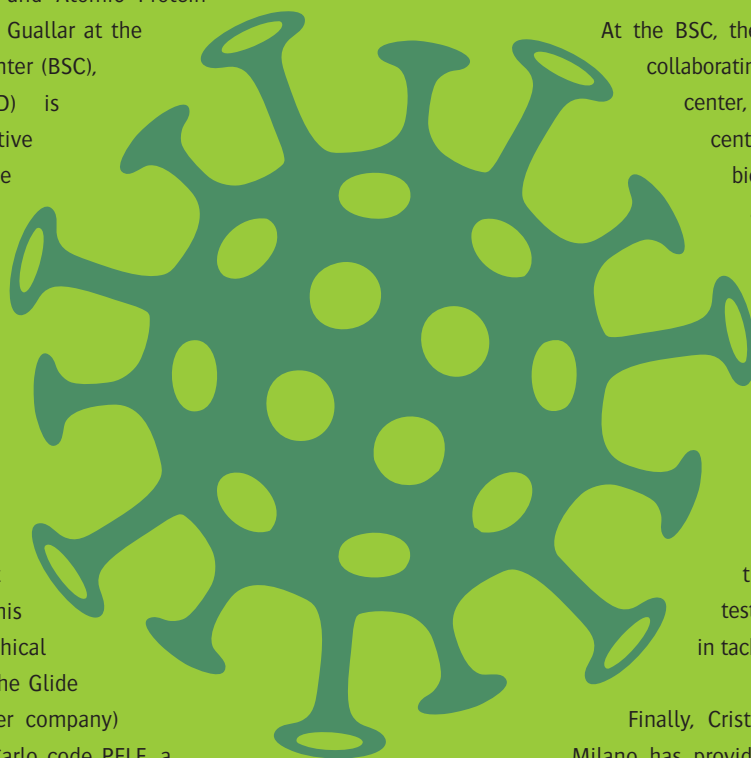


HiPEAC Member Efforts to Combat COVID-19: An Overview

As the world battles the COVID-19 crisis, a number of efforts are being made around the globe to combat the disease caused by the SARS-CoV-2 virus. Among these efforts are initiatives taken by HiPEAC members.

Flavio Vella and his team at the Free University of Bozen are investigating novel and efficient parallel algorithms in order to evaluate the spreading power of entities in a network. More specifically, they are working on distributed parallel algorithms to compute the expected force and other centrality measure of a network. While this work is not only focused on COVID-19, it is related to it since it aims to compute infection rates. It is funded by the Free University of Bozen in the context of the project SpGAS and COMPANET.

Together with the Electronic and Atomic Protein Modelling Group led by Victor Guallar at the Barcelona Supercomputing Center (BSC), Nostrum Biodiscovery (NBD) is putting in place a collaborative research effort in response to the new global emergency resulting from the novel coronavirus SARS-CoV-2. At present, NBD is focusing on screening their proprietary virtual library, ChemistriX, as well as other open libraries (Zinc), into the 3C main protease of SARS-CoV-2; blocking this enzyme, the virus cannot replicate efficiently. For this reason, they are using a hierarchical docking approach combining the Glide software (from the Schrodinger company) with their proprietary Monte Carlo code PELE, a computational protocol that has shown remarkable results in international blind competitions. In addition, this approach is highly parallel and can take advantage of the supercomputer facilities at BSC. The results will be contributed altruistically in the current EXSCALATE4CoronaVirus consortia of which BSC is part, and also to the scientific community as a whole.



A multidisciplinary team coordinated by David E. Singh of University Carlos III in Madrid and in cooperation with the BSC and the National Centre for Epidemiology in Spain has developed a simulation tool for the influenza and SARS-CoV-2 viruses which, unlike most models, is able to account for individuals within a population. This permits the evaluation of different enforcement policies such as working from home, school closures, and restrictions on transport. More information about the project can be found at <https://www.arcos.inf.uc3m.es/epigraph>, which will be regularly updated with the results of the simulation. At present, the simulator has been validated for influenza, taking into account different real-life scenarios. They have now extended this tool to SARS-CoV-2. They also are actively collaborating with researchers in Wuhan, who are planning to provide data to calibrate and validate the simulator. The team is currently developing larger simulations for Spain and Europe, as well as refining the accuracy of the tool.

At the BSC, the Life Sciences Department is collaborating with other groups at the center, as well as other research centers around Europe, to find a biomedical solution in the fight against COVID-19. The Department of Operations is facilitating access to Mare Nostrum 4 resources not only for their researchers, but also for the entire scientific community working to resolve the situation. Mateo Valero states that "circumstances such as the ones we now face serve as testaments to the value of science in tackling societal challenges."

Finally, Cristina Silvano of Politecnico di Milano has provided a detailed account of her work in the battle against COVID-19 in the context of the Exscalate4CoV project in a conversation, also published in this issue.

These initiatives, along with others around the globe, will ensure victory in the battle against the SARS-CoV-2 virus. We must remain united and strong throughout, for we will only defeat it together.

From Cyber-Physical Systems to the Web of Things

Cyber-Physical Systems (CPS) and the associated technologies enable the control of physical actuator and sensor devices, where the control applications can run over networked architectures. This allows what is called the separation of concerns where the physical device that is close to the physical process can contain less higher-level control logic and the logic can be moved to other devices further away that have more configurability, more physical space, fewer constraints, etc., which decreases maintenance costs and gives more flexibility.

When connecting such devices to a network in the context of the Internet of Things (IoT), the existing and constantly expanding variety of network solutions results in a crowded solution space, making it difficult to choose one for the system designers. Furthermore, even after choosing a solution, new devices that cannot support this solution due to their own requirements are either not considered or require significant integration effort. The Thing Description (TD)^[1] standard was published in January 2020 after years of work by industry and academia, united under the World Wide Web Consortium (W3C) to enable what we call the Web of Things (WoT).

TD allows the description of concrete device endpoints to be used in an application and is designed to be flexible from the ground up. It can describe any protocol that supports a protocol scheme, different security mechanisms supported by the device and data structures

that are transmitted between the device and the control application. In addition to the device description, it allows programming of application logic independent from the protocol. The Scripting API standard^[2] and its corresponding implementations^[3,4,5] make it possible to write the application logic and transfer it between implementations or protocol stacks. Moreover, the now-common paradigm of integrating sensor data into the cloud or edge becomes independent from a specific solution provider where TDs can describe the devices that are on the cloud or on the local network.

As a side effect, TD also reduces the tooling effort and makes it easier to perform conformance testing^[6] or device simulation with reduced effort^[7]. Additionally, it can be used to abstract the device development, where programming language or libraries used to develop the device can be abstracted via TDs.

We invite you to the official homepage of the W3C Working Group^[8] that gives insights to the different use cases of WoT, as well as wotify.org^[9] that contains implementations for different sensors and actuators on different platforms.

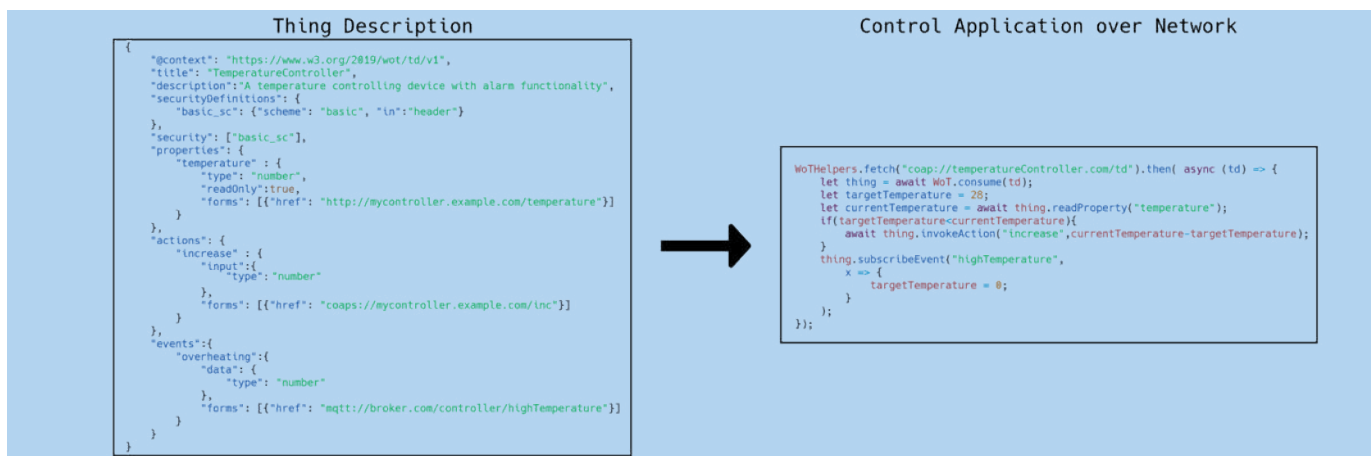
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Author: Ege Korkan



Transparency and co-responsibility: Preparations for a Key Digital Technologies partnership

ECSEL, the Joint Undertaking (JU) on Electronic Components and Systems (ECS), will launch its final calls for proposals in 2020. As a result, the presidents of the three industry associations – ARTEMIS-IA, AENEAS and EPoSS – used EFECTS 2019 as an opportunity to deliver a ‘Joint statement on preparations for a partnership on key digital technologies’. This covers ECSEL’s successes, recent geopolitical and technological developments, a European Partnership for Key Digital Technologies and envisioned improvements. ARTEMIS President and Chair of the Private Members Board, Jean-Luc di Paola-Galloni, delves deeper into what this all means.

One clear voice from the beneficiaries of ECSEL

“What I want to say, in the name of the three Associations, is that ECSEL has delivered,” begins Jean-Luc, quoting the opening section of the joint statement. “Clearly, we have done a lot in improving collaboration on ECS, maintaining competitiveness, driving innovativeness and scientific excellence and contributing to addressing European societal challenges. As listed and unlisted companies, we are all worldwide leaders.” This is more than just a pat on the back – those four areas of impact have all been proven by the preliminary results of the ECSEL impact assessment.

“However,” Jean-Luc continues, “we need to have a wider scope from the proposal. I couldn’t agree more that we need to double the budget of ECSEL. Sectors of the economy are multiplying their R&D budgets three, four, five times. I belong to a company which is the number one patent depository in its country (*Valeo, one of France’s biggest automotive suppliers*) and we dedicate more than 11% gross of our turnover to R&D. I also want to salute Finland, which is the best in class in Europe for dedicating 4% of GDP to R&D. Private members are making the biggest efforts, so we don’t have to be ashamed to ask for a bigger budget. On the other hand, I do



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hear the Commission and the public when they ask us to speak with one voice. That is what we’re trying to do.”

Ethics should reinforce the spirit of innovation

The world’s geopolitical situation was a driving force behind the European Partnership, as the pushback against global trade increasingly hampers European access to Key Digital Technologies (KDT). At the same time, other parts of the world have rapidly increased their R&D investments and threaten to create an insurmountable lead in fields such as Artificial Intelligence (AI). As Jean-Luc notes, there is also a conscientious element to this.

“In China, for example, we know that a lot of data-related technologies can be used for the control of social credit. If you misbehave, data is going to control you as a citizen or company. In America, the regulators have given too much freedom to the digital platforms and the new players to do whatever they want. We are in-between. In Europe, with the arrival of GDPR, there is a cultural, ethical and juridical spirit on how to use data.”

“We need to collaborate with fair rules when other areas of the world are imposing theirs. If we disagree, we need to be strong and clear. We need to see where our value chain lies as European actors. Semiconductors and Tier 1 automotive suppliers, for instance, were able to provide European technologies that we can sell to final users as solutions systems in other worldwide markets. That’s where the value chain is strong and that’s what we need to protect.”

He refers back to the keynote speech by Khalil Rouhana of the European Commission, who reminded EFECTS of the need to protect Europe’s inclusiveness while also focusing on environmental aspects. “For sure, sustainability is important: we need to make sure that the huge development of digital is not going to harm the environment, such as through the electricity consumption that data centres and clouds could create. I couldn’t be happier as this is one of the parameters in my operational duties.”

Written by ARTEMIS-IA

MEMTONOMY: Research project on memory issues in autonomous driving

Fraunhofer aims to close research gap with the participation of Bosch and TU Kaiserslautern

Heterogeneous multi-core architectures enhanced by custom accelerator cores are widely used today in many embedded applications. These types of computer platforms, which were originally developed for consumer applications, are now entering safety-critical applications, especially in the automotive domain, where autonomous driving is currently disrupting conventional automotive electronics development. The immense computing power of such architectures brings additional great challenges. The increasing gap between the speed of these heterogeneous multi-core architectures and accesses to the main memories poses a severe limit.

The dominant type of main memories are Dynamic Random Access Memories (DRAMs), which offer the best trade-off between storage density and access times. Algorithms for Advanced Driver Assistance Systems (ADAS) and Autonomous Driving (AD) in automotive require low latency and huge external memory bandwidth. Thus, memory bandwidth becomes one of the big bottlenecks. In recent years, many new DRAM memory devices have been presented (e.g., DDR4, LPDDR4, GDDR6, Wide I/O, HMB2). It is not yet clear, however, how to use these memory modules and how they will perform in the automotive context with respect to bandwidth, latency, power, temperature, reliability, safety, and security.

To date, scientific DRAM research has mainly focused on mobile devices and data centres. These applications have totally different profiles compared to the safety-critical automotive domain. Thus, there is great need to close this research gap by transferring basic research into industry, considering automotive application requirements. To the best of our knowledge, there are no investigations or publications that optimize the DRAM memory subsystem with respect to future automotive applications.

MEMTONOMY is a trilateral transfer project that further develops the results of basic research at the Technical University of Kaiserslautern towards applicability for the automotive industry. Fraunhofer IESE will support and coordinate this transfer with their strong background in safety for automotive and embedded systems. The application partner Bosch, one of the major automotive suppliers, will provide detailed application know-how, requirements, and concrete research challenges from an industry perspective. The MEMTONOMY project is funded by the German Research Foundation (DFG) and the Fraunhofer-Gesellschaft.

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Dates for your diary

PUMPS+AI 2020 Summer School

Cancelled due to COVID-19

5-10 July 2020, Barcelona, Spain

<https://pumps.bsc.es>

FNC 2020: Future Networks and Communications

9-12 August 2020, Leuven, Belgium

cs-conferences.acadiau.ca/fnc-20/#workshop_call

Embedded Systems Week

11-16 October 2020, Shanghai, China

esweek.org

EF ECS 2020: The European Forum for Electronic Components and Systems

24-26 November 2020, Berlin, Germany

<https://www.ecsel.eu/>

53rd IEEE/ACM International Symposium on Microarchitecture (MICRO-53)

17-21 October 2020, Athens, Greece

<http://www.microarch.org/micro53/>

ICT 2020 - Leading the Digital Age

1-3 December 2020, Cologne, Germany

<https://ec.europa.eu/digital-single-market/en/news/ict-2020-exhibitors-guide>

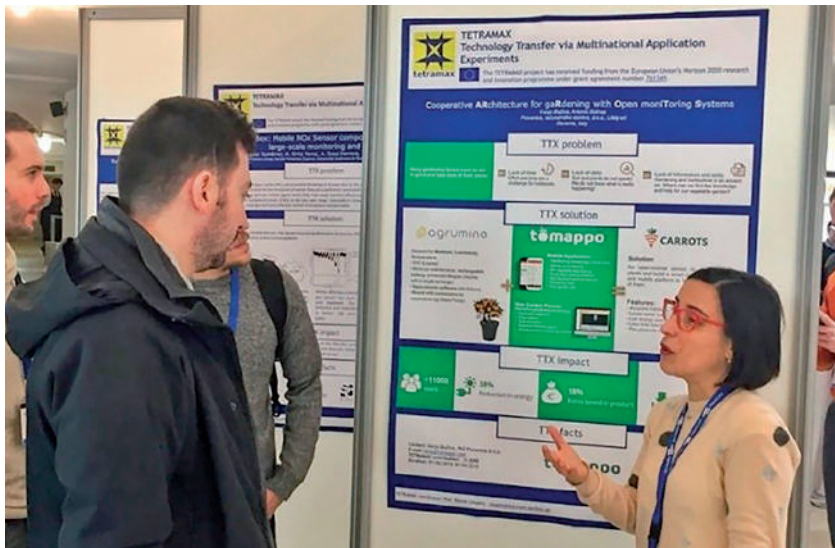
Save the date:

EF ECS 2020:

The European Forum for Electronic Components and Systems

EF ECS is the international forum with a focus on 'Our Digital Future' along the Electronic Components and Systems value chain in Europe. The organisers of this event, AENEAS, ARTEMIS-IA, EPoSS, ECSEL Joint Undertaking and the European Commission, in association with EUREKA, have joined forces to bring all stakeholders together on 24-26 November 2020 in Berlin.

EF ECS provides numerous opportunities to learn more about the latest developments, cooperation and funding possibilities in the ECS Community.



TETRAMAX organized its first poster session at the HiPEAC2020 conference!

TETRAMAX (Technology Transfer via Multinational Application Experiments), a Horizon 2020 innovation action, brings added value to European industry through faster digitization in the domain of customised and low-energy computing for Cyber-Physical Systems (CPS) and the Internet of Things (IoT). For this goal, TETRAMAX has so far supported 27 technology transfer experiments (TTX) to bring their own products to the market, and still more will be supported this year!

During Industry Day of the HiPEAC2020 conference, all TTX from different European Union (EU) countries presented their experience and impact on the industry. Each TTX poster, a product of the collaboration of a technology provider and a receiver (e.g. manufacturing company), captured the attention of many attendees.

During the conference's social dinner, the first TETRAMAX technology transfer award was handed over to TTX Carrots for their outstanding innovative technology transfer and its impact on the market. TTX Carrots improved the existing digital gardening solutions for end-users with Lify's advanced sensors and Tomappo's social app. Prof. Rainer Leupers, as the TETRAMAX coordinator, handed out the award to Katuscia Zedda from Lify, who represented the Carrots team.

Please visit www.tetramax.eu for more information – especially if you'd like to be part of the next technology transfer experiment!



TETRAMAX launches investor portal for start-ups and scale-ups

A core activity of the TETRAMAX Innovation Action is the co-funding and coaching of approximately 27 technology transfer experiments (TTX) in the domain of customized and low-energy computing. TTX exist in different flavors, a typical one being focused technology transfers from academia to industry within a mini-consortium of two partners. Those "bilateral TTX" often address innovative products or industrial processes for very specific markets. However, a certain fraction of the TTX portfolio results in completely new and highly scalable business cases thanks to the testbed supported by TETRAMAX. Similar opportunities also arise from "entrepreneurial TTX", which provide very early seed funding for academic spin-off teams before formal incorporation of a company.

As a result, numerous TTX clients become investor-ready for the first time, or are even already looking for larger funding rounds to finance further growth. In response to various requests, TETRAMAX now also supports the community in this stage via a new, investor-centric WWW landing page. Its design is inspired by interviews conducted with various venture capital (VC) firms to ensure that exactly their needs are reflected. In particular, all relevant initial information, such as market sector, location, and LinkedIn profiles of key team members, is concisely available at-a-glance.

You can check out the new portal at <https://www.tetramax.eu/startups>. It is not restricted to the TETRAMAX nor the HiPEAC community. Any European ICT start-up or scale-up company is invited to post its brief profile and desired funding type. Interested VCs or strategic investors will scan the offerings and contact the corresponding key people individually and confidentially. In case of questions, please contact us at investors@tetramax.eu.

Rainer Leupers
TETRAMAX Project Coordinator

EuroLab4HPC updates its Long-Term Vision for High-Performance Computing

New technologies and applications are leading to radical changes across the whole high-performance computing stack, from applications and software systems through to new hardware architectures and down to the enabling technologies. It is an exciting time for high-performance computing, and all researchers must be aware of the changing context if they wish their work to be relevant over the new decade.

In March 2020, with the aim of fostering European academic excellence in HPC, the EuroLab4HPC project released its 2020 update of the “EuroLab-4-HPC Long-Term Vision on High-Performance Computing”. This document surveys the new hardware/software technologies for the post-exascale period 2023 to 2030, identifying the main research challenges and open questions.

The end of complementary metal–oxide–semiconductor (CMOS) scaling is driving an explosion in new technologies. Whichever technologies eventually triumph, there is a trend towards more complex systems, with

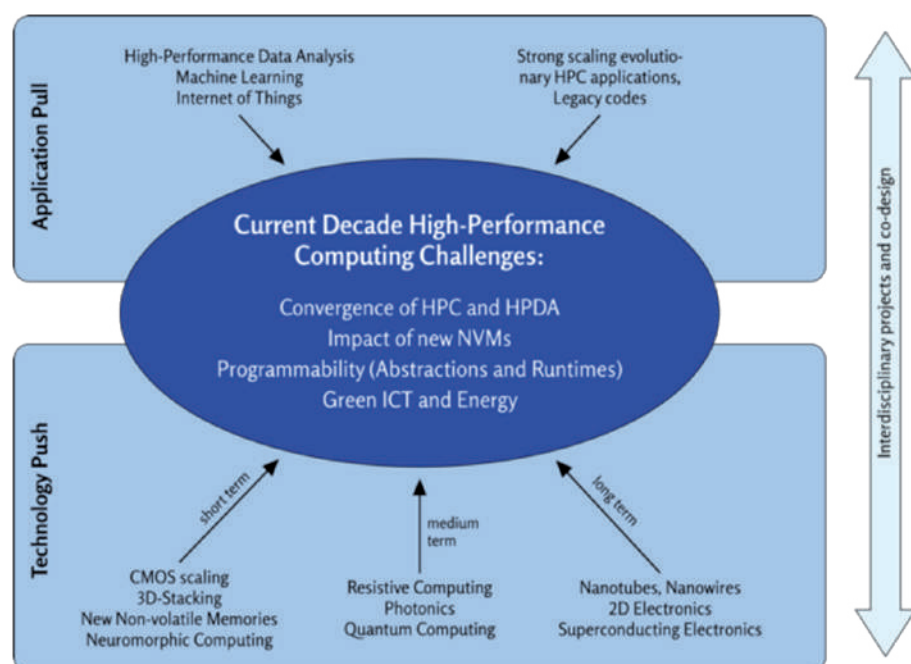
system architectures including heterogeneous accelerators, in- and near-memory computing and storage-class memories, and new underlying technologies such as photonics, graphene, resistive computing, and quantum computing. Much more is needed, of course, than the basic technologies. In order to build a real, scalable quantum computer, for instance, it will be necessary to develop a full stack, as for classical computers, encompassing high-level languages, compilers, microarchitectures and, until large numbers of physical qubits are possible, simulators.

The Von Neumann architecture has served as the execution model for more than five decades. But energy consumption and demands for more and more memory bandwidth mean that the distance between memory and processing must be reduced. Research on in-memory and near-memory computing is in an early stage, and various approaches are being investigated. The document summarises the key challenges in materials for new kinds of in-memory computing, as well as architectures, compilers and tools.

Hiding or mitigating complex, heterogeneous and diverse hardware will require single-source programming models coupled with intelligence across the whole programming environment. Manual optimization of data layout, placement, and caching in highly complex software will become uneconomic and time-consuming, and will, in any case, exceed the abilities of the best human programmers. Performance tools to diagnose performance bottlenecks or spot anomalous behaviour, and map back to the source code, will need techniques from data mining, clustering and structure detection. Nevertheless, with scientific codebases having very long lifetimes, on the order of decades, today’s abstractions will continue to evolve incrementally well beyond 2030.

The document discusses many other important topics, such as the convergence of HPC and cloud computing, the impact of heterogeneous accelerator interfaces (CCIX, Gen-Z, CAPI, etc.), and the integration of network and storage.

To learn about these technologies and the main research challenges and open questions, download and read the EuroLab-4-HPC Long-Term Vision on High-Performance Computing from the EuroLab-4-HPC website at www.eurolab4hpc.eu.



“Around the corner” with Eduardo Quiñones: on smart transport and cities



CLASS and ELASTIC

When Cyber meets Physical

When software responds to its surroundings, Cyber-Physical Systems (CPS) are formed. While most of society is both unfamiliar with this term and the frequency with which we increasingly rely on such systems in our everyday lives, they nevertheless play important roles in the development of smart transport and cities. In an interview with Eudardo Quiñones, he describes two great examples of the application of techniques from the High-Performance Computing (HPC) arena to CPS.

How are new technologies transforming transportation in cities, whether connected cars or public transport?

To begin, I'd like to give a brief overview of the projects (CLASS and ELASTIC), as well as point to their main objectives. Data generated within the city that connects a lot of information from different installments around the city, e.g. cameras, could be fused with data collected by sensors from cars, buses or trams in order to better understand what is happening within the city at any given time. At the moment, most of the data goes to a centralized place upon which data analytics are applied. What these two projects aim to do is look for a more distributed solution to leverage benefits from the edge and the cloud computing paradigms into a unified framework in which computation is distributed across the compute continuum, depending on the system requirements: it will occur as close as possible to the data sources on the edge,

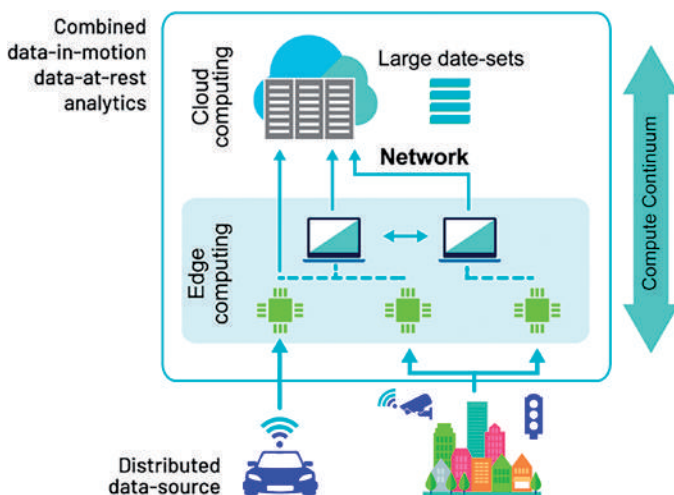
when requiring to quickly reach (in real-time) a service requested by, e.g., a vehicle, or it will occur in powerful data-centers on the cloud, when requiring more computing power with soft timing constraints.

Because the data is processed right next to the data source, the amount of information that is transferred through networks is much smaller due to the extraction of relevant data. This clearly benefits the privacy of citizens, as personal data can be discarded. For example, the city can extract only the speed and direction of vehicles at the edge and transfer it, discarding information related to people and cars, which might result in a privacy threat if the communication were hacked.

To do this, the CLASS and ELASTIC projects are investigating potential software architecture capable of programming this distributed environment in the simplest way possible, so people who are developing mobility solutions in such scenarios can easily do so without having to have knowledge about the underlying computing and communication. All of this is extracted so that the programmer just needs to focus on the functionality.

Specifically, what tangible benefits will CLASS and ELASTIC deliver for transportation in cities like Modena and Florence?

This is about having access to knowledge at the right time. If the city is capable of having a deep understanding about what is going on within its limits, down to the granularity of a single car, then it can implement more “intelligent” traffic management solutions that rely on real-time knowledge. More specifically, in the case of the CLASS project, we are implementing the use case “looking behind a corner” (also known as “virtual mirror”): a car has a view that is limited (it cannot see behind a building, for example). But the city, as well as other cars in the vicinity, can. Our objective is to enlarge the sensing capabilities of the car by incorporating information from both the city and the other surrounding cars so rather than having a view of let's say 100 metres, it can have a much wider view, even beyond the buildings and other obstacles, and in having this, prevent accidents, such as a car running a red light. Moreover, we are investigating how this information can be exploited by the system to provide real-time predictions and solutions. For example, we are focusing on the prediction of the pollution levels at the granularity of a single car, so we can know if there is a street that is very congested, and



“We are developing a distributed computing framework that leverages the benefits of the edge and the cloud computing paradigms so the knowledge generated from the city and the vehicles’ data sources can be fused and quickly provided to various actors.”

try to re-direct traffic, especially if it is close to a school or a park. In ELASTIC, we are trying to do the same at a public transport level. For example, we aim to alert a tram to when a car is trying to cross the tracks, or when it is approaching a crowded platform.

What are the main innovations introduced by CLASS and ELASTIC? What have the main technical challenges been?

The key innovation that we are focusing on in these two projects is addressing what we call non-functional requirements that have been inherited due to cyber-physical interactions. A car, a tram and a city are Cyber-Physical Systems. This means that the systems are getting information from sensors (the physical part) that is then analyzed (the cyber part) and then either providing knowledge or acting accordingly; hence, Cyber-Physical Systems. For this, real-time requirements are necessary to quickly react to physical events. In the case of CLASS, if we want to identify and prevent a potential car accident by sending this information to a car, it needs to be done in real-time, because even a one-second delay can mean crashing or not. This is what we call a non-functional requirement. These are requirements of the system that are unrelated to its functionality, but are related to its correct operation. Another non-functional requirement is energy: one doesn't want to install a supercomputer at every street corner to analyze the surroundings. Traditionally, these requirements are addressed at the embedded level to guarantee the correct operation in the automotive domain and in the avionics domain, but not that much in distributed and cloud systems, in which non-functional requirements are not fundamental to the correct operation of the system. CLASS and ELASTIC aim to provide guarantees on the fulfillment of non-functional requirements for distributed cyber-physical systems, such as those existing in smart cities.

The biggest main technical challenge is the trade-off between where the data analytics are processed and the time that it takes to send the data to the corresponding computing nodes. The further one is from data sources, the more computing power one



“The key innovation of these two projects is to account for non-functional requirements so one can implement mobility systems with real-time requirements.”

has. The Cloud has a lot of computing power, but one is paying the penalty of sending data to the Cloud, and it is difficult to guarantee real-time interactions. On the other hand, if you move the computing element close to these data sources, there is no communication delay at all, but the computing capabilities are significantly diminished, so one is unable to extract that fine grain knowledge of data one is collecting. So, how does one distribute one's analysis across the compute continuum, such that the latency of communication is reduced as much as possible while still having the computing power one needs to implement one's analysis and guarantee the real-time requirements of the system? This is addressed in the CLASS and ELASTIC project, in which the system is capable of distributing computation based on the necessities of one's data analytics, which could have an impact on real-time guarantees.

What are potential unintended consequences of these technologies?

The technologies still aren't mature enough, especially from a safety and security point of view, which are key elements to complete implementation. Safety is a term that refers to the guarantee of the system not to damage people (or equipment), which means that the system needs to operate correctly in response to its inputs, e.g., a car must brake when the brake pedal is pushed. Security is the other way around: it is the guarantee that no human adversely affects the system. Of course, one is related to the other. If one damages the system, it can then adversely affect people. We need to guarantee that the system is safe and secure by construction, and we still have a long way to go. For example, it is important to make sure that no one can hack a city's system and provide wrong information to vehicles that could affect the safety of the cars.

What are the project's main achievements so far? What results do you expect in the future?

In the case of CLASS, which is two years in the making, the entire software stack has almost been finished, so all of the components that are needed to provide this function have already been integrated, and as soon as the COVID-19 situation is resolved, we plan to test this with real vehicles in the city of Modena. We expect the cars we use to have the data they need on time. In the case of ELASTIC, which is one year in the making, we will try to integrate all of the software components we are developing for it so that we provide all expected functionalities; it is still work in progress.



Industry focus

From the automotive to the avionic to the healthcare sector, Cyber-Physical Systems (CPS) are revolutionizing the ways in which we interact with our environment. For a more detailed look at how two of these technologies are changing healthcare for the better, read more:

An Engine for Health Care Innovation

Authors: **Ramona Marfievici** (Digital Catapult), **John Farserotu** (CSEM), **Marcello Coppola** (STMicroelectronics), **Ana Gheorghe** (Digital Catapult), **Isabelle Dor** (CEA)

Cyber-Physical Systems (CPS) pose to revolutionize the healthcare provision with advances in sensing technology and microelectronics. This is especially important as our health systems are challenged by increasing chronic illness. The long-term sustainability of healthcare can be improved by the early detection of medical conditions to enable cost-effective and personalized treatment. Moreover, the feasibility for patients to collect and share relevant data at any time, and not just when they happen to visit a clinic, allows for a more rapid convergence of optimal treatment.

To realize this vision, Althexis Solutions Ltd from Cyprus and Protolab srl from Italy turned to the European Union-funded innovation action FED4SAE to support their application experiments.

First, SpectroX, a digital dermoscopy system for instant (snapshot or single-shot) evaluation of underlying skin conditions, with special emphasis on the early detection of melanoma was built. SpectroX exploits multispectral imaging technology with advanced image processing tasks and machine learning for

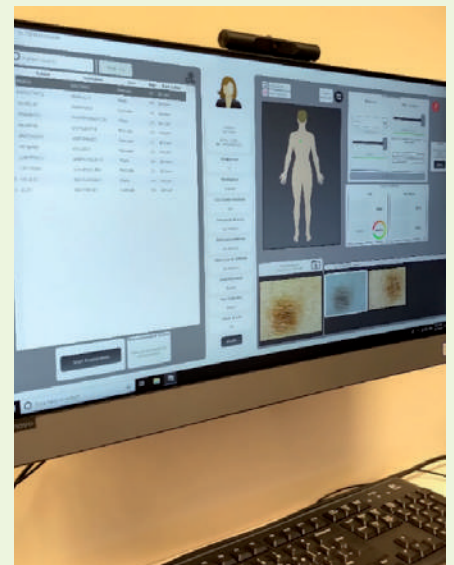
automated predictions. The use of a multispectral camera enables the capture of rich information, both in and under the skin, beyond the capabilities of the human eye and the current state of the art systems.

The prototype system consists of a multispectral camera from the Swiss Centre for Electronics and Microtechnology (CSEM), Intel's OpenVINO deep learning development toolkit, and Althexis proprietary software, i.e., image processing and deep learning algorithms and a touch-enabled, easy-to-use, user interface. A back-end cloud infrastructure is used for centralized and seamless data aggregation for automatic model retraining and deployment. Anonymization and end-to-end encryption is implemented for local and cloud storage.

The image processing module has already been evaluated for different skin types, mole sizes, and lighting conditions. Mole segmentation and morphological feature extraction was successful in 51 out of 56 hypercubes. The mole state prediction algorithm has an 89% accuracy rate for 13K RGB images from open datasets. Data collection is ongoing, and the training and evaluation of the multispectral learning algorithms follow. SpectroX is operational, and utilized in two private clinics and a university hospital in Greece.

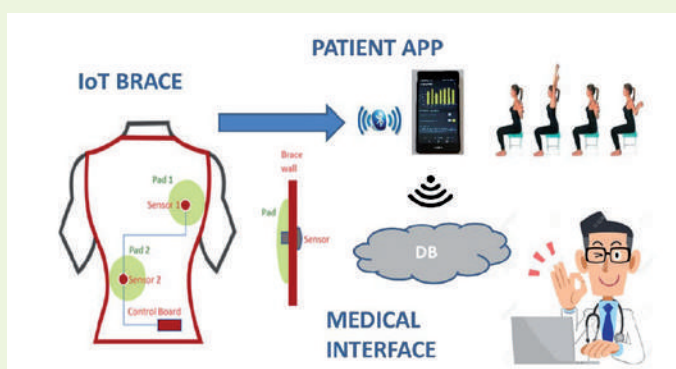


SpectroX





The latter developed EMBrace, a plug and play smart wearable sensor kit for the monitoring of scoliosis treatment braces. EMBrace has a sensor unit, a mobile application for patients, a web-based GUI for clinicians, and a backend database. The sensor unit quantitatively assesses the corrective forces acting inside the braces, as well as the time worn. It uses two force sensor units and a control and communication board with a Bluetooth Low Energy (BLE) radio. The board is equipped with a Micro USB type B interface for battery recharging and programming/debugging tasks. Two modes are supported: monitor wearing and patient. In monitor wearing, data acquisition from sensors is performed. The radio is in sleep mode to save battery. Data is locally stored on a dedicated SD card. In patient, the radio wakes up and initiates BLE advertising. A point-to-point connection is established, with a phone running the mobile application. This connection enables data offloading and real-time check fitting during the dressing phase. The synchronization with the backend database is done through the mobile application, and the battery level can be queried. The web-based application is used by clinicians for visualisation, analysis and feedback.



EMBrace

A prototype using the STM32WB55 Nucleo Pack from STMicroelectronics was developed. It has a dedicated ARM 32-bit Cortex M0+ CPU for real-time radio layer and a 2.4 GHz RF transceiver supporting BLE v5.0. The prototype was tested under realistic conditions in the Products & Technologies Living-Lab (PTL) of IRT Nanoelec at CEA-Leti in Grenoble. The next step is to develop and test the miniaturized and integrated solution in the same realistic environment. Protolab aims to enter the market by end of 2020, its customers being the manufacturers of the braces.

FED4SAE is a three-year innovation action with a budget of €7.6million, which started in 2017. Its partners are the French Alternative Energies and Atomic Energy Commission (CEA), Intel, STMicroelectronics, Thales, AVL, Digital Catapult, Fraunhofer, fortiss, the Swiss Center for Electronics and Microtechnology (CSEM), Stockholm Royal Institute of Technology (KTH), Budapest University of Technology and Economics (BME), University of Cantabria, and Blumorpho.



European technologies for a better-integrated world

Innovation Europe

A DEEPER LOOK INTO THE SYSTEM MADE POSSIBLE BY COEMS

Decades have passed since the times you could find a bug in your system as a small insect between your relays. But of course, it is necessary to know what is happening inside the system, whether everything is working properly, and whether you get the results you expect. Today you have to create a tool which allows this insight. An interesting point in that context is the question of what happens to the system and the way it does its job while you observe it. Is it affected? Does it lose speed?

This is where COEMS comes into play. What sounds like a matter of course is truly a world innovation. COEMS allows to check correct and safe behavior of a system without influencing it. This is of absolute necessity for safety critical fields such as those in aviation or medical devices. While thinking about the future of the project's result, you may get the idea it could become nothing less than an invisible life guard.



Within the last three years, a consortium of six international partners has been developing the COEMS solution, which was made possible with European Union (EU) support. The consortium consists of the Bavarian start-up Accemic Technologies, which primarily has been developing the hardware platform and the universities of Lübeck, Germany and Bergen, Norway, as well as the industrial partners Airbus Germany, Thales Romania and Thales Austria.

The variety of COEMS does not only imply theoretical consideration and fundamental research. During the development phase the results were directly discussed and verified with industrial partners. Thus, it is warranted that the development meets practical requirements.

By the end of April, the project will be completed after an intensive period of fruitful collaboration across state borders and institutions, but the technical solution will continue to go on.

www.coems.eu

ADMORPH: TOWARDS ADAPTIVELY MORPHING EMBEDDED SYSTEMS

The domain of Cyber-Physical Systems (CPS) is one of the largest information-technology sectors worldwide and a driver for innovation in many other crucial industrial sectors such as health industries, industrial automation, avionics and space. The embedded computer systems in these physically-entangled CPS increasingly rely on complex system architectures. Oftentimes these architectures are heterogeneous multi-core or many-core systems, which are distributed and connected via complex networks. Highly distributed and networked systems entrusted with the control of physical assets are called Cyber-Physical Systems of Systems (CPSoS).

Designers of these CPS(oS) face several daunting challenges as these systems have to meet a range of stringent extra-functional design requirements in terms of e.g. real-time performance and energy efficiency. Mission- and safety-critical CPS(oS), like those in the avionics and space domains, usually also demand ultra-high levels of dependability. This is becoming even more important as the levels of system autonomy rise. With advanced levels of autonomy, more and more systems that were traditionally not considered safety-critical now become safety-critical. Furthermore, as mission- and safety-critical CPS(oS) become increasingly connected, they receive more and more attention from attackers, which may also render these systems unreliable and unavailable and thus potentially cause dangerous situations. To provide a high degree of reliability, availability, and safety, mission- and safety-critical CPS(oS) need to be able to cope with various disruptive events, which could be related to hardware component failures or cyber-attacks aimed at disrupting the system or worse, attacks compromising software components with the goal of taking over critical system functionality.

System adaptivity, foremost in terms of dynamically remapping of application components to processing cores, represents a promising technique to fuse fault- and intrusion tolerance with the increasing performance requirements of these mission-

and safety-critical CPS(oS). In the ADMORPH project, we evaluate this hypothesis using a novel, holistic approach to the specification, design, analysis and runtime deployment of adaptive, i.e., dynamically morphing, mission- and safety-critical CPS(oS) that are robust against both component failures and cyber-attacks. To this end, we will address four aspects that are instrumental for the realization of these adaptively morphing systems: (i) the formal specification of adaptive systems, e.g. by means of a coordination language to specify system requirements and adaptivity strategies; (ii) adaptivity methods like strategies for maintaining safe and secure control of CPS(oS); (iii) analysis techniques for adaptive systems to e.g. perform timing verification of adaptive systems to avoid timing violations after system reconfigurations; and (iv) run-time systems for adaptive systems that realize the actual run-time system reconfigurations to achieve fault and intrusion tolerance. The developed technology will be evaluated using three industrial use cases taken from the radar surveillance systems, autonomous operations for aircrafts, and transport management systems domains.

FUNDED UNDER: H2020-EU.2.1.1, Grant agreement ID: 871259

START/END DATE: 1 January 2020 – 31 December 2022

KEY THEMES: Cyber-Physical Systems (of Systems), Fault-tolerance, Intrusion-tolerance, Adaptive systems, Mission- and safety-critical systems, Run-time systems, Analysis of adaptive systems

PARTNERS: University of Amsterdam (NL, Coordinator), Thales Nederland B.V. (NL), SYSGO S.A.S. (FR), University of Luxembourg (LU), Lund University (SE), United Technologies Research Centre Ireland (IE), Q-Media (CZ), FCIENCIAS.ID (PT), University of Augsburg (DE)

BUDGET: €4.499.468

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Pictures from the kickoff meeting 29 & 30 January 2020

AITIA: EMBEDDED AI TECHNIQUES FOR INDUSTRIAL APPLICATIONS

New achievements in Artificial Intelligence (AI) and Machine Learning (ML) are reported almost daily by the big companies. While those achievements are accomplished by fast and massive data processing techniques, the potential of embedded ML, where intelligent algorithms run in resource-constrained devices rather than in the cloud, is still not understood well by the majority of the industrial players and Small and Medium Enterprises (SMEs). Nevertheless, the potential of embedded ML for processing high-performance algorithms without relying on expensive cloud solutions is perceived as very high. This potential has led to a broad demand by industry and SMEs for a practical and application-oriented feasibility study, which helps them to understand the potential benefits, but also the limitations, of embedded AI. In general, the realization on embedded systems such as Field-Programmable Gate Arrays (FPGAs) is, therefore, a crucial challenge for SMEs.

On the other hand, the question of where specific algorithms are realized, at the embedded device or in the cloud, is under discussion in several fields of applications. For instance, FPGA vendors now support the so-called edge computing approach where algorithms are realized on FPGA-based System-on-Chips (SoCs). In addition, some also support the high-performance FPGA-based cloud system with Amazon. Both realization alternatives have their pros and cons and need to be analyzed according to the respective application domain.

To address these needs, the AITIA project aims at developing and demonstrating best practices for embedded AI by means of four industrial case studies of high-relevance for European industry and SMEs: sensors, security, automotive and industry 4.0.

- Embedded Security: Network intrusion detection systems based on AI algorithms
- Smart Sensing: Improving sensor accuracy by AI and detecting sensor-anomalies by AI
- Automotive and Mobile Robots: Machine Vision for Mobile Systems
- Industry 4.0: Machine Learning for Predictive Maintenance

The technological challenges which we will tackle are related to:

- The use of FPGAs as accelerators for embedded AI, bit-width optimizations, soft processors versus dedicated processors versus hard embedded processors, dynamic reconfiguration techniques, frameworks for FPGA AI code generation
- Certifiability of embedded AI techniques
- Safety aspects of AI in machines and smart objects

NAME: AITIA - Embedded AI Techniques for Industrial Applications

START/END DATE: 01/10/2019 - 30/09/2021

KEY THEMES: artificial intelligence (AI), machine learning (ML), embedded systems, field-programmable gate arrays (FPGAs), sensors, security, automotive, industry 4.0

COORDINATOR: Abdellah Touhafi, Vrije Universiteit Brussel, Belgium
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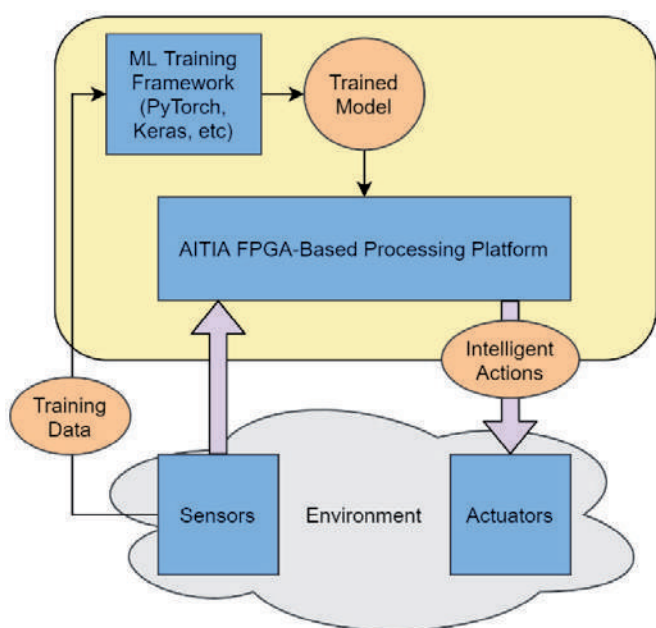
PARTNERS: Belgium: Vrije Universiteit Brussel (VUB), Katholieke Universiteit Leuven (KU Leuven); Germany: Technische Universität Dresden (TU Dresden), Brandenburgische Technische Universität (B-TU), Gesellschaft zur Förderung angewandter Informatik (GfAI)

BUDGET: €856,748

AITIAproject.eu

This work is part of the COLlective REsearch NETworking (CORNET) project AITIA: Embedded AI Techniques for Industrial Applications.

The Belgian partners are funded by VLAIO under grant number HBC.2018.0491, while the German partners are funded by the BMWi (Federal Ministry for Economic Affairs and Energy) under IGF-Project Number 249 EBG.



Overview of the AITIA Framework



SELENE: SELF-MONITORED DEPENDABLE PLATFORM FOR HIGH-PERFORMANCE SAFETY-CRITICAL SYSTEMS

Existing hardware/software (HW/SW) platforms for safety-critical systems suffer from limited performance and/or lack of flexibility due to the building on of specific proprietary components, which jeopardize their wide deployment across domains. While some research attempts have been made to overcome some of these limitations, their degree of success has been low due to missing flexibility and extensibility, which would ensure that industry can take that path, as many industries need technologies on which they can rely over the course of decades (e.g. avionics, space, automotive).

A number of high-performance computing (HPC) commercial off-the-shelf (COTS) platforms offer the computation capabilities needed by autonomous systems in domains such as automotive, space, avionics, robotics and factory automation by means of multicores, graphics processing units (GPUs) and other accelerators. Unfortunately, the utilization of HPC platforms has been traditionally considered out of the reach of the safety critical systems industry due to the difficulties or roadblocks these platforms bring to the certification process.

SELENE aims to cover this gap by proposing a new family of safety-critical computing platforms that builds upon open source components such as RISC-V cores, GNU/Linux, and Jailhouse hypervisor. SELENE will develop an advanced computing platform that is able to: (1) adapt the system to the specific requirements of different application domains, to the changing environmental conditions, and to the internal conditions of the system itself, (2) allow the integration of applications of different criticalities and performance demands in the same platform, guaranteeing functional and temporal isolation properties, (3) achieve flexible diverse redundancy by exploiting the inherent redundant capabilities of the multicore,

and (4) execute in an efficient way compute intensive applications by means of specific accelerators.

The SELENE project is coordinated by Universitat Politècnica de València (UPV) and involves eleven partners in total. UPV, Cobham Gaisler, Barcelona Supercomputing Center (BSC), and SIEMENS (Austria) as hardware technology providers and SIEMENS (Germany), OpenTech, and Ikerlan as software providers and safety experts. Finally, the SELENE platform will be demonstrated with four different use-cases: an autonomous robot from Virtual Vehicles, an autonomous train from CAF Signalling, and two space use-cases covering satellites and deep space stations from Airbus Defence and Space, France and Germany, respectively.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871467.

NAME: SELENE: Self-monitored Dependable platform for High-Performance Safety-Critical Systems

START/END DATE: 01/12/2019 - 30/11/2022

KEY THEMES: Safety critical systems, Open-source computing, RISC-V, Linux.

PARTNERS: UPV, BSC, Ikerlan, OpenTech, SIEMENS (Austria and Germany), Virtual Vehicles, CAF signalling, and Airbus Defence and Space (France and Germany).

BUDGET: €4, 996, 526,25

[@H2020Selene](#)

SELENE



AN OPEN PLATFORM FOR DEPENDABLE COMPUTING

Nicholas McGuire (OpenTech) and Carles Hernandez (Universitat Politècnica de València) on the SELENE project (page 23).

The limited performance of proprietary HW/SW platforms for safety-critical systems limits their capabilities in achieving the expected increased autonomy. Moreover, by being proprietary (and closed source), industry is unable to extend those platforms on their own, which hampers the innovation potential of Europe's safety-related industry. Therefore, industry in the safety-critical domain needs alternative platforms that deliver higher performance and, potentially, flexible enough to fit their specific needs.

Safe Open-Systems - combining open-hardware, software and processes

Our society is increasingly dependent on safety and security properties of computing devices integrated in the everyday socio-technical systems that comprise our environment. Traditionally, such systems built on bespoke elements created under a strict regime of managed processes with defined competency of (ideally) all actors. At the same time, these traditional approaches have been built on assumptions that no longer hold: functional simplicity and determinism. Attaining tolerable risk of complex and dynamically-changing systems is an open issue, and the crucial context in which the SELENE H2020 project was formed to foster the necessary transformations.

Beyond the dynamics of general markets that address common needs, niches exist that, while low-volume, address critical resources of modern societies. Safety-related systems, rail,

aircraft and power-systems are not mass-market devices produced in large volumes – whether or not autonomous vehicles will be a first such mass-market high-volume complex safety-related system is an open (rather questionable) issue at this point. The development of safety critical systems requires functional adaptability (market/use-case) and incident response (CVEs, normative changes) that when paired with complexity result in a massive diversification of needs. At the same time, safety-related system properties must be transparent and match actual societal needs to avoid intended or unintended hidden malfunctions or backdoors. Only if as a society we have access to critical technologies, can they ultimately be safe and secure.

Open hardware and open-source as a principle assurance strategy for complex socio-technical systems

Low-complexity systems allow “development from scratch” – complex defy this option - why? Technically it would be doable to create a highly complex safe and secure system with capabilities comparable to mainstream computing systems (Microsoft Windows or GNU/Linux). However, the cost of building such systems would be prohibitive - estimated at 50 B\$ for the Linux kernel. But more importantly - the development model of “requirements-design-implement” does not play well with complex systems exposed to a dynamically changing and highly diversified market. For such environments evolutionary development cycles, as well as a significant configurability, and last, but not least, the ability to tailor down to “one-of” systems becomes the key aspect for selection of technologies.

Nowadays, flagship open-source projects like the Linux kernel, GNU glibc or gcc as well as RISC-V have established rigorous (while not rigid) processes and meritocratic management structures to allow for the systematic evolution of these highly complex elements under competent oversight. Assessing these processes, aligning them with objectives of normative safety and security demands, and where necessary, amending them by well-defined, context-specific, processes, and limited software extensions as well as hardware modifications, will allow for the safe and secure construction of systems from free-software/open-source elements embedded in a rigorous “assessment of non-compliant development”, as supported by IEC 61508. Enabling the potentials of open hardware, software and processes to form open systems will not only contribute to establishing confidence in the socio-technical systems we depend on, but also bear economic advantages that Europe needs to leverage.



THE ARETE PROJECT

The ARETE project (www.areteproject.eu/) aims to support the pan-European interactive technologies effort within industry and academia, through the multi-user interactions with AR technologies, evaluated in education within both professional and private contexts.

The consortium consists of partners from seven European countries. University College Dublin is the project coordinator, and the rest of the partners include CleverBooks and WordsWorth Learning (SMEs from Ireland), Stichting VU, University of Leicester, EUN Partnership AISBL, Consiglio Nazionale delle Ricerche, Julius-Maximilian- Universität Würzburg, Fundacion Centro De Tecnologias de Interaccion Visual y Comunicaciones Vicomtech and Oxford Brookes University.

The strong team has ambitious plans to test a pilot ARETE platform with Augmented Reality in Europe in about a year. The three pilots aim to cover not only ten countries in Europe but also multiple school disciplines that include literacy, geometry, geography and social sciences and positive behaviour.

The authoring tools used within ARETE and the provision of access of the AR content developed for the broader community of users within the EU will increase the European innovation capacity in AR. Through systematic application of human-centred design approaches, ARETE will deliver highly usable, useful and desirable AR technologies and content, leading to a wider uptake, as well as further stimulating their creative usage. The ARETE consortium aims to develop a collaborative resource with Augmented Reality for education in Europe. The goal is not only to introduce emerging technology and showcase its possibilities in the education sector, but also to introduce the opportunity for businesses to collaborate together for future generations.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 856533. The total budget is €3.935.035 (<https://cordis.europa.eu/project/id/856533>). The project started on 1 November 2019, and its duration is for three years.

MULTIFORESEE PROJECT



MULTI-modal Imaging of FOREnsic SciEnce Evidence (MULTIFORESEE) - tools for

Forensic Science, project is a COST Action, CA16101, supported by the European Union (EU) framework program HORIZON 2020. MULTIFORESEE started in early 2017 (and is expected to end in 2021), and has delivered scientific results from the very beginning. The project is focused on advanced imaging technologies, which are used for analyzing digital evidence and giving details from crime scenes. MULTIFORESEE has had a huge impact on European countries, and this is the reason why its groups consist of members from 27 countries. Project leader is Prof. Simona Francese, Sheffield Hallam University, UK.

The main objectives of MULTIFORESEE are to find new imaging techniques which could be used for analyzing digital evidence and give solutions to crime investigations. However, these techniques must be practical and adapted to reality. When successful imaging techniques are applied, many details can be extracted from a single piece of evidence. This way, the extracted information can be used more efficiently and faster and give immediate results to the investigators. The evidence can be preserved through time and be reused without being modified. Criminal Justice Systems become stronger as detectives are able to get oriented towards a specific direction and solve the case easier and faster, without having to waste many financial resources.

Although the use of imaging techniques is a strong tool in Digital Forensics, these technologies have not been used at their full potential. The interaction between the different science sectors is not effective, and even though Academia has developed cutting edge techniques, communication with End Users has not been enough to achieve the desired results. The project aims to connect relevant cutting-edge research, within the already existing imaging techniques and the ones under development, in order to have the ability to exploit them.

The project is organized in two Working Groups (WG). WG1 deals with best practice guidelines for the application of imaging protocols/technologies. The main objective of WG1 is the identification of the state-of-the-art of technological/methodological imaging capabilities and application range. WG2 aims to image processing and capabilities integration within a digital environment. WG2's main target centers on the standardization of structure and approach to knowledge generation, from forensic evidence.

MULTIFORESEE will try to connect and combine the best of the knowledge of its members in order to provide successful results for new, innovative, advanced imaging technologies.

For more information, please visit MULTIFORESEE website at:

<https://multiforesee.com>

Nicolas Sklavos - University of Patras, Hellas

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MASPATECHNOLOGIES

In an interview with Francisco Cazorla and Jaume Abella, co-founders of Maspatechnologies, a Barcelona Supercomputing Center (BSC) spin-off, they explain how the microbenchmark technologies used by the company help adapt computing to the constraints of Cyber-Physical Systems (CPS), as well as offer advice to other HiPEAC members interested in launching spin-offs based on niche technologies.

How do the microbenchmark technologies used by Maspatechnologies help adapt computing to the constraints of Cyber-Physical Systems?

Our microbenchmark technologies provide a systematic approach to verify (budgeting) and validate (testing) the timing characteristics of critical applications running on a Commercial-Off-The-Shelf (COTS) system on chip (SoC). Our technologies help providing the evidence required to reach the highest integrity/assurance levels required in domains such as avionics, automotive and space. Hence, by easing the adoption of high-performance processors in critical real-time markets, high-performance processors covering the performance needs of the target Cyber-Physical Systems can be easily adopted, making the verification and validation of the timing aspects attainable and in accordance with safety regulations in their respective domains.

In HiPEACinfo 54, Francisco described how the microbenchmark technology, M μ BT, enables the use of multicore systems for safety-related functions in avionics and automotive applications, for example. How has M μ BT evolved since then?

Microbenchmarks have increasingly been ported and extended to new target devices, and have started its qualification process to ease adhering to the corresponding safety regulations for software tools. Also, we have expanded the microbenchmark technology with task contention models and interference channel discovery technologies, among others. Last but not least, interference channel analyses, both qualitative and quantitative, have been developed for a variety of hardware targets, as an entry point for end users to our technology. Example platforms targeted by our technologies include the NXP T1040/1041, T2040/2041, T2080/2081, Xilinx Zynq UltraScale+, and Infineon AURIX TC27x/29x/37x/39x families, just to name a few.

How did you come to launch a spin-off based on this technology? What services will Maspatechnologies provide?

We have been developing these technologies from TRL1 up to TRL6-8, and thus have reached the end of the road for research activities, and need to continue with exploitation (commercial) activities. The natural next step was to create a spin-off in which these technologies can be exploited, delivering high-quality



services and creating qualified jobs, and thus returning taxpayers' investment.

Maspatechnologies provides multicore timing analysis and testing services and solutions with particular emphasis on the avionics, automotive and space markets, although other domains and services within this scope can be served thanks to the expertise and skills of Maspatechnologies personnel, whose founders have more than a decade of experience each in this particular industrial challenge.

Maspatechnologies shows how you can launch a spin-off based on niche technologies. What advice would you have for other HiPEAC members who wish to do something similar?

As a first step you need to have clear evidence that a particular service/tool to be provided is something demanded by industry. Creating an appropriate business plan, likely with help from professional services, is fundamental to start such an adventure. In particular, taking extra care with the cash flow is imperative, since even a highly profitable business may fail simply because expenses arrive earlier than income.

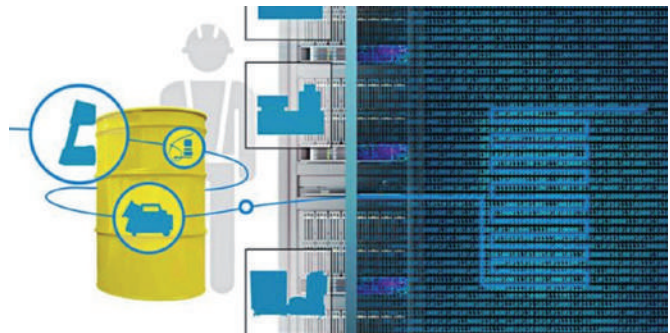
🔗 <https://www.bsc.es/news/bsc-news/maspatechnologies-the-new-bsc-spin-multicore-safety-validation-aerospace-and-automotive-domains>

MICADO: MEASUREMENT AND INSTRUMENTATION FOR CLEANING AND DECOMMISSIONING OPERATIONS

The goal of the MICADO project is to propose a cost-effective solution for the non-destructive characterization of low and medium activity nuclear waste, implementing a digitization process that could become a referenced standard, facilitating and harmonizing the methodology used for the in-field Waste Management and Dismantling & Decommissioning (D&D) operations. The D&D process of nuclear infrastructures demands methods for a full traceability of waste material to improve quality management and operational safety. Precise procedures provide twofold benefits: the optimization of costs, associated with D&D, and the minimization of dose exposure to operators and personnel.

The absence of a consistent and straightforward solution to characterize all types of materials, along with the lack of an integrated solution for digitizing the enormous amount of data produced, is a critical issue. Now the systems rely on the operator's ability to maintain high operational skills and quality assurance with precision measurements that unfortunately today are often associated with high uncertainties, and therefore do not allow a real optimization of the waste.

The utilization of several un-automatized instruments implies taking many notes and inserting them into specific ad-hoc formats and on a database manually, without the possibility to combine data, including previously available legacy data if present. The RCMS Digi-Waste proposed in the MICADO project will result in a proven modular solution offering an opportunity to proactively develop a unified and standardized Waste NDA



Characterization Procedure and Method that could become an international reference allowing all nuclear operators, research laboratories and safety authorities to facilitate their exchanges. The MICADO project involves some key European Union (EU) players with deep knowledge of nuclear waste and the common interest of converging technologies and methods, as well as implementing a full digitization process applied to nuclear waste management.

PROJECT START DATE: June 2019

PROJECT DURATION: 36 months

BUDGET: €5 million Euros

<https://www.micado-project.eu/>

PARTNERS: CAEN (coordinator) (IT), CEA (FR), CTU (CZ), ENEA (IT), INFN (IT), ORANO (FR), SCK-CEN (FR), XIE (GE).

KEY THEMES: Nuclear waste characterization, digitization, non-destructive assays, waste monitoring grid, nuclear repository, measurement and uncertainty assessment, safety, radioprotection, gamma imaging.



HiPEAC Jobs Career Center: A well-established mentoring scheme!

Over the past 16 years, HiPEAC has been a driving force in the development of its members' careers.

The ACACES summer school has enabled many computer science students to bridge the skills gap needed to become advanced computing systems specialists. Doctorate students have also enriched their experiences thanks to HiPEAC internships and collaboration grants, learning to work both in academia and industry, or getting external insights to complete their theses. More established researchers and professionals have met at Computing Systems Week to discuss and network about their research topics. Many European Union-funded projects have emerged thanks to these interactions. Furthermore, the HiPEAC conference has become one of the yearly venues where our members share their research results and findings with an even wider audience than themselves.

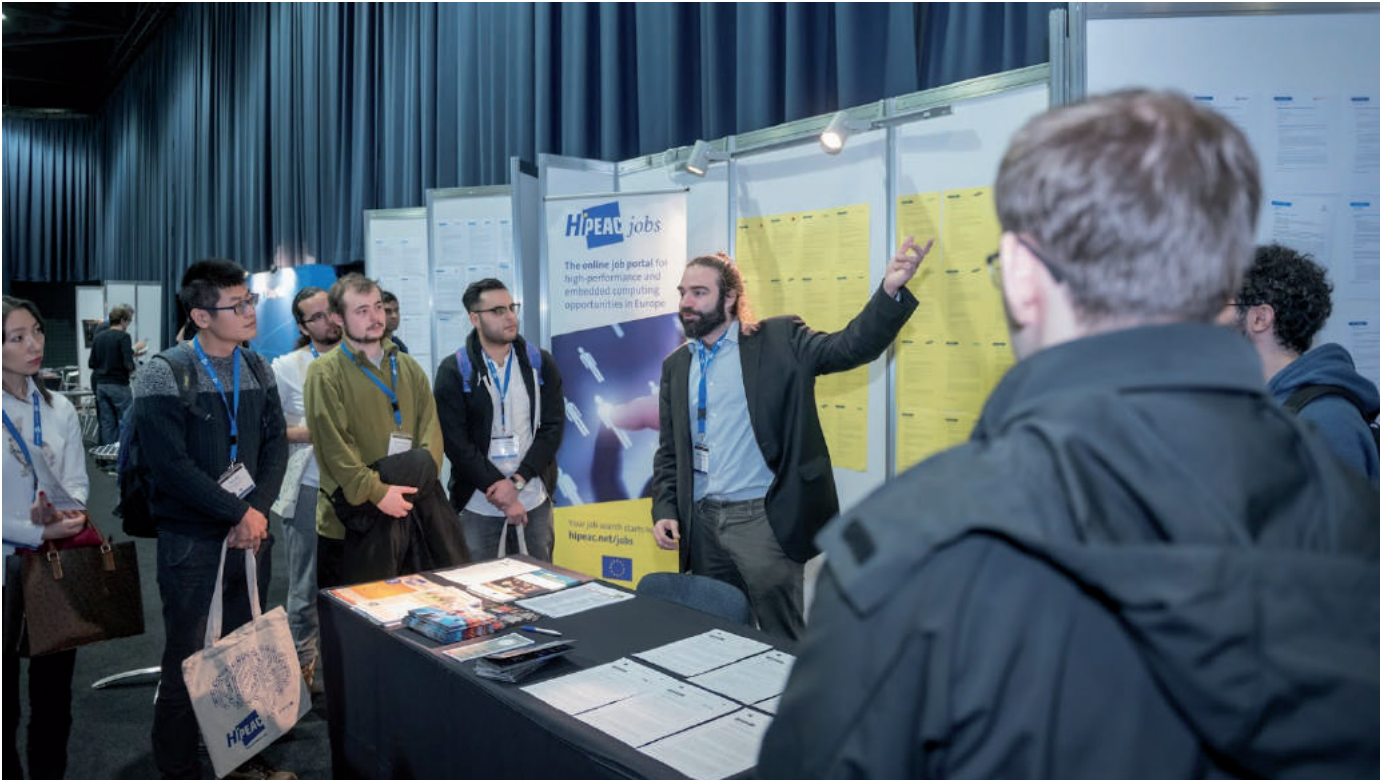
One of the biggest challenges for such a network is to keep on growing after so many years. Many actions are needed to attract new students, who will become future members of the network. Back in October 2017 in the HiPEACinfo52 magazine, we addressed how we had started leveraging the strong experience base of our members to mentor the newest generations of students. Over the course of the following two years, those mentoring activities have crystalized into a well-established scheme present at all events organized by HiPEAC.

Inspiring Futures! The mentoring & careers sessions at Computing Systems Weeks: CSWs are the perfect events for close networking between peers, as well as an opportunity for students to meet and interact with senior researchers. At Inspiring Futures! Workshop sessions, we invite companies and institutions to pitch and discuss career opportunities / internships or promote employer branding for a selected group of students all over Europe (at the undergraduate, masters and doctorate levels).

Career Day – Advice & round table sessions at ACACES Summer School: Each year, more than 200 students meet at the HiPEAC summer school to learn about the latest advances in scientific knowledge and have the chance to interact with their European and inter-continental peers. Mentoring-wise, we leverage this to organize a career day, including a session on “How to pitch your science across different audiences”, and a round table featuring different interesting senior members such as university professors, principal engineers in industry, innovators at SMEs, business angels and patent examiners. They share with students their experiences, and discuss the different possible career paths around HiPEAC's areas.

STEM Day – at the HiPEAC conference: The programme includes an invitation for students at local and nearby universities to attend the conference for free for a day. It includes access to the keynote speech, a guided tour along HiPEAC's exhibition, the presentation of the jobs wall, careers mentoring and Q&As, access to the industrial session of our sponsors and the rest of the conference sessions on the given day.

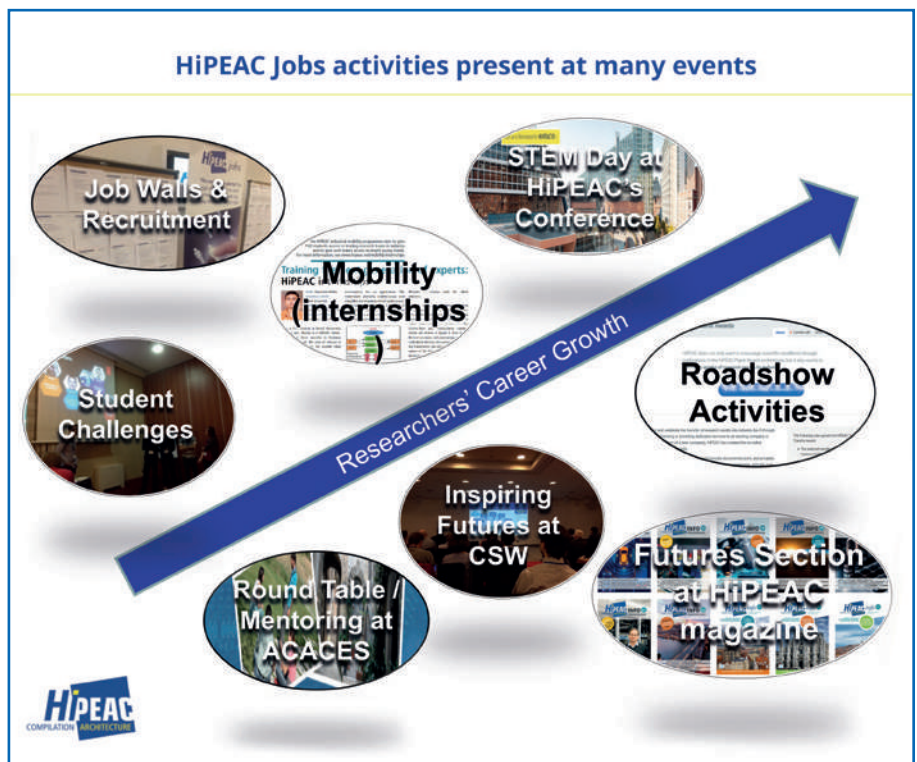
In the HiPEACinfo magazine, the HiPEAC Futures section covers a number of interesting career talks by our senior members, collaboration grants and internship experiences, 3 minute-thesis, etc.







HiPEAC has been invited by external universities and organizations such as PRACE, ACM Womencourage, ISC STEM day, DATE Conference and PUMPS summer school, among others, to collaborate and provide content on career activities or mentoring at their events.

Would you like to help with the mentoring activities? Contact recruitment@hipeac.net and we will be happy to find a slot for you at some of the sessions we organize.

Are you planning a career-related activity at your organization? Contact recruitment@hipeac.net and we will help you promote it among our members, provide material or suggest content.



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The HiPEAC network includes almost 1,000 PhD students who are researching the key topics of tomorrow's computing systems. In this issue, we find out how heterogeneous parallel computing systems lend to the fast analysis of vast amounts of data

Three-minute thesis



NAME: Suejb Memeti
RESEARCH CENTRE: High-performance Computing Centre at Linnaeus University
SUPERVISORS: Sabri Pllana

Programming and Optimization of Big-Data Applications on Heterogeneous Computing Systems

Nowadays, various mechanisms, such as scientific measurements and experiments (including genetics, physics, and astronomy), social media (including Facebook and Twitter), and healthcare (including health monitoring devices) generate huge amounts of data. Whilst, in the near future, it is projected that genomics will be the largest source of big data. A major challenge of big data is the efficient analysis of very large data sets. Modern heterogeneous parallel computing systems, which comprise multiple CPUs, GPUs, and Intel Xeon Phi, can cope with the requirements of big-data analysis applications. However, utilizing these resources to their highest possible extent demands advanced knowledge of various hardware architectures and programming frameworks. Furthermore, optimized software execution on such systems demands consideration of many compile-time and run-time system parameters.

This dissertation proposes techniques for using heterogeneous parallel computing systems for fast analysis of the vast amount of generated data. In particular, it studies and develops (1) parallel pattern matching algorithms for heterogeneous computing systems; (2) software optimization techniques that use meta-

heuristics and machine learning to evaluate the performance on heterogeneous parallel computing systems; and (3) programming abstractions for stream computing on heterogeneous computing systems accelerated with GPUs and/or Intel Xeon Phi.

In this research project, the parallel pattern matching algorithm was used for the analysis of large-scale DNA sequences and speedup improvements of up to 50x compared to the sequential execution when using only CPU resources, and up to 30x when using only the resources on the accelerating device, have been observed. Thereafter, the software optimization techniques were used to determine the near-optimal workload distribution and other system configuration parameters for execution on a heterogeneous system that comprise Intel Xeon CPUs and the Xeon Phi accelerator. The collaborative utilization of the available resources of host CPUs and accelerating devices outperformed the host-only and the device-only executions by up to 2.18x.

The proposed programming abstractions enable developers to write high-level stream-computing applications that target heterogeneous systems while maintaining the same programming complexity as OpenMP. The source-to-source compiler can generate device-specific code (including the wrapper code that enables their execution on a heterogeneous system). The run-time system can automatically distribute the workload across the available processing units (CPUs, GPUs, Intel Xeon Phi's), which results with performance improvements of up to 7.18x when collaboratively using 2CPUs and 4GPUs compared to the CPUs-only, and up to 1.96x compared to the accelerator-only execution.

Access the public version of the thesis for free:

<http://www.diva-portal.org/smash/record.jsf?pid=diva2:1270537>

Hacking into a cure for rare diseases: The BitsxlaMarató hackathon

#bitsxlaMarató aims at becoming an annual interdisciplinary hackathon for contributing to La Marató, a public Catalan charity effort. The first edition was co-sponsored by HiPEAC, involved more than 250 students and research groups (ViRVIG, groups at the Vall d'Hebron Hospital, and the Catalan Blood and Tissue Bank), companies (Hewlett Packard, Nostrum Biodiscovery, and Pfizer) as well as patients and patient organizations (Asdent, Objectivo Diagnóstico, and the Catalan association on rare diseases FECAMM).

The main goal was to find innovative solutions to rare disease challenges. #bitsxlaMarató was co-organized by the Barcelona School of Informatics (FIB), the Barcelona Supercomputing Center (BSC), the Campus Docent and the Research Institute of the Hospital Sant Joan de Déu, Hackers@UPC, the Research Centre for Biomedical Engineering of the Universitat



Politécnica de Catalunya-Barcelonatech (UPC), and rarehacks.

Professor Mateo Valero, director of the BSC and co-founder and first coordinator of HiPEAC, said: 'Working on challenges

related to personalized medicine forms part of our day job at BSC. I believe that an event like #bitsxlaMarató contributes towards this objective in many senses: by helping us join forces with other computer scientists and bioinformaticians, by accelerating research, by finding out about other points of view and by demonstrating our commitment to causes as vital as the fight against rare diseases. This initiative was a huge success by the FIB at the UPC, and we were proud to be involved from the get-go.'

More information on the impact of this hackathon will be published in the next edition of HiPEACInfo.

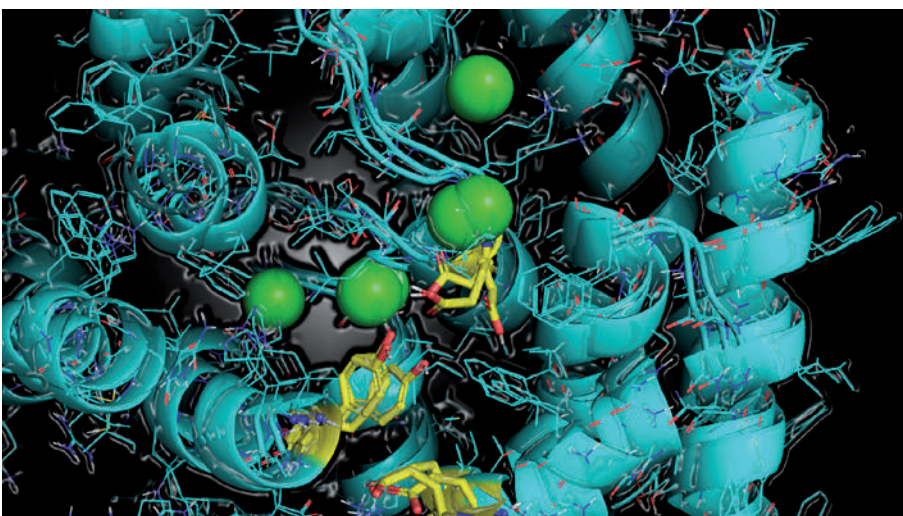
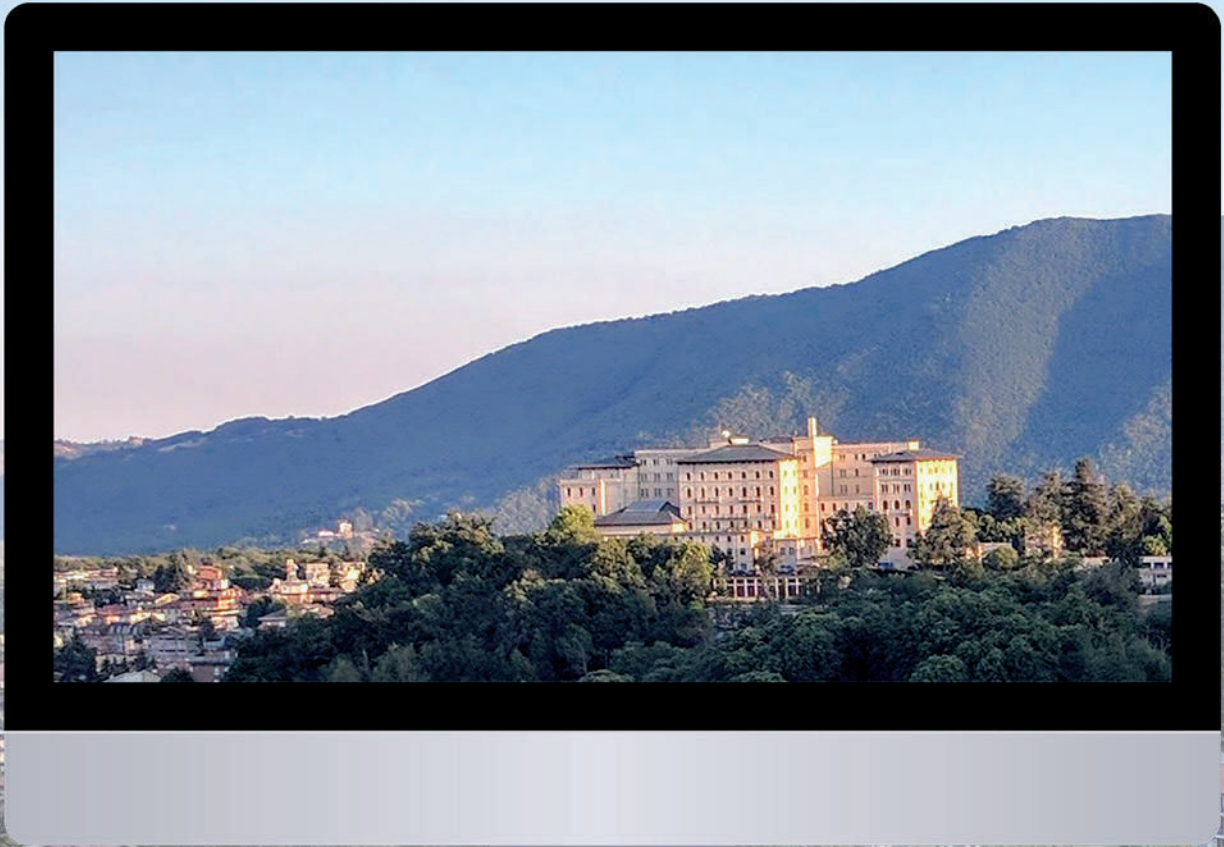


Figure 1: On the left, the data analysis challenge on the rare kidney disease Dent1 involved comparing movements of the "healthy"CLC5 protein with the disease-causing protein. Chlorines travelling through the protein during molecular dynamics are shown as green balls, important amino acids as sticks with yellow carbon atoms, and the protein in cyan. On the right, hackers presenting and sharing their prototypes and the ideas that have guided them.



ACACES 2020

Fiuggi, 12-18 July 2020

Sixteenth international summer school on Advanced Computer Architecture and Compilation for High-Performance and Embedded Systems
Due to the COVID-19 pandemic, the ACACES 2020 Summer School will be a virtual summer school.
Registration for the virtual summer school will open on 1 May. Participation will be free.

acaces.hipeac.net/2020