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D5.5
HPC Career Case Studies (update and additional case studies)

Final

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Table of Contents

References and Applicable Documents

[1]   EXDCI Deliverable D5.1: HPC Career Case Studies: https://bscw.zam.kfa-juelich.de/bscw/bscw.cgi/1771082?op=preview&back_url=1590388

List of Acronyms and Abbreviations

BSC	Barcelona Supercomputing Center
CINECA	Consorzio interuniversitario per la gestione del Centro di calcolo elettronico dell'Italia nord-orientale (Supercomputing centre based in Bologna, Italy)
D	Deliverable
EPCC	Edinburgh Parallel Computing Centre
EXDCI	European Extreme Data and Computing Initiative
HPC	High Performance Computing
ICHEC	Irish Centre for High-End Computing
IHPCSS	International HPC Summer School
ISC	International Supercomputing Conference
PRACE	Partnership for Advanced Computing in Europe
SC	Supercomputing Conference
URL	Uniform Resource Locator (i.e. a web address)
WP	Work Package

Executive Summary

This Deliverable, **D5.5 – HPC Career Case Studies (update and additional case studies)**, is a follow-up to **D5.1 – HPC Career Case Studies[1]**, which was produced for Month 5 of the EXDCI project[2] and contained the first 5 case studies. This new deliverable includes an additional 10 case studies which have since been produced, summarises the lessons learned, and gives plans for exploitation of the material.

The HPC Career Case Studies are designed to promote High Performance Computing (HPC) as an interesting and exciting career to young students who represent the potential HPC specialists of the future. The idea to produce these case studies arose from the recognition that there is a shortage of HPC-skilled personnel in the European workforce, and that this is limiting the uptake of HPC in both academia and industry, which in turn threatens Europe's ability to remain competitive.

The case studies are targeted primarily at young people, especially undergraduate and postgraduate students. They aim to raise awareness of the many different job opportunities open to those with HPC skills, both within the HPC community itself and also in associated professions, where modelling skills coupled with domain expertise are of key importance.

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[1] https://bscw.zam.kfa-juelich.de/bscw/bscw.cgi/1771082?op=preview&back_url=1590388
[2] https://exdci.eu/

1   Introduction

This Deliverable was produced for **WP5, Talent Generation and Training for the Future**, and more specifically as part of **Task 5.1, Supporting Talent Generation**.

One of the acknowledged barriers to increasing the uptake of HPC in academia and industry is the shortage of skilled personnel. EXDCI considers that the nurturing of young talent is a crucial element in the development of an HPC-literate workforce in Europe, and Task 5.1 focuses on the promotion of HPC to young people as an exciting and rewarding area for study and employment.

To achieve this goal, a series of HPC Career Case Studies has been produced, in which people from a variety of backgrounds working in a range of different jobs explain how they came to be involved with HPC, and in which ways HPC is relevant to their current job or has led them into their current position.

All of the case studies are available on the HPC Careers Case Studies section of the EXDCI website[3], and can be downloaded and presented at events such as local science festivals and school or university visits.

In order to encourage people from diverse backgrounds to consider a career in an area that is still often viewed as "not for people like me", we have tried to highlight the wide spectrum of people who work in HPC. In particular, we have managed to achieve a good mix of male and female candidates. We have also included on the HPC Career Case Studies webpage links to initiatives such as Women in HPC[4] and Diversity in HPC[5], who do very good work in seeking to improve the participation of under-represented groups in the HPC and supercomputing community.

This Deliverable describes the production of the second set of HPC Career Case Studies, produced for Project Month 23, gives details of some lessons learned, and provides plans for exploitation of the case studies. It is a brief summary document, as the case studies themselves form the main part of the Deliverable. These are included as Annex 1: HPC Career Case Studies.

The Deliverable is structured as follows:

Chapter 1 introduces the Deliverable.

Chapter 2 provides details about the second set of HPC Career Case Studies, and provides an overview of each of the candidates featured.

Chapter 3 discusses the lessons learned, and provides suggestions for how to approach this sort of task in the future.

Chapter 4 gives plans for the exploitation of the material produced in this task.

Finally, Chapter 5 (Annex 1) contains the case studies themselves, which constitute the main part of this Deliverable.

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[3] https://exdci.eu/jobs-and-training/hpc-career-case-studies
[4] https://www.womeninhpc.org/
[5] http://www.hpc-diversity.ac.uk/

2   The second set of HPC Career Case Studies

In addition to the 5 case studies that formed D5.1, another 10 case studies have now been produced. This activity has not yet finished, and we expect to produce more case studies after the submission of this Deliverable. The reasons for this are discussed further in Section 2.3 and Section 3.

2.1   Purpose and design of the HPC Career Case Studies

This series of HPC Career Case Studies responds to the identified lack of HPC skills within the current European workforce, and in the upcoming generation of young workers.

The objective of the HPC Career Case Studies is therefore to increase awareness among young people – particularly undergraduate and postgraduate students – that HPC knowledge is an increasingly important skill which can lead to a wide variety of exciting career opportunities. The fundamental message is that HPC techniques are used in many different types of jobs, and are not merely restricted to a handful of very specialised jobs in support or development of HPC hardware or software.

The HPC Career Case Studies are designed as single-page, double-sided A4 flyers, which can be printed for distribution at relevant events, such as visits to schools and universities, science fairs and careers fairs. They are also available for download from the EXDCI webpage.

2.2   Format of the HPC Career Case Studies

In order to keep a consistent appearance, the format of the new set of case studies is much the same as the first set. The aim continues to be to strike the right balance between having a professional and consistent style, in order to be taken seriously, and yet setting an informal, "chatty" tone which is not too dry or technical, in order for the testimonies to be enjoyable and easy to read. In this way, the reader, and in particular young students, will be able to identify with the people featured.

For these reasons, we have kept the first-person "question and answer" format, and the preference for the accompanying photographs to be of an informal nature, to allow candidates to show a bit of their personality, and to more easily catch the eye of the potential reader.

Following the project mid-term review, the reviewers' comments have been taken on board. Some of the content of the existing case studies has been modified, while in the new case studies fewer words have been used in the word cloud, to allow the use of a larger font and prevent the box from being too cluttered.

A balance has also had to be struck between using exactly the same set of questions for each candidate, and adapting each case study to the individual. Candidates are given a general framework to follow, but are advised that they do not necessarily have to cover all of the points. The case studies are then edited to try to standardise them as much as possible, without making significant changes to the content. The overall suggested framework is as follows:

- A general introduction, including a bit of background / biography
- A summary of the person's current job, including how HPC is relevant to the job
- Career path to current job: details of their first experience of HPC, or any course or career choices that turned out to be key moments
- Working in HPC: exciting aspects and challenges
- A look to the future: next career steps, and the future of HPC in their specific field

2.3 Identifying HPC Career Case Studies candidates

The aim was to find candidates who were young enough to be relevant to the target audience, which might include final-year secondary school pupils, undergraduate and postgraduate students, or early-stage researchers in academia or industry – anyone who might be considering which path to follow next in education or employment. At the same time, the candidates needed to have enough experience to have an interesting career history to tell.

The featured candidates needed to have HPC as a common strand in their stories, but to be as varied as possible in other respects. We looked to achieve a range of male/female candidates, working in a variety of different countries in a range of academic and industrial environments. We also aimed to feature some who had moved into HPC from another background (i.e. not originally from a computer science background), and some who are not working in pure HPC but are making use of their HPC skills in an applied area of research.

However, we discovered that it was not always easy to persuade people to spend their time contributing to a case study. Some people are reluctant to take part in what they might view as self-publicity, while others agreed in principle, but then failed to submit their contributions by the deadline(s) because of other commitments.

Project partners from both the academic and industrial arenas exploited their network of contacts as fully as possible, both through targeted emails to individuals who had been identified as having a suitable story to tell, and through general requests sent to relevant mailing lists (including, on the academic side, to lists of previous participants in programmes such as the PRACE Summer of HPC[6] and the HPC-Europa3 research visitor programme[7]).

The initial response rate was fairly low, and the completion rate was lower still. There was a particularly low response rate from industrial and commercial contacts, perhaps because this sort of activity is very much outside the scope of their usual work, meaning that they would have had to commit their own spare time to doing it. In some cases, the employer even prohibited their employees being involved in this sort of activity.

Meanwhile another initiative, Diversity in HPC, has been producing its own series of personal case studies, called "Faces of HPC"[8], with the aim of celebrating the diversity that exists in the HPC community. Although the focus of Faces of HPC is slightly different from ours, it has similarities in that its aim is to show that HPC can be a career for anyone – not just the introverted male computing enthusiast of the stereotypes – and its ultimate objective is essentially the same, i.e. to increase the number of people in the HPC workforce.

The Faces of HPC co-ordinator plans to identify more candidates for case studies at the International HPC Summer School (IHPCSS)[9], which will take place in Boulder, Colorado (USA) from 25th to 30th June 2017. The IHPCSS is aimed at graduate students from all disciplines that can benefit from HPC, and one of the strengths of the programme is its mentoring system, whereby there is an assigned mentor (either an instructor, HPC staff, or a student from a previous year) for every three students. As both Faces of HPC and EXDCI were aiming to produce more case studies featuring similar candidates discussing similar topics, we decided to pool our resources and produce a combined questionnaire based on those that each of us had been using separately. This questionnaire, along with an explanation of the objectives of EXDCI and the Faces of HPC, will be circulated to all of the mentors at the event, who are

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[6] https://summerofhpc.prace-ri.eu/
[7] http://www.hpc-europa.org/
[8] http://www.hpc-diversity.ac.uk/faces-of-hpc
[9] http://www.ihpcss.org/

typically young and enthusiastic HPC practitioners from a variety of different backgrounds. We then aim to produce case studies for both purposes from the responses received.

Unfortunately, due to the timing of this Deliverable, any resulting case studies will not be included here, but will be added to the HPC Career Case Studies webpage in due course.

2.4   List of additional HPC Career Case Studies (forming D5.5)

A further 10 case studies have been produced for this Deliverable.

The candidates are 5 females and 5 males, working in the Czech Republic, Ireland, Italy, Slovenia, Spain and the USA. Some of the people featured have backgrounds in computer science, while others started in applied domains such as chemistry and physics. The jobs represented include various jobs within HPC centres (systems administration, consultancy and support, project management, and HPC research), compiler optimisation at Apple (contributing to reducing battery drain by applications on mobile phones), and jobs involving the application of HPC techniques to meteorology and landscape modelling.

Marta García: PhD student (female, working in Spain)

Marta is a PhD student at Barcelona Supercomputing Center (BSC)[10]. Unlike many of the candidates, who were interested in computing from a young age, Marta fell into informatics by chance, and it was only her final project that introduced her to HPC. She is now studying for a PhD and loves the multidisciplinary nature of HPC and being able to help researchers from different fields solve real problems.

Rosa M. Badia, Research Manager (female, working in Spain)

Rosa is a researcher and research manager at BSC, with a background in computer science. Her job involves a variety of different tasks, including development of a programming model, supervising PhD and Master's students, and project management. However, what she enjoys most of all is working with end users, helping researchers to advance scientific research.

Felip Moll Marquès, System Administrator (male, working in Spain)

Felip was initially self-taught in terms of HPC: in his first job, he took on responsibility for a small cluster which nobody was maintaining. With no previous knowledge of HPC, he taught himself how it worked, and how to manage and upgrade it. From these small beginnings, he has progressed to become one of the people responsible for ensuring that Spain's biggest supercomputer, MareNostrum[11], is always available for its users.

Jure Jerman, Meteorologist (male, working in Slovenia)

Jure is a meteorologist at the Slovenian Environmental Agency[12], and was one of the first people to build a Linux cluster for operational weather forecasting, motivated at the time by the unfeasibly high cost of acquiring an HPC system. The development of commercial HPC systems has changed the nature of his work considerably.

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[10] https://www.bsc.es/
[11] https://www.bsc.es/innovation-and-services/supercomputers-and-facilities/marenostrum
[12] http://www.arso.gov.si/en/

Nicola McDonnell, Consultancy & Solutions for Industry Activity Leader (female, working in Ireland)

Nicola (Nix) is the Consultancy & Solutions for Industry Activity Leader at ICHEC, the Irish Centre for High-End Computing[13]. She has had a very varied career: she studied chemistry, worked briefly in marketing, took Master's courses in computer science and in computer games development, and has had various jobs in both academia and in industry. As well as working for ICHEC, she has also worked for EPCC[14], the HPC centre in Edinburgh, Scotland.

Mehdi Amini, Compiler Engineer at Apple (male, working in USA)

Mehdi is a tech enthusiast with two Master's Degrees and a PhD, whose first exposure to HPC was on a Master's course. His Master's thesis project involved working with an astrophysicist on galactic simulations, showing him the cross-disciplinary nature of HPC. He has experience of working both in a university environment and in industry, in organisations ranging from a start-up company to one of the world's largest technology companies.

Ondřej Vysocký, Research Assistant & PhD Student (male, working in Czech Republic)

Ondřej is a Czech computer scientist, who defines the key moment in his career as being his decision to do his Bachelor's thesis on a parallel computing topic related to healthcare. Having completed his studies, he now works at IT4Innovations, the Czech National Supercomputing Center[15], while also studying for a PhD. He was a participant in the PRACE Summer of HPC programme in 2015 and will be attending the International HPC Summer School in Colorado in 2017.

Massimiliano Alvioli, Landslide modelling researcher (male, working in Italy)

Massimiliano (Massi) is a physics graduate who now works for the Italian National Research Council's Research Institute for Geo-Hydrological Protection[16], with a focus on landslide modelling. He has held several post-doc positions in nuclear physics research, in Italy and the USA, and now applies his numerical modelling and HPC skills to the world of geosciences. He attended the Cineca parallel computing school[17] in Bologna when he was a postgraduate student, and has been using HPC ever since.

Luna Backes Drault, Graduate Student of Computer Engineering (female, working in USA)

Luna graduated in Computer Engineering from the Universitat Politècnica de Catalunya[18] in 2015, and is now a Graduate Research Assistant at Texas A&M University[19], about to embark on a PhD. Her career has been characterised by participation in summer schools and internships in several different countries, including a PRACE Summer of HPC placement at the University of Ljubljana (Slovenia)[20], an Erasmus exchange and subsequent internship at the University of Edinburgh (UK)[21], and graduate studies at Texas A&M University (USA), along with two summer internships at the Samsung Austin Research Center[22].

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[13] https://www.ichec.ie/
[14] https://www.epcc.ed.ac.uk/
[15] http://www.it4i.cz/?lang=en
[16] http://www.irpi.cnr.it/
[17] https://www.cineca.it/it/content/summer-school-parallel-computing
[18] http://www.upc.edu/
[19] https://www.tamu.edu/
[20] https://www.uni-lj.si/eng/
[21] http://www.ed.ac.uk/
[22] http://www.samsung.com/us/labs/labs/austinrd.html

Claudia Rosas Mendoza (female, working in Spain)

Claudia is a performance analyst at Barcelona Supercomputing Center. In her own words, "Eight years ago I did not know what HPC was, but after seeing just a glimpse of its potential, I felt like a kid in a candy store." Claudia never felt that Computer Science was a degree reserved only for boys or men, and is keen to encourage young people, especially girls, to be curious about the opportunities that exist beyond regular careers.

3 Lessons learned

A number of lessons have been learned in the process of preparing the EXDCI HPC Career Case Studies.

Most importantly, this is not an activity which can be completed in a short period of time, and this was particularly challenging when completing the first batch of case studies for D5.1, due at Project Month 5. Even if a good number of seemingly ideal candidates come to mind initially, not all of these might agree to be involved (and in some cases their employer might even prohibit their participation, something which we had not foreseen). Once candidates have agreed to take part, they may need several reminders and extensions to the proposed deadline, because producing the case study is likely to be a low priority for them, being outside their own critical path. After the material has been received from the candidate, there may still be considerable work to be done in proof-reading and editing the text to make it fit the format and ensure that it addresses the objectives. All in all, the production of each individual case study can be quite a time-consuming process.

Further, the difficulty in persuading people to participate made it more challenging to feature the range of people initially planned. For this reason, fewer of the case studies than we would have liked are from people who work in an industrial or commercial environment. This is due to the difficulty in convincing people from these sectors to get involved, which we believe stems from a lack of time and encouragement in their workplace to do this sort of activity.

Additionally, it is also important to be aware of other activities which may be working on a similar task. The Diversity in HPC project is producing the "Faces of HPC" case studies, which emphasise the diverse background of the HPC workforce. There is much overlap here, and after discussions with Diversity in HPC we have now decided to merge our efforts, in order to target people more efficiently. This has happened at a late stage of preparing the case studies, and the main focus will be on the International HPC Summer School on 26-30 June, so the outcome of this effort is not known at the time of writing this Deliverable.

The Diversity in HPC team tell us that, in their experience, it is particularly difficult to convince applied computational scientists to take part, as they often do not see themselves as "HPC people", and therefore do not think that they are the right people to feature in these case studies. This would be something to bear in mind when preparing case studies of this type in the future – to introduce the idea to them with a more clear explanation of why they are indeed, for our purposes, exactly the sort of "HPC people" we are targeting.

We aim to target such people more effectively by working together with the HPC-Europa3 team to identify suitable HPC Career Case Studies candidates from among the participants in the HPC-Europa3 Transnational Access research visit programme, which is just beginning again after a gap of some years. The programme has an emphasis on supporting HPC beginners and those with only moderate HPC experience in particular. Many of the visitors, and also some of the hosts with whom they collaborate during their visit, are young researchers working in applied computational science. We hope that by contacting these people via a trusted source (the HPC-Europa3 team), we will be able to convince them that they are indeed the type of

person we are looking for, and persuade them to take part. The HPC-Europa3 team may also be able to benefit from the EXDCI HPC Career Case Studies in order to attract applicants to the Transnational Access programme.

Finally, timing seems to be important in terms of getting a positive response. Many requests were sent out over a period of some months, resulting in a relatively small number of replies, and a smaller still return in terms of actual case studies eventually received. However, a series of reminders sent shortly before the ISC conference[23] produced a far greater response, with some people taking the opportunity to discuss this further with project representatives at the conference. Whether or not this translates into completed case studies remains to be seen, but it does suggest that timing can be important, and that it could be beneficial to contact people shortly before events such as ISC and SC[24], with the suggestion to talk to the project team in person at the event if they wish. This could be done informally if the candidate already knows someone in the project team, or candidates could be invited to arrange a specific time to meet a project representative at the appropriate booth.

We hope that a similar approach will be successful when targeting the mentors at the International HPC Summer School. The mentors have been told about the initiative in the week leading up to the International HPC Summer School, and they will be reminded about it during the event. The hope is that they will be able to find a bit of time during the week of the summer school to produce their case study. The EXDCI and Diversity in HPC staff who are attending the event will offer to discuss the initiative with anyone who would like further guidance, and it will even be possible for the candidates to give their testimony orally.

At the stage of writing this report, in the week prior to the International HPC Summer School, we have already received one response, and while the content initially looks to be more suitable for the Faces of HPC than the EXDCI HPC Career Case Studies, the author is very keen to be involved in any activity to promote diversity within STEM, so at the very least will be a useful contact for this and any future activities addressing the objectives of WP5.

4 Plans for exploitation of the HPC Career Case Studies

Over the coming months, in addition to producing any further HPC Career Case Studies for which we receive material, we will focus our effort on publicising them.

Paper copies will be made available at the PRACE and EXDCI booth at events such as ISC, SC, and PRACEdays, as well as at any other relevant events in which project partners are involved, such as the European Union Contest for Young Scientists[25], which is sponsored by PRACE.

However, most effort will focus on making the online versions more visible, through the use of Twitter and via news items on the websites of EXDCI, its partners, and other relevant organisations (e.g. Women in HPC, HiPEAC[26]). Information will also be disseminated via any relevant email contact lists which these organisations have, such as PRACE Summer of HPC students and HPC-Europa3 participants.

Currently the HPC Career Case Studies are accessed either via the "Jobs & Training" link from the menu on the EXDCI homepage – either directly from the "HPC Career Case Studies" drop-

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[23] http://isc-hpc.com/
[24] http://sc17.supercomputing.org/
[25] https://eucys2017.eu/
[26] https://www.hipeac.net/

down link from the menu, or via the intermediate "Jobs & Training" page[27]. Some work is still to be done to improve the HPC Career Case Studies section of the webpage. We aim to add more images, to make the page more attractive, including thumbnail photos of the featured people next to the link to their case study, to increase interest.

We already link to other related initiatives (Women in HPC, Diversity in HPC) and personal testimonies (Faces of HPC, profiles of EPCC MSc in HPC alumni[28]). We could enhance this section with more links, such as the University of Edinburgh School of Informatics "Girls in Tech" video[29], and information from HLRS[30], the High Performance Computing Centre in Stuttgart, Germany, about its involvement in Girls' Day[31], a nationwide event across Germany[32] that gives schoolgirls the chance to learn about careers in science and technology.

We will monitor the impact of any Twitter announcements (number and origin of likes and retweets), and also use Google Analytics to measure the impact of specific activities to promote the case studies, such as announcements by email, news articles, or tweets. As the URL quoted on the case studies (http://www.exdci.eu/CaseStudies/) is slightly different from the actual address where these are located (https://exdci.eu/jobs-and-training/hpc-career-case-studies), we should be able to track visits arising from the case studies themselves, rather than from visitors to the webpage who have clicked through from the homepage. Downloads of the case studies will also be monitored.

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[27] https://exdci.eu/jobs-and-training
[28] https://www.epcc.ed.ac.uk/msc/career-prospects/alumni-profiles
[29] https://www.youtube.com/watch?v=6Cd_BquE95Q&feature=youtu.be
[30] http://www.hlrs.de
[31] http://www.hlrs.de/en/events/detail-view/2017-04-27/
[32] https://www.girls-day.de/english

5   Annex 1: HPC Career Case Studies

The new case studies are included here in Annex 1.

All case studies, including those produced for D5.1, and – in the future – any produced after the completion of D5.5 (this Deliverable), can be found on the EXDCI website in the HPC Career Case Studies section:

https://exdci.eu/jobs-and-training/hpc-career-case-studies

EXDCI Case Studies: HPC talent generation
Marta García Gasulla: PhD student

Marta García Gasulla is a PhD student at Barcelona Supercomputing Center (BSC), working in the Distributed Computing group. Her research is focused on improving the performance of HPC applications without modifying them. She enjoys the challenge of the constantly-evolving world of HPC and the idea that it contributes to advances in science.

applications
PhD maths
distributed computing
HPC
constantly-evolving
performance

EXDCI is a European-funded project led by PRACE and ETP4HPC, the two most significant HPC bodies in Europe. It aims to co-ordinate the development and implementation of a common strategy for the European HPC ecosystem by supporting road-mapping, strategy-making and performance-monitoring activities.

This is one of a series of case studies designed to demonstrate the range of interesting careers in High Performance Computing (HPC). More case studies are available at http://www.exdci.eu/CaseStudies/

Marta, tell us a bit about yourself, and how your career path has led you to where you are now.

I am a PhD student at Barcelona Supercomputing Center (BSC). I belong to the distributed computing group. In my PhD work I am improving the performance of HPC applications without modifying the applications themselves.

I studied informatics by chance, I just knew I liked maths and physics and this degree seemed like it had both. I was very lucky because I found out I loved computers and programming.

With my final project I had the opportunity to learn about HPC and found it a fascinating world. Up to then I was working as a web developer for a company. At that point I had the opportunity to change and work in HPC at BSC and to study for a Master's degree to continue learning about it.

With the Master's thesis I started the project that led me to my PhD and where I am now.

So what does your job involve?

Currently at BSC I do research related to parallel computing and programming models. Our focus is to provide to HPC application developers an easy and efficient way to program and run their applications.

I program these tools, test them and evaluate their performance in benchmarks, and then finally apply them to real applications. Although sometimes the process is the other way around, we get an application with a problem and try to find a solution for it.

What are the exciting aspects of working in an HPC-related career? What are the challenges in working with HPC?

I love when we work together with researchers from other areas and we help to solve real problems.

Working in HPC means you get to help a diversity of areas, from forecasting the air quality to simulating and understanding how the human heart works. From finding new drugs to detecting unknown stars.

In HPC everything is multiplied by a very high number, this means a small mistake that implies a performance loss will be multiplied and scaled up to a big performance loss.

When working in HPC you must think big but at the same time be careful with the details and control every tiny aspect that can affect the performance.

Another challenging aspect of HPC is the continuous change. The architectures, the technologies, and everything is changing very fast and you must keep up to date always.

What is your outlook on the use of HPC in your field?

I think HPC will continue to grow faster and maybe it will use new technologies. I do not think it will be available to general users but that it will remain for research or development. I do believe that the variety of fields in which it can be applied will continue expanding.

Where do you see your career leading you next?

The next step will be to finish my PhD, and after that I see myself working in HPC for a long time, I like the challenge it implies, the continuous learning but most of all the idea that we are helping other sciences to advance, discover things about diseases, prevent natural disasters and explore tiny or huge things, from an atom to a galaxy.

MareNostrum supercomputer at BSC: By courtesy of Barcelona Supercomputing Center - www.bsc.es

EXDCI Case Studies: HPC talent generation

Rosa Badia: Research Manager at BSC

Rosa M. Badia is a Researcher and Research Manager at Barcelona Supercomputing Center (BSC), working in the Workflows and Distributed Computing research group and coordinating the Big Data activities. Her research is focused on programming models for complex platforms. Outside the office, she enjoys sports and spending time with friends.

Rosa, tell us a bit about yourself, and how your career path has led you to where you are now.

I am a researcher at Barcelona Supercomputing Center (BSC). I started at BSC in 2005 and now I am a team manager of the Workflows and Distributed Computing research group and the Coordinator of the Big Data activities.

My current research interests are programming models for complex platforms (from multicore, GPUs to Grid/Cloud). I have been deeply involved in several EU-funded projects in HPC.

Outside work, I like going to the gym (Pilates) and playing padel. I also like going for walks, in the mountains or at the seaside, and meeting with friends.

I decided to pursue a computer science degree because it includes both technical and engineering aspects. After finishing my degree, I felt that I wanted to know more and I pursued a PhD in computer science at the Technical University of Catalonia (UPC), focusing on the automatic design of asynchronous circuits. In parallel, I was offered a full-time assistant professor position at the UPC, which enabled me to start teaching very early in my career. After the PhD, I started to collaborate with the European Center for Parallelism of Barcelona (CEPBA) on parallel and distributed computing aspects, and I started to collaborate in EU-funded projects.

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So what does your job involve?

My group focuses on the development of the PyCOMPSs/COMPSs programming model, which is a task-based programming model that aims to parallelize sequential applications and to execute them in distributed platforms. As the manager of the group, I have several roles, like supervising the day-to-day work, attending meetings to define new research or collaborations, monitoring of PhD and Master students, paperwork related to the projects in which I'm involved, etc. However, what excites me most is working with end-users: we help scientists in fields such as life sciences, astronomy, earth science, etc. to optimize the performance of their applications through our programming models and computer infrastructure at BSC. The fact that my work helps the advance of science and research is very gratifying.

What are the exciting aspects of working in an HPC-related career?

I find HPC extremely exciting as a tool that enables progress to be made in science and research in general. It is very exciting and gratifying for me that it can be used to simulate the human brain or heart, assist in the discovery of new drugs targeted at individual genomes, or improve weather prediction and so help people and businesses to make better decisions.

HPC and its environment are a complex system. As such, the challenge in my work is to make it as easy and transparent as possible for the application developer. And this involves different aspects of the HPC systems: computing, storage, software stack, etc.

What was your first experience with HPC? Did that change the course of your career?

My first experience with HPC was with the computer Karnak at CEPBA. Karnak was an SGI Origin O2000 server with 64 processors. On that machine, I was validating the results from the Dimemas simulator (an MPI simulator, developed initially by CEPBA and now developed by BSC). These experiments were part of the European project SEP-TOOLS.

What is your outlook on the use of HPC in your field?

I expect that the new generation of HPC systems will not only be faster, but that they will also enable faster access to large, heterogeneous sets of data, enabling the convergence between HPC simulations and Big Data Analytics.

Where do you see your career leading you next?

New challenges in my career are related to the complexity of exascale systems and their convergence with Big Data. The application of cognitive computing and analytics to the results of the HPC simulations is opening a broad number of challenges, to which our group can significantly contribute with new programming tools and access to new storage technologies.

MareNostrum supercomputer at BSC: By courtesy of Barcelona Supercomputing Center - www.bsc.es

EXDCI Case Studies: HPC talent generation

Felip Moll Marquès: System Adminstrator

Felip Moll Marquès is a System Adminstrator at Barcelona Supercomputing Center (BSC), where he helps to ensure that Spain's biggest supercomputer, MareNostrum, is always available for its users. He participates in one of the Work Packages of the EU-funded PRACE-5IP project, on behalf of BSC. His work takes him to many European HPC centres. Outside of work, he enjoys sailing and other sports, and spending time by the sea.

HPC
cluster
project management Big Data
new technologies
distributed computing
data management

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Felip, tell us a bit about yourself, and how your career path has led you to where you are now.

I currently work at Barcelona Supercomputing Center (BSC) as a System Adminstrator. My main responsibilities are project management, design and implementation tasks, and carrying out continuous improvement to the services and HPC clusters. I like having the chance to innovate and to solve problems while ensuring that everything is kept clear and is well documented.

Curiosity and an interest in understanding at a very detailed level how things work have been the main motivations that have helped me to get to where I am now. When I was young I always wondered how a computer worked. When I found the opportunity to play with some hardware and electronics, I started coding some small programmes, installing new operating systems, and in this way I began to learn how it all worked together.

On the personal side, I love sailing, the sea and sports. I often participate in sailing races, and this experience has taught me that having a target – such as winning a regatta – and sticking to it, and always keeping that target in mind when planning your daily actions, can be a very successful way to achieve a successful end result.

So what does your job involve?

MareNostrum is the biggest supercomputer in Spain. I have the pleasure of being one of the system administrators of this machine. We manage more than 1 petabyte of data, more than 3000 computer nodes, different cluster stack software, and much more besides.

We also manage three other medium-sized clusters that give me the opportunity to use many different technologies, including GPFS, Lustre, Slurm, LSF, Big Data, and GPUs, and finally also other technologies for managing services, such as IBM Spectrum Protect, LDAP, Puppet, Oracle Fusion Middleware, Oracle RAC, MySQL, Bind and Samba.

Another part of my job is to coordinate some tasks within the PRACE Fifth Implementation Phase Project (PRACE-5IP). This is also a very interesting task for me that allows me to see how other HPC centres work, and to not only stick in Spain but also to experience other cultures.
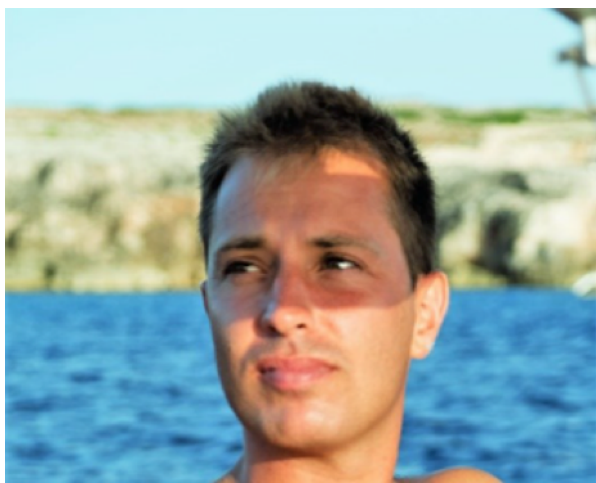
What are the exciting aspects of working in an HPC-related career?

Research is one of the most motivating things. For me it has an ethical component: the aim to create progress for society and the environment is really satisfying.

The major challenge that I see in the HPC world is the one of keeping up to date while maintaining competitiveness, while adapting to the very particular needs of the research staff, given the very different needs that different research teams have. In addition, Big Data, data management, backup/archive, are big and interesting challenges for me.

What was your first experience with HPC? Did that change the course of your career?

I started my HPC experience in my first job at a research centre called CIMNE. There was a small 12-node cluster that nobody was maintaining and I took on the responsibility of investigating on my own how it worked, how to upgrade everything, how to configure schedulers, and so on. At that time (in 2009), I did not know that clusters existed, and didn't even know what a scheduler or a workload manager were. I really enjoyed discovering this world, from hardware, to cluster stack, to software stack, and finishing helping researchers with their parallel codes. All this work was used to do the final project for my degree, and a document of approximately 300 pages is available either from my personal webpage (http://lipix.ciutadella.es/) of from the Universitat Politècnica de Catalunya institutional repository, UPC Commons (http://upcommons.upc.edu/).

Where do you see your career leading you next?

I see myself managing a team, leading the progress of some company or department, doing things professionally and keeping my mind open to new technologies. I like to innovate and work for companies that have their mission focused on the benefits for the society and the environment.

MareNostrum supercomputer at BSC: By courtesy of Barcelona Supercomputing Center - www.bsc.es

EXDCI Case Studies: HPC talent generation
Jure Jerman: Meteorologist

Jure Jerman is a meteorologist at the Slovenian Environmental Agency (ARSO), and he was one of the first people to build a Linux cluster for operational weather forecasting. While the development of commercial HPC solutions means he no longer has to tinker with the system as much, he still fins working with HPC exciting. Outside the office, he enjoys applying his meteorology knowledge to sailing.

weather forecasting
environmental agency
HPC
meteorology
ALADIN meterological model
code optimisation

Jure, tell us a bit about yourself, and how your career path has led you to where you are now.

I am a meteorologist at the Slovenian Environmental Agency (ARSO), where I manage the Department for Numerical Weather Modelling and Meteorological Techniques. At my work, I'm faced with the biggest challenge in forecasting the weather, i.e. the changeability of weather forecasts, which means they are effectively perishable goods – and unfortunately people usually remember us for the wrong forecasts, not the accurate ones.

My first visit to Meteo France was as early as 1994, and there I was involved in the development of the limited area meteorological model ALADIN. These visits were a good way to learn about the operation of large-scale meteorological services and my colleagues and I always strived to have as many good practices as possible implemented at the former HMZ (Hydro Meteorological Institute). We were among the first to have succeeded in operationally implementing the ALADIN model outside of MeteoFrance. Above all, for me the period between 1996 and 2003 was highly associated with the development of HPC systems; after that I was an interim deputy director of the Meteorological Office at the ARSO. In recent years I've been able to dedicate more time to more substantive meteorological work.

So what does your job involve?

Planning, implementation of procedures and the procurement of HPC equipment. In the past, we dedicated a lot of time to optimization of systems, but today the pioneering stage of development of HPC systems based on Linux clusters is at the end. The remaining HPC tasks are the administration and optimization.

What are the exciting aspects of working in an HPC-related career?

You could say that in some ways the romantic phase is long gone, but on the positive side, the "ready-made" solutions make my job much easier. If the operating system fails, it is often no longer a challenge - but nevertheless, fixing a problem with the HPC system can still lift one's mood.

Are there any challenging aspects in working with HPC?

The biggest challenge probably lies in optimizing the operation of the program code on a truly large number of processors. ECMWF (European Center for Medium Range Weather Forecasting) as the world's leading organization in the field of global numerical weather forecasting has perceived this problem as critical and is addressing it as a priority under the "Scalability" project.

What was your first experience with HPC? Did that change the course of your career?

We have been modelling the weather in a limited area for more than 20 years, and had our own infrastructure since 1997. As the numerical modelling of weather is a typical HPC application, but we were unable to afford an HPC system in the beginning, we initially began porting the weather model code to Linux around 1996 and in 1997 we were one of the first in the world, if not the very first, to use a Linux cluster for the calculation of an operational model. As a curiosity, in 1997 we were educating one of today's world leading manufacturers of HPC systems on what Linux clusters are and on their importance in meteorology.

What is your outlook on the use of HPC in your field?

Unless there is a qualitative (quantum) leap in this field, we are doomed to using systems that require megawatts for their operation and further megawatts for their cooling. The direction of development where more computing power is achieved only by increasing the number of processors is probably not right. I still have the feeling that in many cases the available computing power is not used properly. After all, we still haven't invented the cure for the common cold!

Where do you see your career leading you next?

The smart use of meteorology in various fields. To optimize the operation of business systems with the use of meteorological information.
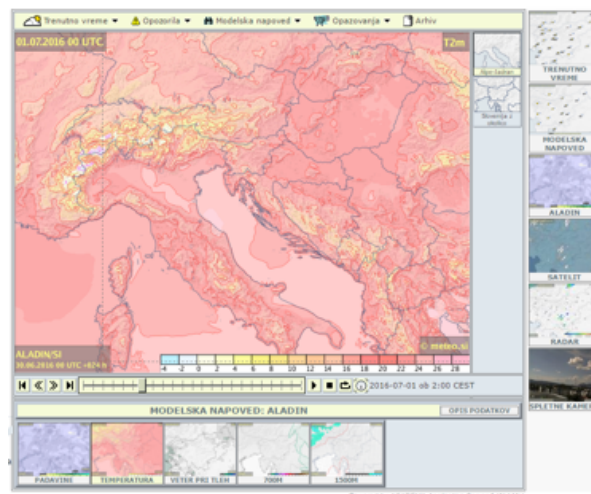
Temperature prediction using ALADIN model: By courtesy of the Slovenian Environment Agency – www.arso.gov.si

EXDCI Case Studies: HPC talent generation

Nicola McDonnell: Consultancy & Solutions for Industry Activity Leader, ICHEC

Nicola (Nix) McDonnell is the Consultancy & Solutions for Industry Activity Leader at the Irish Centre for High-End Computing (ICHEC). Her work includes project management, project proposals coordination, and EC H2020 activities. Nix started as a chemist, briefly worked in marketing, and then began a love affair with computer science. Now, as a qualified Project Manager, she uses her talents and interests to propel her career in HPC.

Nix, tell us a bit about what you do.

My role is to coordinate the project management within ICHEC, with a focus on industrial projects. All projects need managers, and I ensure anyone who needs training gets it. I go to courses on new management methodologies, and consider how these might work for us. Project management is something I enjoy and in which I am certified (eg PRINCE2, Scrum Alliance). I've been a full-time project manager at ICHEC for 5 years, but I have always managed at some level.

How does HPC relate to what you do?

I work with industry partners who are in need of HPC resources and expertise. HPC resources are limited and efficiency is a key component of HPC, so both my project management experience and computer science expertise are highly important.

Where has your career taken you so far?

I studied Natural Sciences at Trinity College Dublin, specialising in Chemistry, but then wanted to explore my creativity so took a job in marketing with a biomedical equipment manufacturer in the USA. I sat beside the IT guy and grew interested in his work, especially the programming aspects. I began to code for him when opportunities arose, and did an evening course in programming. That job is where my passion for programming began, and I decided to pursue it by returning to college.

Please tell us more – what happened then?

I did a conversion Master's in Computer Science at Queen's University, Belfast, and around that time, I read "Distributed Objects", an article in *Wired* magazine by Steve Jobs. It happened that a Dublin company which made distributed object middleware, IONA Technologies, was recruiting

for a java programmer. Java was very cutting-edge at the time, as it had only recently been released, – but I had studied it in my Master's and got the job. After 3 years, I took a year off to travel the world!

That's very exciting! You drifted into gaming then, didn't you?

On my return, I worked for a company which made hardware as well as software. My Master's was heavily software-focused, so I was intrigued to learn about hardware. This position was exciting, but after two years the IT industry hit a downturn. An interest in video games led me to a Postgraduate Diploma in Computer Games Development at Abertay University.

What happened then?

It's a funny story. I applied for a short-term post in a spin-off from the University of Edinburgh, but at interview I was asked all kinds of really strange questions. Completely puzzled, I went back to look at the job spec – and realised there were two very different jobs open, and I had interviewed for the wrong one: a 2-year neuroinformatician post within the university instead of a 3-month Java contract in the spin-out company! Amazingly, I got the job, as they needed someone with 3D visualization / graphic experience to build models of rats' brains and monkey brains.

While working there at the Institute for Adaptive and Neural Computation, I discovered a common thread to much that had interested me over the years: I distinctly remember as a child watching fascinated as ants carried away food I had thrown on the ground; in video games my interest was in management simulation games like SimCity; I was interested in genetics in college; and my Master's project was to build an agent system. I learned that these all had the same underlying system: a self-organising system. This lifelong interest has now led me to a part-time PhD in this subject!

What was your first experience of HPC? Did that change the course of your career?

When the university contract ended, I returned to industry, but missed the academic environment. So I applied for a job at EPCC at the University of Edinburgh. I had no HPC experience, but EPCC developed Grid middleware software, OGSA-DAI, which related loosely to the CORBA middleware technologies I had worked on at IONA.

At EPCC I worked mainly on Grid-related projects. My first explicit experience of HPC came during a six-month secondment to ICHEC, working on a CUDA weather code. CUDA was quite novel at the time so I was thrilled to get this opportunity. With this under my belt, when I returned to EPCC I worked on another CUDA project and an HPC micro-benchmark project. I really enjoyed the work and environment at EPCC, but during my secondment I had decided to relocate back to Dublin permanently, and managed to get a job at ICHEC.

What are the exciting aspects of working in an HPC-related career?

The significance of the work that we facilitate is what excites me; working on groundbreaking science and technologies which will influence the world in the future gives me a strong purpose.

Project management is tough - how do you find it in relation to the HPC environment?

My background in science and computer science helps me to understand the technical side of HPC. Years of experience and training, plus strong organisation and communication skills, help me to ensure we all work towards the client's or user's vision. It's very important to know what you don't know and spend extra energy there, to identify risks. Reducing the risk of a project dramatically reduces its likelihood of failure. Fostering an open environment where critique is well received and given is also invaluable. The most important thing I can do is create an environment where everyone understands the purpose of the work and has enough autonomy to take ownership and responsibility for achieving the objectives, and also to ensure that we are always challenged and improving, in technical aspects and, just as importantly, in soft skills such as teamwork.

Are there any challenging aspects?

Plenty of good challenges! It's a very fast-paced, highly technical environment, and a competitive environment with little room for error. All of the people I work with are highly intelligent. These challenges enable me to push myself to new heights, which is something I value in my career.

Where do you see your career leading next?

Well, I will continue working on my PhD – it is part-time so it's going to take a while. I am excited to see how the HPC industry evolves and so at the moment I am very happy in aligning my research with my skills, abilities, and experience. I also find the new Women in HPC initiative (www.womeninhpc.org) very inspiring and I'm keen to get more involved.

EXDCI Case Studies: HPC talent generation

Mehdi Amini: Compiler Engineer

Mehdi Amini is a tech enthusiast who works for Apple, and is based in the San Francisco Bay Area. He has a particular interest in parallel and heterogeneous programming, including GPUs, and holds two Master's degrees and a PhD. A cross-disciplinary Master's project, working with an astrophysicist, first sparked his interest in HPC.

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Medhi, tell us a bit about yourself, and how your career path has led you to where you are now.

Originally from Strasbourg, I am now enjoying the California weather in the San Francisco Bay Area, where I work as a compiler engineer at Apple.

My first contact with HPC was during an introductory Master's class on parallel computing. My Master's thesis project was a collaboration between the HPC centre and an astrophysicist who was interested in doing galactic simulations using GPUs. This was right when CUDA was first released and I found it mind-blowing at that time. The cross-disciplinary collaboration with brilliant researchers was also a very interesting part of the job. My interest has been in HPC since that time.

After completing two Master's Degrees in Strasbourg, I was employed at the University as an engineer for three years, working on the HPC resources amongst other things.

I left the university to join SILKAN, a startup specialising in high-performance simulations, which has now built up a particularly strong presence in the aerospace and defence, transport, and energy sectors. There I was working in collaboration with MINES ParisTech on a research project which involved compilers technology and heterogeneous computing with GPUs.

After completing my PhD, I relocated to Silicon Valley to help with the launch of the subsidiary which the company was just opening there. Finally, my last move led me to join the compiler group at Apple, where I'm currently working on the open-source Clang/LLVM project (https://clang.llvm.org/). My focus is on trying to improve the optimisations in the project.

So what does your job involve? How does HPC relate to what you do?

As a compiler engineer, multiple aspects are important: supporting new hardware, helping to develop new languages or language features, and improving performance.

My main focus is currently on performance: optimisations in the compiler provide a double-digit percent improvement in performance.

This translates directly into cost-efficiency in devices of all sizes, from improved efficiency in the utilisation of supercomputers, all the way down to a slower drain on the battery in your smartphone.

What are the exciting aspects of working in an HPC-related career?

The exciting aspect of working in a performance-constrained environment is how challenging it can be to get the next few percents of improved efficiency out of the available components. We constantly have to be innovative, and usually go to great lengths to reach the next step.

Another aspect of being a compiler engineer is the need both to understand the software, as written by the programmer, and have a strong knowledge of the details of the hardware. We often gain significant improvements when collaborating with the hardware designers directly. It is definitely an advantage to work in a company – such as Apple – which controls the end-to-end project.

Are there any challenging aspects?

The mobile market today is also very demanding, presenting its own challenges. The power budget is limited because the battery is a scarce resource. From a compiler point of view, improving the performance of the software usually translates directly into power saving.

Another important aspect is the binary size: building and shipping a full OS on a watch requires great care in terms of the size of the program we produce, and we sometimes have to go the extra mile to get just a few percent reduction.

Where do you see your career leading you next?

Compilers are very large beasts (LLVM is approaching 1.5M of lines of C++, and Clang is over 1M). I am sure that I have plenty of time ahead of me working on various related projects.

The compiler is also a critical component of the developer toolkit, and it will be for some time.

Working on the compiler is a place where I feel I have opportunities to be innovative, while being surrounded by brilliant engineers from whom I am learning every day.

Finally working on an open-source project is definitely a plus, and the LLVM project has a focus on quality and moves at a fast pace that matches what I like.

The prominence of heterogeneous hardware everywhere, from the smartphone to the supercomputer, and the respective challenges they offer, make it a common goal to extract even more performance out of the software.

HPC used to be a niche for supercomputers, but that has been over for some time now: HPC is everywhere.

Golden Gate Bridge, San Francisco (USA)

European
Extreme Data
& Computing
Initiative

EXDCI Case Studies: HPC talent generation

Ondřej Vysocký: Research Assistant & PhD student

Ondřej Vysocký is a Research Assistant at IT4Innovations National Supercomputing Center of the Czech Republic. His Bachelor's thesis introduced him to the world of HPC, leading him on to do a Master's degree. His interest was furthered by a two-month PRACE Summer of HPC placement at EPCC in Edinburgh. He is currently working on READEX, a European project for energy-efficient exascale computing, and is also studying for a PhD.

Simulations
Interdisciplinary cooperation
Energy-efficient computing
HPC
Summer schools
Exascale
Visualisation

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Ondřej, tell us a bit about yourself.

I am from the Czech Republic, from Ostrava. I decided to move to Brno with my friends, to study programming at Brno University of Technology. I completed my Master's degree there, and got my first experience of working with HPC there. Now I work at IT4Innovations National Supercomputing Center of the Czech Republic, in Ostrava.

How did your career path lead you to HPC?

When it was time to choose the topic for my Bachelor's thesis, I was considering two areas. The first was computer vision, which is very popular at the university because there is a large group of people with a strong background in this field. The second was parallel programming, and I selected this, as I saw in it the future of computer applications. This decision was a milestone in my career.

The key moment was my first meeting with Dr. Jiří Jaroš, who introduced me to an HPC toolbox k-Wave that is designed for time-domain acoustic and ultrasound simulations. It is mainly used in medicine, for non-invasive surgery and screening. The basic idea is the use of high-intensity, focused ultrasound that has a destructive effect on the human body tissue in the beam focus only, and nowhere else. At this meeting I didn't understand much, however the topic sounded so interesting that I joined the group and started to work on I/O optimisation, which was a serious problem in this particular library. I was working on this issue for three years, successfully finished a Bachelor's and a Master's thesis, and improved the speed of storing data in problematic cases several times.

During that time, I applied for the PRACE Summer of HPC[1] summer school, and was selected to go to EPCC in Edinburgh. I spent two months there, working on a visualisation of proteins using the Fluctuating Finite Element Analysis (FFEA) tool. It was a great experience to work abroad, travel, and meet new people who all shared a common interest in HPC despite being from different parts of Europe and from different fields of study.

So what does your current job involve? How does HPC relate to what you do?

After finishing my Master's studies I moved back to my hometown of Ostrava because I wanted to be closer to my family. After three years in HPC, applying for a job at IT4Innovations National Supercomputing Center in Ostrava was the obvious next step in my career. Also, besides working at IT4Innovations, which is connected with VŠB - Technical University of Ostrava, I have started my PhD studies there as well.

At IT4Innovations I was supposed to work on I/O optimisation of the ESPRESO linear solver, which is being developed there. However, I had the opportunity to join an EC-funded FETHPC project, READEX[2] – Runtime Exploitation of Application Dynamism for Energy-efficient eXascale computing. READEX deals with energy consumption optimisation of HPC applications, based on changing a set of hardware, software system and application-level parameters during the runtime to fit application needs without wasting resources. In the project we develop tools to analyse application behaviour, search for the best configuration for separate parts of the code, and apply the configuration during the application runtime. All of these will be done automatically. My role in the project is in manual tuning of applications. At this stage we are searching for the maximal savings that we can achieve with the automatic tools. To do this, I have developed a MERIC library, which allows manual tuning of C, C++ and Fortran applications with MPI or OpenMP.

What are the exciting aspects of working in an HPC-related career?

In general, there are three things that express the meaning of HPC for me: programming, exploring, and connection with other fields. First, I really like to write code. There is no reason to worry about parallel programming, especially when using a high-end MPI or OpenMP interface. As HPC researchers we develop new tools, and our work has an effect on the state-of-the-art in many different fields. It is important to realise that most HPC projects involve people from different fields of research. Cooperation with experts in, for example, mathematics, physics or molecular dynamics always brings new challenges. Each side has their own specific needs and opinions that must be explained to others and integrated into the project. Having at least some knowledge of what others do can simplify the communication. I was really surprised when I found out that most of the Summer of HPC participants were not programmers, but students from different fields of study. However, I now understand the organisers' choices. It is important to introduce more people to what we do and how we do it, and ensure that they can have access to HPC resources if they need them.

Finally, I should not forget that working on an international project is also an exciting challenge. READEX is not a typical HPC project, because it pushes towards knowledge about HPC itself. In this case we are applying techniques related to embedded systems, thanks to our colleagues from Norway, who are experts in this field.

What are your plans for the future?

I don't like to plan ahead too much, however there are some exciting events on the horizon. This summer, after finishing my first year of PhD studies, I will spend a week in the USA, at the International HPC Summer School at the University of Colorado. I hope that this will be another memorable event, where I will learn a lot. The READEX project also has more than a year to run and there are always more new projects coming to IT4Innovations. I will not get bored!

Ondřej with Jana and Anna, his companions on the 2015 Summer of HPC programme in Edinburgh

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[1] Summer of HPC: https://summerofhpc.prace-ri.eu/
[2] READEX project: https://www.readex.eu/

EXDCI Case Studies: HPC talent generation

Massimiliano Alvioli: Landslide modelling researcher

Massimiliano Alvioli graduated in physics and works at the Italian National Research Council, Research Institute for Geo-Hydrological Protection. He mainly deals with numerical modelling of landslides on a large scale. He likes to apply parallel and distributed computing techniques borrowed from his physics background and the HPC world to the geosciences domain, trying to bring HPC awareness into this potentially enormous user base.

Problem solving
Geosciences
HPC
Landslide modelling
Data
Nuclear physics
Parallel computing

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Marta, tell us a bit about yourself.

My current job is at the Italian National Research Council, specifically at the Research Institute for Geo-Hydrological Protection (CNR IRPI). The Institute is nation-wide, with five offices: I work in Perugia. We specialize in the study and assessment of geo-hydrological hazards, mostly landslides and floods. I am interested in landslide modeling, both with so-called physically-based models and with statistical models.

The use of HPC techniques in the geosciences world is very challenging, and thus interesting, for various reasons. First, typical applications are very demanding in terms of the CPU, RAM and I/O requirements. Second, geo-data exist in either raster (i.e. matrix) or vector format, and the interoperability of the two usually requires working with databases, not a trivial issue when it comes to high performance. Third, virtually any application dealing with geo-data was born as a desktop application, with a few, more versatile exceptions: most of the HPC-like improvements must be worked out as exploits of the original application capabilities.

How did your career path lead you to HPC?

I landed at CNR IRPI after a few post-doc positions. I graduated from the University of Perugia, where I obtained my PhD (Italian Dottorato di Ricerca) in 2003, specializing in Theoretical Nuclear Physics. Afterwards, I stayed in Perugia for a 5-year post-doc in the same field.

Then I moved to the United States thanks to a two-year post-doc at the Pennsylvania State University, and then came back to Italy, to Trento, where I worked at the European Centre

for Theoretical Studies in Nuclear Physics and Related Areas (known as ECT*) for two years until 2012. Both in the USA and in Trento I continued to work in Nuclear Physics, though a bit more on the phenomenology side. At this point I switched to my current job. The liason between the Physics-related work and my current job was computing, of course.

I started looking at parallel computing when I was an undergraduate student, back in the 1990s, and I learned from my fellow PhD students that you could put several desktop computers together and build your own computing cluster. Thus I decided to attend the CINECA parallel computing school in Bologna, and have never stopped using HPC techniques and facilities since then. I participated in the HPC-Europa mobility program several times, which allowed me to visit EPCC in Edinburgh, University of Glasgow, University of Manchester, Universitat Politècnica de Catalunya in Barcelona, CSC in Helsinki and University of Jyväskylä in Finland. I also participated in the DEISA Extreme Computing Initiative and, recently, obtained access to the Italian HPC facilities thanks to the CASPUR/CINECA HPC grants from 2010 through 2017. I took my last HPC course about parallel I/O and management of large scientific data last month at CINECA, in Rome. That is all to say that HPC surely was a relevant part of my career and I am grateful that I started looking into that when I was a physics student.

In addition to work in landslide modelling, I continue to keep in touch with the Nuclear Physics community, and enjoy doing some research in that field. Needless to say, a lot of my work in this sense involves numerical modeling and accessing HPC facilities. Recently, in my spare time, I have embarked with a few former colleagues on a rather different project, founding a startup devoted to disseminating technologies and innovations, including computing expertise, from academia to the private sector.

Why work in HPC? What are the exciting aspects?

In my experience, the computing community is so diverse that you hardly ever leave an HPC meeting without having learnt something new, even from seemingly different fields. The average HPC user can either be a Physicist, a Chemist, a Mathematician or a "pure" Computer Scientist, but they all share the same attitude to problem solving and need for smart and fast applications. Nevertheless, in my current research field, HPC techniques are vastly underrated: that is why I talk about awareness of modern computing

capabilities. The challenge is to use existing and established technologies in fields like Geosciences, where they were historically not the main focus, at least for the vast majority of researchers in the public/non-profit sector. That is not counting meteorology, of course, which is probably one of the largest communities using HPC resources.

What are your plans for the future?

In the last few years, I have tried to take advantage of what I have learnt from the HPC community to develop applications for my current job. In doing so, I have found out that despite the huge number of researchers working in this field – just think that the European Geosciences Union general assembly which takes place in Vienna every year gathers about 15,000 participants with an even larger number of oral/poster presentations – when you go to the HPC world little is done in this direction. For example, when accessing HPC facilities, you can't find the basic geo-spatial tools in the list of available software.

My aim for the near future is to explore the possibilities of further improving the use of high performance resources in my field of research, and I believe it is feasible and worth doing. We have one general purpose GIS (Geographic Information System) application which is probably the best candidate for such an effort. I already have installed and used the software with success on Galileo@CINECA. The next step would be to develop a custom, HPC version of the GIS in order to make it useful for a vast number of users.

Massi supports the movement against temporary employment contracts for researchers.

EXDCI Case Studies: HPC talent generation

Luna Backes Drault: Graduate Student of Computer Engineering

Luna Backes Drault, a Graduate Student of Computer Engineering at Texas A&M University, has always had an international outlook – while studying for her first degree in Spain, she undertook internships in Slovenia and the UK. In her spare time she loves cooking for friends and listening to music, and also used to compete in ballroom dancing.

EXDCI is a European-funded project led by PRACE and ETP4HPC, the two most significant HPC bodies in Europe. It aims to co-ordinate the development and implementation of a common strategy for the European HPC ecosystem by supporting road-mapping, strategy-making and performance-monitoring activities.

This is one of a series of case studies designed to demonstrate the range of interesting careers in High Performance Computing (HPC). More case studies are available at http://www.exdci.eu/CaseStudies/

Luna, tell us a bit about yourself.

I completed my studies in Computer Engineering at the Universitat Politècnica de Catalunya in Barcelona (Spain) in 2015. I am now a Graduate Research Assistant at Texas A&M University in the USA, and am also undertaking my second summer internship at the Samsung Austin R&D Center, in the Performance Architecture team.

I have always taken opportunities to live international experiences. During my studies, I spent two months at the University of Ljubljana (Slovenia) through the PRACE Summer of HPC programme (https://summerofhpc.prace-ri.eu/). The following year, I spent a semester as an Erasmus exchange student at the University of Edinburgh (UK), and this led on to a three-month internship as a Research Assistant there. I have also attended many conferences and events in Europe and in the United States.

How did your career path lead you to HPC?

During my undergraduate studies, I had a few courses on parallel architectures and programming that were very interesting, plus many of my professors were also researchers at the Barcelona Supercomputing Center (BSC). I reached the conclusion that HPC is both an interesting and highly useful field of Computer Science. Through the faculty webpage, I learned about the PRACE Summer of HPC programme, and taking part in this opened my eyes to the world of HPC.

For my Summer of HPC placement, I spent 2 months in the Laboratory of Computer-Aided Design at the University of Ljubljana, working on a project to allow additional ways to visualise data from tokamak nuclear fusion reactor simulations.

Nuclear fusion promises to be the energy of the future – it is not possible to produce energy this way yet, but researchers from across Europe are carrying out simulations to try to understand how to do it. All the simulations are stored in a very complex database which only a supercomputer can deal with. This project aimed to improve the way scientists could analyse their experiments.

Working with my mentor, Leon Kos, was a great experience and I learnt a lot from him and the other people in the lab. It was also exciting to be part of a project which aims to benefit society as a whole, through finding a way to create a new alternative to fossil fuels.

Following on from this experience, the next year I took part in the ACACES Summer School, organised by the HiPEAC Network of Excellence (http://acaces.hipeac.net/2014/). The aims of this summer school are the dissemination of advanced scientific knowledge and the promotion of international contacts among scientists from academia and industry. This was during the period when I was working as a Research Assistant at the University of Edinburgh, following on from my semester there as an Erasmus exchange student.

When I came back from Edinburgh, I joined BSC as a Research Assistant, where I worked on the EC-funded Mont-Blanc project. Through this project, I ended up leading the *Mont-Blanc Climbers* team, one of 11 teams that took part in the HPCAC-ISC Student Cluster Competition 2015 at ISC, the major annual European HPC conference. This annual competition is designed to introduce the next generation of students to the world of HPC. Teams of students have to build a small cluster of their own design on the exhibit floor, and race to demonstrate the best performance across a series of benchmarks and applications. We were the first team to bring an ARM-based cluster to the competition to promote emerging technologies in HPC.

In 2015, I also took part in the International HPC Summer School, which was held in Toronto (Canada).

Why work in HPC? What are the exciting aspects?

One of my passions is computer architecture. I like to think that by improving the processor's architecture and making it faster and more efficient, I am contributing my grain of sand towards solving current social challenges while other scientists develop the algorithms. These kinds of problems require lots of compute resources to solve them in a timely manner. It is also great that for HPC it is necessary to combine the expertise of scientists from different fields.

Are there any challenging aspects in working with HPC?

There are many. For example, the challenge of scaling an application to a huge number of cores, while making efficient use of resources. This is important to minimize costs and still get an accurate result.

Another significant problem is power: today's supercomputers already consume about 20MW. This, combined with the impossibility of making the transistors smaller to get more performance, brings an important challenge to computer architects. Adding more processors would just require a huge amount of power.

And third, in HPC, it is necessary to work and collaborate with scientists from different fields. This is very nice, but it can be a challenge too, especially if they all are in different countries.

Where do you see your career leading you next?

I just finished my master's degree and I am starting a PhD right after my internship. After that, I expect to apply my knowledge and keep working on computer architecture. In the future, I would like to manage a team to create high performance and efficient processor architectures.

Luna (centre) and her PRACE Summer of HPC companions, Ezhilmathi and Evguenia, at Predjama Castle (Slovenia).

EXDCI Case Studies: HPC talent generation

Claudia Rosas Mendoza: Performance Analyst

Claudia Rosas Mendoza is a Performance Analyst at Barcelona Supercomputing Center (BSC). Her main research focuses on the prediction and understanding of the behaviour of parallel code. As she says, "Eight years ago, I did not know what HPC was, but after seeing just a glimpse of its potential, I felt like a kid in a candy store". Having followed her interest in computers from a young age, she now has a dream job working with a supercomputer, and has an interesting story to share.

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Claudia, tell us a bit about yourself. How did you come to work in HPC?

I come from a small city in a country which generates most of its income from the oil and gas industry. I was lucky to grow up in a home where computers and technology were welcome, with parents who encouraged my curiosity, and who fed my interest in doing fun and useful things with computers, and in developing my organisational, planning and development skills.

When the time came to choose my studies, I naturally enrolled for a Bachelor of Computer Science, and finished a ten-semester degree in my hometown university in record time. I was 21 when I graduated, and already felt comfortable with computers and programming languages. I have never felt that Computer Science is a subject area reserved only for boys or men. On the contrary, I have always felt in my element, and capable of accomplishing more in the future.

With my Bachelor's degree in one hand and a wide range of possibilities in the other, I enrolled for graduate studies in simulation and modelling at the Universidad de Los Andes, Venezuela – but I also dreamed of studying abroad. So I applied for a scholarship from the Universitat Autònoma de Barcelona, Spain, and was accepted to carry out pre-doctoral research in the Computer Architecture and Operating Systems Department. Without thinking twice, I was on a plane to Barcelona.

In my first weeks as a graduate student, I had the opportunity to visit MareNostrum, the most powerful supercomputer in Spain, on the campus of UPC, the Universitat Politècnia de Catalunya (or BarcelonaTech). They showed us a simulation of the very first second of the Big Bang, which the researchers were working on in those days. At that very moment, I knew that I wanted to be part of it! I wanted to discover new things with that giant 'toy'.

Chapel Torre Girona, housing the MareNostrum IV supercomputer at BSC (source: Claudia Rosas Mendoza)

With hard work I proved to myself that I was able to keep on track, and when I finished the MSc degree, I enrolled in PhD studies. After four years I was holding a qualification in High-Performance Computing and was an expert in the performance analysis in the HPC environment. However, I did not have the chance to play with a big machine like MareNostrum until I got a post-doc position at the Barcelona Supercomputing Center (BSC). At BSC I learned all I know about the analysis of applications running on HPC systems from the Director of the Department of Computer Science and the Performance Tools Group.

In my view, a parallel application running on an HPC system must take into account the hardware in order to get the best performance results. Now I am in the Department of Computer Applications in Science and Engineering, where I am continuing to improve my understanding of the whole picture. Every day I learn something new about what effect the algorithms or optimisation techniques have on specific code when running on new hardware, such as multiprocessors.

Why you are passionate about working with HPC?

Eight years ago I did not know what HPC was, but after seeing just a glimpse of its potential, I felt like a kid in a candy store. I have been involved in studying, analysing and understanding most of the ecosystem of HPC facilities, from architectures to programming models to analysis tools, and it is hard to know them all. But, when you are familiar with the environment, you can see it as a big orchestra in which every instrument knows its role and must be properly tuned in order to play a masterpiece.

We still have a lot of challenges in the field; we want energy-efficient computing, we want to be able to run our codes on exascale machines, and to work with new architectures and paradigms. All these tasks combined with engineering and scientific applications involve a comprehensive toolbox to play with every day.

What would you like to share with young people with interest in computers and HPC?

With my story, I not only want to encourage young people, especially girls, to be curious about opportunities outside the typical careers, but to highlight that variety is the spice of life. When working in HPC, you will not only program a solution for a relevant problem in a certain field, but also work with outstanding professionals from areas as biology, physics, mechanics, materials etc. Everybody will have their own quests and new questions to answer, and will create the history of many fields of science. And of course it's always fun to say that your computer is a supercomputer!

With the legendary Professor John Hopcroft at the Heidelberg Laureate Forum 2016 (source: Claudia Rosas Mendoza)