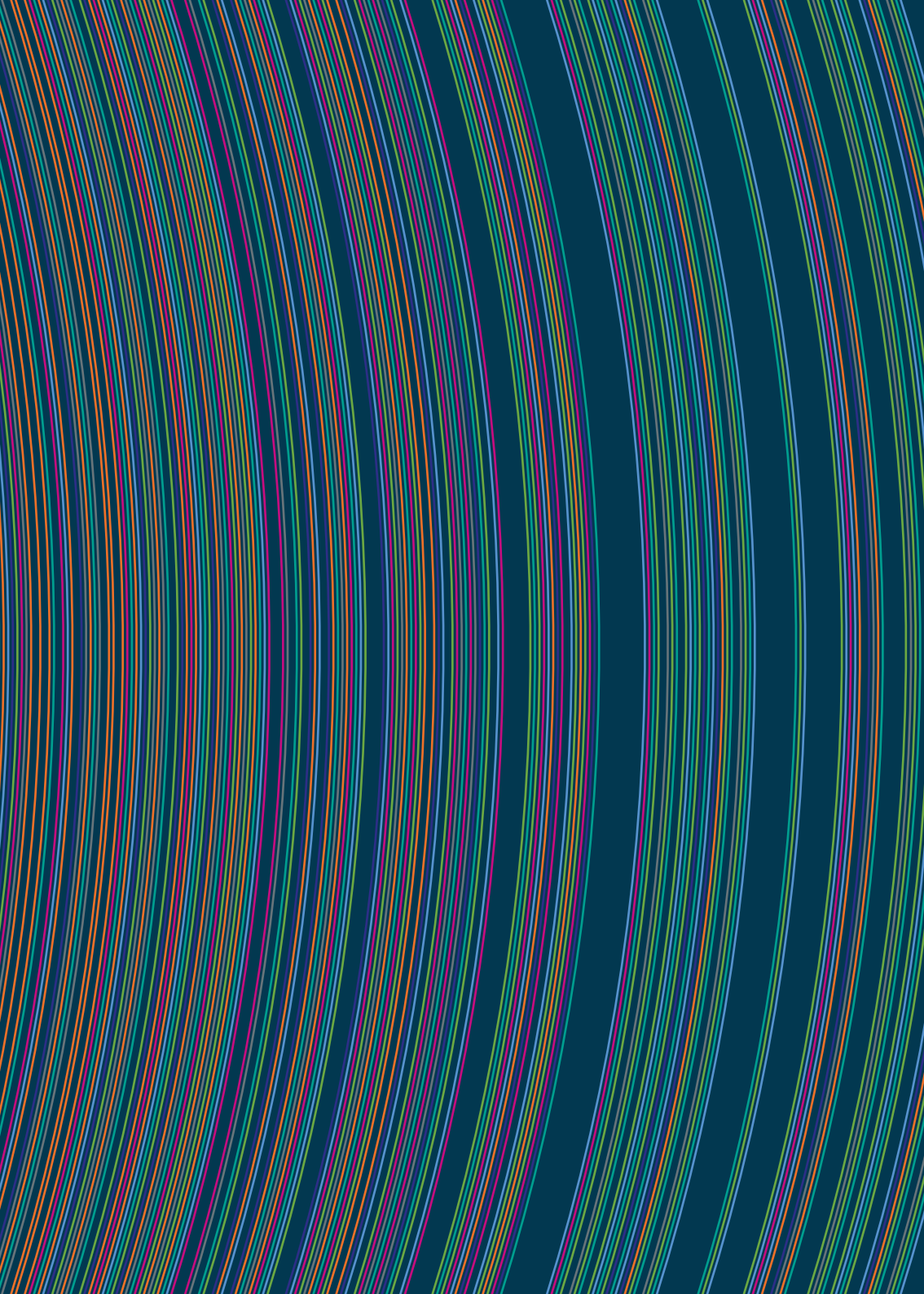




European High-Performance Computing Projects

Handbook **2020**

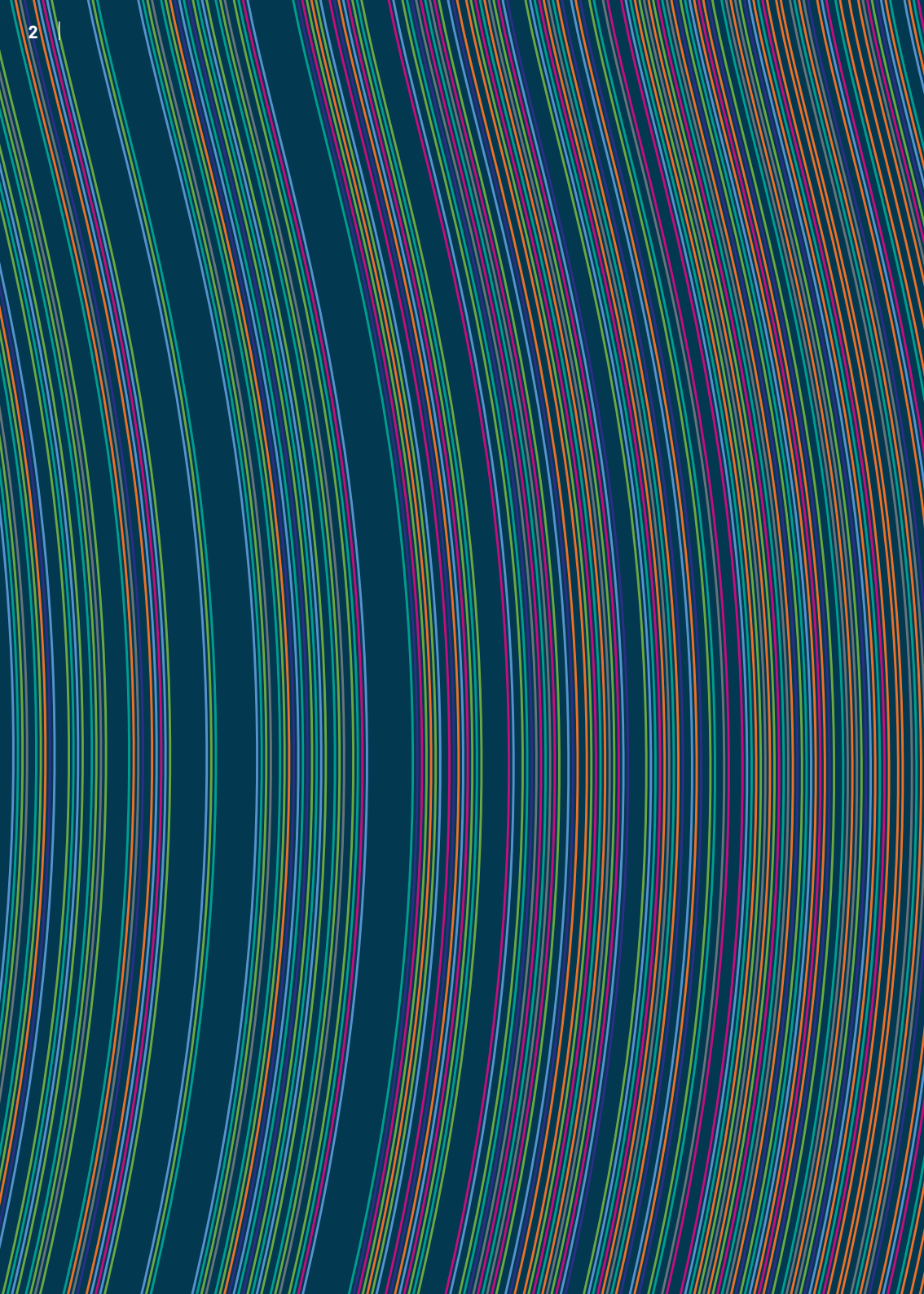




EUROPEAN TECHNOLOGY
PLATFORM FOR HIGH
PERFORMANCE COMPUTING



www.etp4hpc.eu
www.etp4hpc.eu/EuExascale
: @Etp4HPC
: @etp4hpc
Contact: contact@etp4hpc.eu



Dear Reader,

I am told that the idea of this publication goes back to 2015, when ETP4HPC, now a partner in EuroHPC, was looking for a mechanism to provide a comprehensive overview of all projects in our arena. That first issue was a simple summary, photocopied and stapled manually.

The number of pages and the appearance of this year's issue mirror the growth and maturity of our ecosystem: 50 on-going projects are listed in the current edition, and references are included to 30 projects that have been finalised. Also, the current project landscape is characterised by its diversity: from the early FETHPC projects, we have progressed to application-domain specific projects (e.g. the Centres of Excellence), integrated co-design projects, as well as test beds and processor development projects.

I am glad to note that the EuroHPC Joint Undertaking can claim part of the credit for the size and breadth of this effort. In the coming years, the role of our JU will become even more visible as more and more EuroHPC-funded projects get under way.

I would also like to emphasise the emergence of a new concept: the TransContinuum, which is being developed by ETP4HPC and other similar organisations. A number of projects already fit into the definition of this term: the role HPC plays in complex workflows in conjunction with Big Data, Artificial Intelligence, Internet of Things and other technologies. I am sure we will see more work of this sort – the application of HPC being at the core of the Digital of the Future.

I trust this Handbook will continue to serve as an efficient repository of our project work, helping you to orientate in this complex landscape. In these difficult times, it is important to keep in touch and keep the light of progress lit.
Best regards,

ETP4HPC Chairman
Jean-Pierre Panziera

Table of Contents

6. European Exascale Projects

9. Technology Projects

10. ASPIDE
12. DEEP projects
14. EPEEC
16. EPiGRAM-HS
18. ESCAPE-2
20. EuroExa
22. EXA2PRO
24. ExaQUte
26. MAESTRO
28. RECIPE
30. Sage2
32. VECMA
34. VESTEC

36. Centres of Excellence in computing applications

38. FocusCoE
40. BioExcel
42. ChEESE
44. CoEC
46. CompBioMed2
48. E-cam
50. EoCoE-II
52. ESiWACE2
54. EXCELLERAT
56. HiDALGO
58. MaX
60. NOMAD
62. PerMedCoE
64. POP2
66. TREX

68. European Processor

70. EPI

74. Mont-Blanc 2020

76. Applications in the HPC Continuum

78. AQMO

80. CYBELE

82. DeepHealth

84. EVOLVE

86. LEXIS

88. Phidias

90. International Cooperation

92. ENERXICO

94. HPCWE

96. Quantum Computing for HPC

98. NEASQC

100. Other projects

102. EXA MODE

104. EXSCALATE4COV

106. OPRECOMP

108. PROCESS

110. SODALITE

112. Ecosystem development

114. CASTIEL

116. EuroCC

118. EUROLAB-4-HPC-2

120. EXDCI-2

122. FF4EUROHPC

124. HPC-EUROPA3

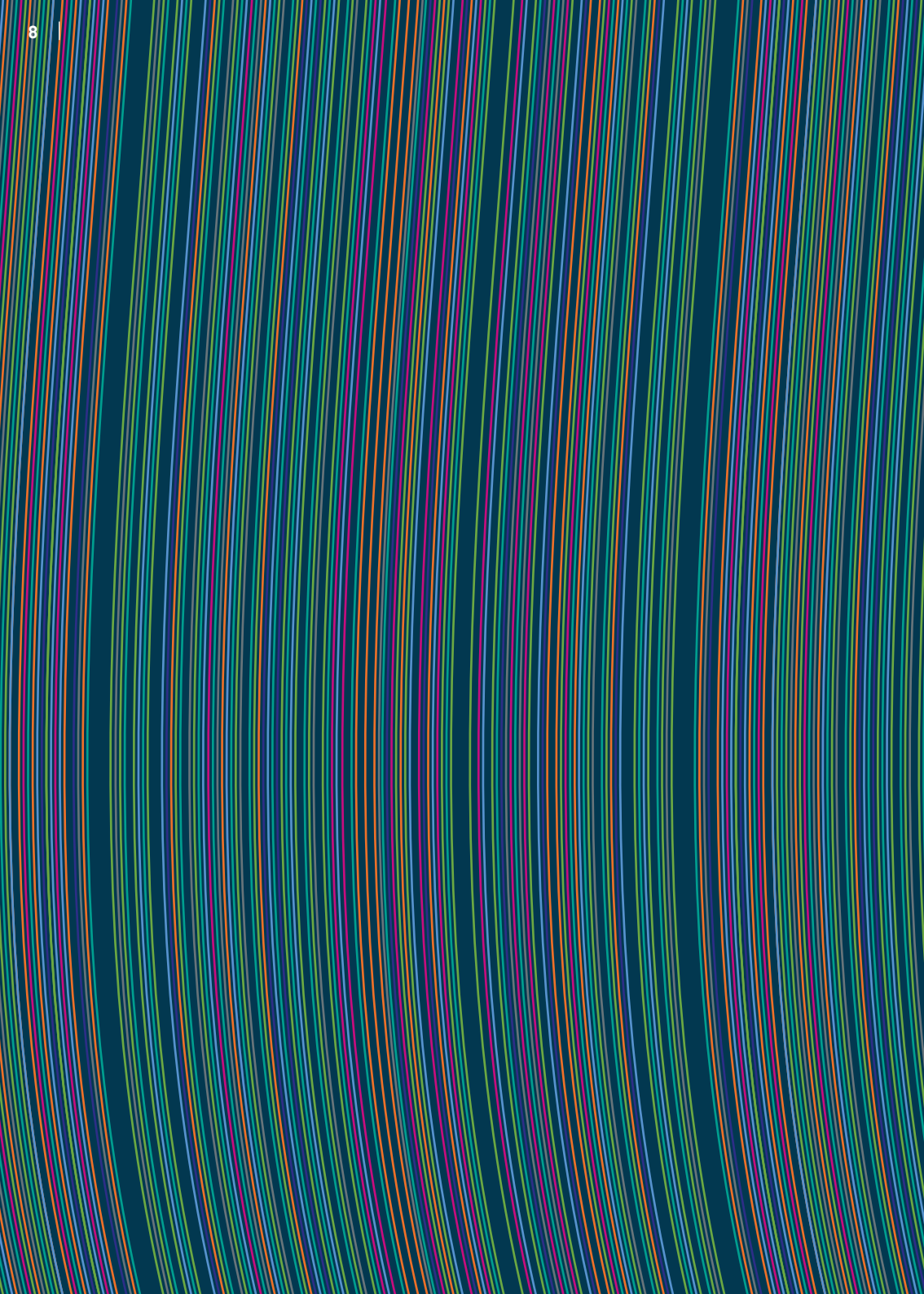
126. Appendix - Completed projects

European Exascale Projects

Our Handbook features a number of projects, which, though not financed by HPC cPPP or EuroHPC-related calls, are closely related to HPC and have their place here. For ease of use, we have grouped projects by scope or objective, instead of by call. However, we also provide in the table below an overview of the different calls, indicating where you will find the corresponding projects in our Handbook. Finally, this Handbook only features on-going projects. Projects that ended before January 2020 are listed in the Annex, and described in detail in previous editions of the Handbook (available on our website at www.etp4hpc.eu/european-hpc-handbook.html).

CHAPTER	CORRESPONDING CALLS	COMMENTS
Technology Projects All projects in this chapter are hardware and/or software oriented	**FETHPC-01-2016** Co-design of HPC systems and applications	2 projects starting in 2017 with a duration of around 3 years 11 projects starting 2018 with a duration of around 3 years
	FETHPC-02-2017 Transition to Exascale	
Centres of Excellence in computing applications	**E-INFRA-5-2015** Centres of Excellence for computing applications	9 projects starting in 2016 with a duration of around 3 years - 1 of which was still on-going in 2020
	INFRAEDI-02-2018 Centres of Excellence for computing applications	10 projects and 1 Coordination and Support Action starting in 2018
	INFRAEDI-05-2020 Centres of Excellence in exascale computing	4 projects starting in 2020 with a duration of around 3 years
European Processor	**ICT-42-2017** Framework Partnership Agreement in European low-power microprocessor technologies	The European Processor Initiative (EPI)
	SGA-LPMT-01-2018 Specific Grant Agreement under the Framework Partnership Agreement "EPI FPA"	
	ICT-05-2017 Customised and low energy computing (including Low power processor technologies)	Prequel to EPI

Applications in the HPC Continuum	**ICT-11-2018-2019** Subtopic (a) HPC and Big Data enabled Large-scale Test-beds and Applications	4 Innovative Action starting in 2018
	CEF-TC-2018-5	1 project related to HPC
	CEF/ICT/A2017	1 project related to HPC
International Cooperation	**FETHPC-01-2018** International Cooperation on HPC	2 projects starting June 2019
Quantum Computing for HPC	**FETFLAG-05-2020** Complementary call on Quantum Computing	1 project related to HPC starting in 2020
Other projects	**ICT-12-2018-2020** Big Data technologies and extreme-scale analytics	A selection of technology projects related to HPC (hardware/software) from various ICT, FET and INFRA calls, as well as from special calls
	FETPROACT-01-2016 Proactive: emerging themes and communities	
	EINFRA-21-2017 Platform-driven e-infrastructure innovation	
	SC1-PHE-CORONAVIRUS-2020 Advancing knowledge for the clinical and public health response to the 2019-nCoV epidemic	
	ICT-16-2018 Software Technologies	
Ecosystem development	**FETHPC-2-2014** HPC Ecosystem Development	2 Coordination and Support Actions
	FETHPC-03-2017 Exascale HPC ecosystem development	2 Coordination and Support Actions
	INFRAIA-01-2016-2017 Integrating Activities for Advanced Communities	HPC-EUROPA3
	EuroHPC-04-2019 Innovating and Widening the HPC use and skills base	2 projects starting in 2020
	EuroHPC-05-2019 Innovating and Widening the HPC use and skills base	1 project related to HPC



Technology Projects

ASPIDE

exAScale Programlng models for extreme Data processing

Objective

Extreme Data is an incarnation of Big Data concept distinguished by the massive amounts of data that must be queried, communicated and analysed in (near) real-time by using a very large number of memory/storage elements and Exascale computing systems. Immediate examples are the scientific data produced at a rate of hundreds of gigabits-per-second that must be stored, filtered and analysed, the millions of images per day that must be mined (analysed) in parallel, the one billion of social data posts queried in real-time on an in-memory components database. Traditional disks or commercial storage cannot handle nowadays the extreme scale of such application data.

Following the need of improvement of current concepts and technologies, ASPIDE's activities focus on data-intensive applications running on systems composed of up to millions of computing elements

www.aspide-project.eu
: @ASPIDE_PROJECT

COORDINATING ORGANISATION

Universidad Carlos III de Madrid,
Spain

OTHER PARTNERS

- Institute e-Austria Timisoara, Romania
- University of Calabria, Italy
- Universität Klagenfurt, Austria
- Institute of Bioorganic Chemistry of Polish Academy of Sciences, Poland
- Servicio Madrileño de Salud, Spain
- INTEGRIS SA Italy
- Bull SAS (Atos Group), France



(Exascale systems). Practical results will include the methodology and software prototypes that will be designed and used to implement Exascale applications.

The ASPIDE project will contribute with the definition of a new programming paradigms, APIs, runtime tools and methodologies for expressing data-intensive tasks on Exascale systems, which can pave the way for the exploitation of massive parallelism over a simplified model of the system architecture, promoting high performance and efficiency, and offering powerful operations and mechanisms for processing extreme data sources at high speed and/or real-time.

CONTACT
Javier GARCIA-BLAS
fjblas@inf.uc3m.es

CALL
FETHPC-02-2017

PROJECT TIMESPAN
15/06/2018 - 14/12/2020

DEEP projects

Dynamical Exascale Entry Platform

There is more than one way to build a supercomputer, and meeting the diverse demands of modern applications, which increasingly combine data analytics and artificial intelligence (AI) with simulation, requires a flexible system architecture. Since 2011, the DEEP series of projects (DEEP, DEEP-ER, DEEP-EST) has pioneered an innovative concept known as the Modular Supercomputer Architecture (MSA), whereby multiple modules are coupled like building blocks. Each module is tailored to the needs of a specific class of applications, and all modules together behave as a single machine.

Connected by a high-speed, federated network and programmed in a uniform system software and programming environment, the supercomputer allows an application to be distributed over several hardware modules, running each code component on the one which best suits its particular needs. Specifically, DEEP-EST, the latest project in the series, has built a prototype with three modules: a general-purpose Cluster Module (CM) for low or medium scalable codes, the highly scalable Extreme Booster Module (ESB) comprising a cluster of accelerators, and a Data Analytics Module (DAM), which will be tested with six applications combining high-performance computing (HPC) with high-performance data analytics (HPDA) and machine learning (ML).The DEEP approach is part of the trend towards using accelerators to improve performance and overall energy efficiency – but with a twist. Traditionally, heterogeneity is done within the node, combining a central processing unit (CPU) with one or more accelerators. In DEEP-EST the resources are segregated and pooled into compute modules, as this enables to flexibly adapt the system to very diverse application requirements.

www.deep-projects.eu
: @DEEPprojects

COORDINATING ORGANISATION

Forschungszentrum Jülich (Jülich Supercomputing Centre)

OTHER PARTNERS

Current partners in DEEP-EST:

- Forschungszentrum Jülich
- Intel
- Leibniz Supercomputing Centre
- Barcelona Supercomputing Centre (BSC), Spain
- Megware Computer Vertrieb und Service GmbH
- Heidelberg University
- EXTOLL
- The University of Edinburgh
- Fraunhofer ITWM
- Astron
- KU Leuven
- National Center For Supercomputing Applications (Bulgaria)
- Norges Miljo-Og Biovitenskaplige Universitet Haskoli Islands
- European Organisation for Nuclear Research (CERN)
- ParTec



In addition to usability and flexibility, the sustained performance made possible by following this approach aims to reach exascale levels.

One important aspect that makes the DEEP architecture stand out is the co-design approach, which is a key component of the project. In DEEP-EST, six ambitious HPC/HPDA applications will be used to define and evaluate the hardware and software technologies developed. Careful analysis of the application codes allows a fuller understanding of their requirements, which informed the prototype's design and configuration.

In addition to traditional compute-intensive HPC applications, the DEEP-EST DAM includes leading-edge memory and storage technology tailored to the needs of data-intensive workloads, which occur in data analytics and ML.Through the DEEP projects, researchers have shown that combining resources in compute modules efficiently serves applications from multi-physics simulations to simulations integrating HPC with HPDA, to complex heterogeneous workflows such as those in artificial intelligence applications.The next step in the series of DEEP projects will be DEEP-SEA – Software for Exascale Architectures. This will deliver the programming environment for future European exascale systems.

Partners in DEEP and DEEP-ER:
- CERFACS
- CGG
- CINECA
- Eurotech
- EPFL
- Seagate
- INRIA, Institut National de Recherche en Informatique et Automatique
- Mellanox
- The Cyprus Institute
- Universität Regensburg

CONTACT

Dr. Estela Suarez
pmt@deep-projects.eu

CALL

ETHPC-01-2016

PROJECT TIMESPAN (DEEP-EST)

01/07/2017 - 31/03/2021

EPEEC

European joint Effort toward a Highly Productive Programming Environment for Heterogeneous Exascale Computing

Objective

EPEEC's main goal is to develop and deploy a production-ready parallel programming environment that turns upcoming overwhelmingly-heterogeneous exascale supercomputers into manageable platforms for domain application developers. The consortium is significantly advancing and integrating existing state-of-the-art components based on European technology (programming models, runtime systems, and tools) with key features enabling 3 overarching objectives: high coding productivity, high performance, and energy awareness.

An automatic generator of compiler directives provides outstanding coding productivity from the very beginning of the application developing/porting process. Developers will be able to leverage either shared memory or distributed-shared memory programming flavours, and code in their preferred language: C, Fortran, or C++. EPEEC ensures the composability and interoperability of its programming models and runtimes, which incorporate specific features to handle data-intensive and extreme-data applications. Enhanced leading-edge performance tools offer integral profiling, performance prediction, and visualisation of traces.

EPEEC exploits results from past FET projects that led to the cutting-edge software components it builds upon, and pursues influencing the most relevant parallel programming standardisation bodies. The consortium is composed of European institutions and individuals with the highest expertise in their field, including not only leading research centres and universities but also SME/start-up companies, all of them recognised as high-tech innovators worldwide. Adhering to the Work Programme's guidelines, EPEEC features

www.epeec-project.eu
: #EPEECproject

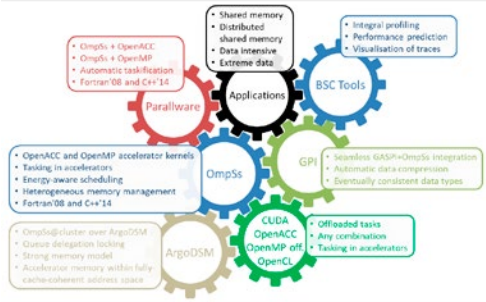
COORDINATING ORGANISATION

Barcelona Supercomputing Centre (BSC), Spain

OTHER PARTNERS

- Fraunhofer Gesellschaft zur Förderung der angewandten Forschung E.V., Germany
- INESC ID - Intituto de Engenhariade Sistemas e Computadores, Investigacao e Desenvolvimento em Lisboa, Portugal
- INRIA, Institut National de Recherche en Informatique et Automatique, France
- Appentra Solutions SL, Spain
- CINECA Consorzio Interuniversitario, Italy
- ETA SCALE AB, Sweden
- CERFACS, France
- Interuniversitair Micro-Electronica Centrum, Belgium
- Uppsala Universitet, Sweden

EPEEC Programming Environment



the participation of young and high-potential researchers, and includes careful dissemination, exploitation, and public engagement plans.

APPLICATIONS

Five applications representative of different relevant scientific domains serve as part of a strong inter-disciplinary co-design approach and as technology demonstrators:

- AVBP
- DIOGENeS
- OSIRIS
- Quantum ESPRESSO
- SMURFF

PROGRAMMING ENVIRONMENT

The EPEEC programming environment for exascale is being developed to achieve high programming productivity, high execution efficiency and scalability, energy awareness, and smooth composability/interoperability. It is formed by five main components:

- Parallelware
- OmpSs
- GASPI
- ArgoDSM
- BSC performance tools (Extrae, Paraver, Dimemas)

Intermediate software prototypes are available for download on the EPEEC website.

CONTACT
Antonio J. Peña,
antonio.pena@bsc.es

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/10/2018 - 30/09/2021

EPiGRAM-HS

Exascale Programming Models for Heterogeneous Systems

MOTIVATION

- Increasing presence of heterogeneous technologies on pre-exascale supercomputers
- Need to port key HPC and emerging applications to these systems on time for exascale

OBJECTIVES

- Extend the programmability of large-scale heterogeneous systems with GPUs, FPGAs, HBM and NVM
- Introduce new concepts and functionalities, and implement them in two widely-used HPC programming systems for large-scale supercomputers: MPI and GASPI

epigram-hs.eu
: @EpigramHs

COORDINATING ORGANISATION

KTH,
Sweden

OTHER PARTNERS

- EPCC, UK
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- Fraunhofer, Germany
- Cray, Switzerland
- ECMWF, UK

EPiGRAM-HS

- Maximize the productivity of application development on heterogeneous supercomputers by:
  - providing auto-tuned collective communication
  - a framework for automatic code generation for FPGAs
  - a memory abstraction device comprised of APIs
  - a runtime for automatic data placement on diverse memories and a DSL for large-scale deep-learning frameworks

CONTACT
Stefano Markidis
markidis@kth.se

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/09/2018 - 31/08/2021

ESCAPE-2

Energy-efficient SCalable Algorithms for weather and climate Prediction at Exascale

Objective

ESCAPE-2 will develop world-class, extreme-scale computing capabilities for European operational numerical weather and climate prediction, and provide the key components for weather and climate domain benchmarks to be deployed on extreme-scale demonstrators and beyond. This will be achieved by developing bespoke and novel mathematical and algorithmic concepts, combining them with proven methods, and thereby reassessing the mathematical foundations forming the basis of Earth system models. ESCAPE-2 also invests in significantly more productive programming models for the weather-climate community through which novel algorithm development will be accelerated and future-proofed. Eventually, the project aims at providing exascale-ready production benchmarks to be operated on extreme-scale demonstrators (EsD) and beyond.

ESCAPE-2 combines cross-disciplinary uncertainty quantification tools (URANIE) for high-performance computing, originating from the energy sector, with ensemble-based weather and climate models to quantify the effect of model and data related uncertainties on forecasting – a capability, which weather and climate prediction has pioneered since the 1960s.

The mathematics and algorithmic research in ESCAPE-2 will focus on implementing data structures and tools supporting

www.ecmwf.int/escape

COORDINATING ORGANISATION

ECMWF - European Centre for Medium-range Weather Forecasts, UK

OTHER PARTNERS

- DKRZ - Deutsches Klimarechenzentrum GmbH, Germany
- Max-Planck-Gesellschaft zur Förderung der Wissenschaften EV, Germany
- Eidgenössisches Depertment des Innern, Switzerland
- Barcelona Supercomputing Centre (BSC), Spain
- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- Loughborough University, United Kingdom
- Institut Royal Météorologique de Belgique, Belgium
- Politecnico di Milano, Italy
- Danmarks Meteorologiske Institut, Denmark
- Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy
- Bull SAS (Atos group), France

ESCAPE 2

parallel computation of dynamics and physics on multiple scales and multiple levels. Highly-scalable spatial discretization will be combined with proven large time-stepping techniques to optimize both time-to-solution and energy-to-solution. Connecting multi-grid tools, iterative solvers, and overlapping computations with flexible-order spatial discretization will strengthen algorithm resilience against soft or hard failure. In addition, machine learning techniques will be applied for accelerating complex sub-components. The sum of these efforts will aim at achieving at the same time: performance, resilience, accuracy and portability.

CONTACT
Peter Bauer
peter.bauer@ecmwf.int

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/10/2018 - 30/09/2021

EuroEXA

The Largest Group of ExaScale Projects and Biggest Co-Design Effort

The Horizon 2020 EuroEXA project proposes a ground-breaking design for mind blowing results: Over four times higher performance and four times higher energy efficiency than today's high-performance platforms. Originally the informal names for a group of H2020 research projects, ExaNeSt, EcoScale and ExaNoDe, EuroEXA has its own EU investment as a co-design project to further develop technologies from the project group and support the EU in its bid to deliver EU based ExaScale supercomputers.

Vision:

- First testbed architecture will be shown to be capable of scaling to world-class peak performance in excess of 400 PFLOPS with an estimated system power of around 30 MW peak
- A compute-centric 250 PFLOPS per 15 MW by 2019
- Show that an exascale machine could be built in 2020 within 30 shipping containers with an edge to edge distance of less than 40m

This project has a €20m investment over a 42-month period and is part of a total €50m, investment made be the European Commission across the EuroEXA group of projects supporting research, innovation and action across applications, system software, hardware, networking, storage liquid cooling and data centre technologies.

The project is also supported by a high value donation of IP from ARM and Synopsys. Funded under H2020-EU.1.2.2. FET Proactive (FETHPC-2016-01) as a result of a competitive selection process, the consortium, partners bring a rich mix of key applications from across climate/weather, physics/energy and life-science/

www.euroexa.eu
: @EuroEXA

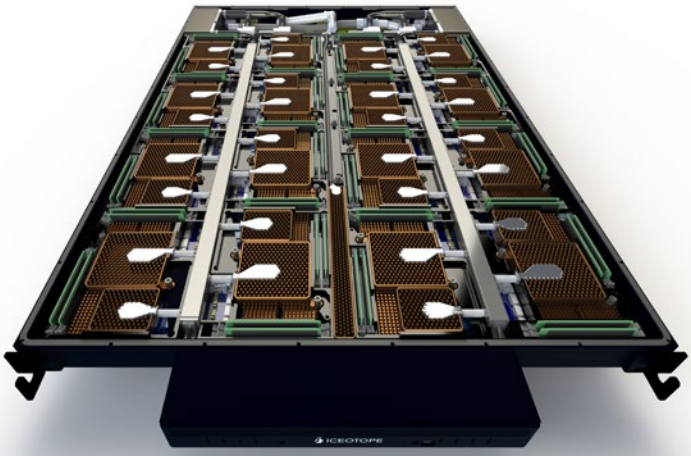
COORDINATING ORGANISATION

ICCS0, Institute of Communication and Computer Systems, Greece

OTHER PARTNERS

- Arm, UK
- The University of Manchester, UK
- Barcelona Supercomputing Centre (BSC), Spain
- FORTH (Foundation for Research and Technology Hellas), Greece
- The Hartree Centre of STFC, UK
- IMEC, Belgium
- ZeroPoint Technologies, SE
- Iceotope, UK
- Synelixis Solutions Ltd., Greece
- Maxeler Technologies, UK
- Neurasmus, Netherlands
- INFN (Istituto Nazionale Di Fisica Nucleare), Italy
- INAF (Istituto Nazionale Di Astrofisica, Italy
- ECMWF (European Centre for Medium- Range Weather Forecasts), International
- Fraunhofer, Germany

The EuroEXA Blade



bioinformatics. The project objectives include to develop and deploy an ARM Cortex technology processing system with FPGA acceleration at peta-flop level an Exa-scale procurement for deployment in 2022/23.

CONTACT

Peter Hopton
(Dissemination
& Exploitation Lead)
peter.hopton@iceotope.com
+44 1142 245500

CALL

FETHPC-01-2016

PROJECT TIMESPAN

01/09/2017 - 28/02/2021

EXA2PRO

Enhancing Programmability and boosting Performance Portability for Exascale Computing Systems

The vision of EXA2PRO is to develop a programming environment that will enable the productive deployment of highly parallel applications in exascale computing systems. EXA2PRO programming environment will integrate tools that will address significant exascale challenges. It will support a wide range of scientific applications, provide tools for improving source code quality, enable efficient exploitation of exascale systems' heterogeneity and integrate tools for data and memory management optimization. Additionally, it will provide fault-tolerance mechanisms, both user-exposed and at runtime system level and performance monitoring features. EXA2PRO will be evaluated using 4 applications from 3 different domains, which will be deployed in JUELICH supercomputing centre: High energy physics, materials and supercapacitors. The applications will leverage the EXA2PRO toolchain and we expect:

1. Increased programmability that enables the efficient exploitation of heterogeneity of modern supercomputing systems, which allows the evaluation of more complex problems.
2. Effective deployment in an environment that provides features critical for exascale computing systems such as fault tolerance, flexibility of execution and performance monitoring based on EXA2PRO optimization tools.
3. Identification of trade-offs between design qualities (source code maintainability/reusability) and run-time constraints (performance/energy consumption).

www.exa2pro.eu

COORDINATING ORGANISATION

ICCS, institute of communication and computer systems, Greece

OTHER PARTNERS

- Linköpings universitet, Sweden
- CERTH, Ethniko Kentro Erevnas kai Technologikis Anaptyxis, Greece
- INRIA, Institut National de Recherche en Informatique et Automatique, France
- Forschungszentrum Jülich GmbH, Germany
- Maxeler Technologies Ltd, United Kingdom
- CNRS, Centre National de la Recherche Scientifique, France
- UoM, University of Macedonia, Greece

EXA2PRO outcome is expected to have major impact on:

1. the scientific and industrial community that focuses on application deployment in supercomputing centres: EXA2PRO environment will allow efficient application deployment with reduced effort.
2. application developers that target exascale systems: EXA2PRO will provide tools for improving source code maintainability/reusability, which will allow application evolution with reduced developers' effort.
3. the scientific community and the industry relevant to the EXA2PRO applications: Significant impact is expected on the materials and processes design for CO2 capture and on the supercapacitors industry.

CONTACT
Prof. Dimitrios Soudris
dsoudris@microlab.ntua.gr

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/05/2018 - 30/04/2021

ExaQUte

EXAscale Quantification of Uncertainties for Technology and Science Simulation

Objective

The ExaQUte project aims at constructing a framework to enable Uncertainty Quantification (UQ) and Optimization Under Uncertainties (OUU) in complex engineering problems using computational simulations on Exascale systems.

The stochastic problem of quantifying uncertainties will be tackled by using a Multi Level MonteCarlo (MLMC) approach that allows a high number of stochastic variables. New theoretical developments will be carried out to enable its combination with adaptive mesh refinement, considering both, octree-based and anisotropic mesh adaptation.

Gradient-based optimization techniques will be extended to consider uncertainties by developing methods to compute stochastic sensitivities. This requires new theoretical and computational developments. With a proper definition of risk measures and constraints, these methods allow high-performance robust designs, also maximizing the solution reliability.

The description of complex geometries will be possible by employing embedded methods, which guarantee a high robustness in the mesh generation and adaptation steps, while allowing preserving the exact geometry representation.

The efficient exploitation of Exascale system will be addressed by combining

www.exaqute.eu
: @ ExaQUteEU

COORDINATING ORGANISATION

CIMNE- Centre Internacional de Metodes Numerics en Enginyeria,
Spain

OTHER PARTNERS

- Barcelona Supercomputing Centre (BSC), Spain
- Technische Universität München, Germany
- INRIA, Institut National de Recherche en Informatique et Automatique, France
- Vysoka Skola Banska - Technicka Univerzita Ostrava, Czech Republic
- Ecole Polytechnique Fédérale de Lausanne, Switzerland
- Universitat Politecnica de Catalunya, Spain
- str.ucture GmbH, Germany

ExaQUte

Exascale **Q**uantification of **U**ncertainties for **Te**chnology and Science Simulation

State-of-the-Art dynamic task-scheduling technologies with space-time accelerated solution methods, where parallelism is harvested both in space and time.

The methods and tools developed in ExaQUte will be applicable to many fields of science and technology. The chosen application focuses on wind engineering, a field of notable industrial interest for which currently no reliable solution exists. This will include the quantification of uncertainties in the response of civil engineering structures to the wind action, and the shape optimization taking into account uncertainties related to wind loading, structural shape and material behaviour.

All developments in ExaQUte will be open-source and will follow a modular approach, thus maximizing future impact.

CONTACT

Cecilia Soriano
csoriano@cimne.upc.edu
Riccardo Rossi
rrossi@cimne.upc.edu

CALL

FETHPC-02-2017

PROJECT TIMESPAN

01/06/2018 - 31/05/2021

MAESTRO

Middleware for memory and data-awareness in workflows

Maestro will build a data-aware and memory-aware middleware framework that addresses ubiquitous problems of data movement in complex memory hierarchies and at many levels of the HPC software stack.

Though HPC and HPDA applications pose a broad variety of efficiency challenges, it would be fair to say that the performance of both has become dominated by data movement through the memory and storage systems, as opposed to floating point computational capability. Despite this shift, current software technologies remain severely limited in their ability to optimise data movement. The Maestro project addresses what it sees as the two major impediments of modern HPC software:

1. Moving data through memory was not always the bottleneck. The software stack that HPC relies upon was built through decades of a different situation – when the cost of performing floating point operations (FLOPS) was paramount. Several decades of technical evolution built a software stack and programming models highly fit for optimising floating point operations but lacking in basic data handling functionality. We characterise the set of technical issues at missing data-awareness.
2. Software rightfully insulates users from hardware details, especially as we move higher up the software stack. But HPC applications, programming environments and systems software cannot make key data movement decisions without some understanding of the hardware, especially the increasingly complex memory hierarchy. With the exception of runtimes, which treat memory in a domain-specific manner, software typically must make hardware-neutral decisions which can often leave performance on the table. We characterise this issue as missing memory-awareness.

www.maestro-data.eu
: @maestrodata

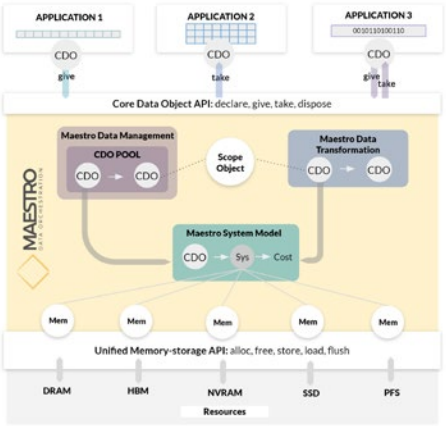
COORDINATING ORGANISATION

Forschungszentrum Jülich GmbH, Germany

OTHER PARTNERS

- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- Appentra Solutions SL, Spain
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- ECMWF - European Centre for Medium-range Weather Forecasts, United Kingdom
- Seagate Systems UK Ltd, United Kingdom
- Hewlett-Packard (Schweiz) GmbH, Switzerland

MAESTRO
DATA ORCHESTRATION



Maestro proposes a middleware framework that enables memory- and data-awareness. Maestro has developed new data-aware abstractions that can be be used in any level of software, e.g. compiler, runtime or application. Core elements are the Core Data Objects (CDO), which through a give/take semantics provided to the middleware. The middleware is being designed such that it enables modelling of memory and storage hierarchies to allow for reasoning about data movement and placement based on costs of moving data objects. The middleware will support automatic movement and promotion of data in memories and storage and allow for data transformations and optimisation.

Maestro follows a co-design methodology using a set of applications and workflows from diverse areas including numerical weather forecasting, earth-system modelling, materials sciences and in-situ data analysis pipelines for computational fluid dynamics simulations.

CONTACT
Dirk Pleiter
d.pleiter@fz-juelich.de

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/09/2018 - 31/08/2021

RECIPE

REliable power and time-ConstraInts-aware Predictive management of heterogeneous Exascale systems

OBJECTIVE

The current HPC facilities will need to grow by an order of magnitude in the next few years to reach the Exascale range. The dedicated middleware needed to manage the enormous complexity of future HPC centres, where deep heterogeneity is needed to handle the wide variety of applications within reasonable power budgets, will be one of the most critical aspects in the evolution of HPC infrastructure towards Exascale. This middleware will need to address the critical issue of reliability in face of the increasing number of resources, and therefore decreasing mean time between failures.

To close this gap, RECIPE provides: a hierarchical runtime resource management infrastructure optimizing energy efficiency and ensuring reliability for both time-critical and throughput-oriented computation; a predictive reliability methodology to support the enforcing of QoS guarantees in face of both transient and long-term hardware failures, including thermal, timing and reliability models; and a set of integration layers allowing the resource manager to interact with both the application and the underlying deeply heterogeneous architecture, addressing them in a disaggregate way.

www.recipe-project.eu
: @EUrecipe

COORDINATING ORGANISATION

Politecnico di Milano, Italy

OTHER PARTNERS

- Universitat Politecnica de Valencia, Spain
- Centro Regionale Information Communication Technology scrl, Italy
- Barcelona Supercomputing Centre (BSC), Spain
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk, Poland
- EPFL - Ecole Polytechnique Fédérale de Lausanne, Switzerland
- Intelligence behind Things Solutions SRL, Italy
- Centre Hospitalier Universitaire Vaudois, Switzerland

Quantitative goals for RECIPE include: 25% increase in energy efficiency (performance/watt) with an 15% MTTF improvement due to proactive thermal management; energy-delay product improved up to 25%; 20% reduction of faulty executions.

The project will assess its results against the following set of real world use cases, addressing key application domains ranging from well-established HPC applications such as geophysical exploration and meteorology, to emerging application domains such as biomedical machine learning and data analytics.

To this end, RECIPE relies on a consortium composed of four leading academic partners (POLIMI, UPV, EPFL, CeRICT); two supercomputing centres, BSC and PSNC; a research hospital, CHUV, and an SME, IBTS, which provide effective exploitation avenues through industry-based use cases.

CONTACT
Prof. William Fornaciari
william.fornaciari@polimi.it

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/05/2018 - 30/04/2021

Sage2

Percipient Storage for Exascale Data Centric Computing 2

Objective

The landscape for High Performance Computing is changing with the proliferation of enormous volumes of data created by scientific instruments and sensors, in addition to data from simulations. This data needs to be stored, processed and analysed, and existing storage system technologies in the realm of extreme computing need to be adapted to achieve reasonable efficiency in achieving higher scientific throughput. We started on the journey to address this problem with the SAGE project. The HPC use cases and the technology ecosystem is now further evolving and there are new requirements and innovations that are brought to the forefront. It is extremely critical to address them today without "reinventing the wheel" leveraging existing initiatives and know-how to build the pieces of the Exascale puzzle as quickly and efficiently as we can.

The SAGE paradigm already provides a basic framework to address the extreme scale data aspects of High Performance Computing on the path to Exascale. Sage2 (Percipient StorAGe for Exascale Data Centric Computing 2) intends to validate a next generation storage system building on top of the already existing SAGE platform to address new use case requirements in the areas of extreme scale computing scientific workflows and AI/deep learning

www.sagestorage.eu
: @SageStorage

COORDINATING ORGANISATION

Seagate Systems UK Ltd, United Kingdom

OTHER PARTNERS

- Bull SAS (Atos Group), France
- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- United Kingdom Atomic Energy Authority, United Kingdom
- Kungliga Tekniska Hoegskolan (KTH), Sweden
- Forschungszentrum Jülich GmbH, Germany
- The University of Edinburgh, United Kingdom
- Kitware SAS, France
- Arm Ltd, United Kingdom



leveraging the latest developments in storage infrastructure software and storage technology ecosystem.

Sage2 aims to provide significantly enhanced scientific throughput, improved scalability, and, time & energy to solution for the use cases at scale. Sage2 will also dramatically increase the productivity of developers and users of these systems.

Sage2 will provide a highly performant and resilient, QoS capable multi-tiered storage system, with data layouts across the tiers managed by the Mero Object Store, which is capable of handling in-transit/in-situ processing of data within the storage system, accessible through the Clovis API. The 3-rack prototype system is now available for use at Juelich Supercomputing Centre.

CONTACT

Sai Narasimhamurthy
sai.narasimhamurthy@seagate.com

CALL

FETHPC-02-2017

PROJECT TIMESPAN

01/09/2018 - 31/08/2021

VECMA

Verified Exascale Computing for Multiscale Applications

The purpose of this project is to enable a diverse set of multiscale, multiphysics applications — from fusion and advanced materials through climate and migration, to drug discovery and the sharp end of clinical decision making in personalised medicine — to run on current multi-petascale computers and emerging exascale environments with high fidelity such that their output is «actionable». That is, the calculations and simulations are certifiable as validated (V), verified (V) and equipped with uncertainty quantification (UQ) by tight error bars such that they may be relied upon for making important decisions in all the domains of concern. The central deliverable is an open source toolkit for multiscale VVUQ based on generic multiscale VV and UQ primitives, to be released in stages over the lifetime of this project, fully tested and evaluated in emerging exascale environments, actively promoted over the lifetime of this project, and made widely available in European HPC centres.

The project includes a fast track that will ensure applications are able to apply available multiscale VVUQ tools as soon as possible, while guiding the deep track development of new capabilities and their integration into a wider set of production applications by the end of the project. The deep track includes the development of more disruptive and automated algorithms, and their exascale-aware implementation in a more intrusive way with respect to the underlying and pre-existing multiscale modelling and simulation schemes.

The potential impact of these certified multiscale simulations is enormous, and we have already been promoting the VVUQ toolkit (VECMAtk) across a wide range of scientific and social scientific domains,

www.vecma.eu
: @VECMA4

COORDINATING ORGANISATION

University College London, UK

OTHER PARTNERS

- Max-Planck-Gesellschaft zur Förderung der Wissenschaften EV, Germany
- Brunel University London, United Kingdom
- Bayerische Akademie der Wissenschaften, Germany
- Bull SAS (Atos Group), France
- Stichting Nederlandse Wetenschappelijk Onderzoek Instituten, Netherlands
- CBK Sci Con Ltd, United Kingdom
- Universiteit van Amsterdam, Netherlands
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk, Poland

INTERNATIONAL PARTNER

Rutgers University, USA

as well as within computational science more broadly. We have made ten releases of the toolkit with the dedicated website at https://www.vecma-toolkit.eu/, available for public users to access, download and use.

To further develop and disseminate the VECMAtk, we have been working with the Alan Turing Institute to jointly run the planned event of Reliability and Reproducibility in Computational Science: Implementing Verification, Validation and Uncertainty Quantification in silico. The event comprised as part of it the first VECMA training workshop in January 2020. Ahead of this event, we had run a VECMA hackathon event in association with VECMAtk in September 2019. We held an online conference: Multiscale Modelling, Uncertainty Quantification and the Reliability of Computer Simulations in June 2020. The conference was a combination of three events that were due to take place at the SIAM Conference on Uncertainty Quantification (UQ20) and the International Conference on Computational Science (ICCS) 2020. These events associated with VECMAtk have participation from some of our external users from industry and government who use the tools we are developing on HPC at supercomputer centres in Europe.

CONTACT
Xuanye Gu
xuanye.gu@ucl.ac.uk

CALL
FETHPC-02-2017

PROJECT TIMESPAN
15/06/2018 - 14/12/2021

VESTEC

Visual Exploration and Sampling Toolkit for Extreme Computing

Objective

Technological advances in high performance computing are creating exciting new opportunities that move well beyond improving the precision of simulation models. The use of extreme computing in real-time applications with high velocity data and live analytics is within reach. The availability of fast growing social and sensor networks raises new possibilities in monitoring, assessing and predicting environmental, social and economic incidents as they happen. Add in grand challenges in data fusion, analysis and visualization, and extreme computing hardware has an increasingly essential role in enabling efficient processing workflows for huge heterogeneous data streams. VESTEC will create the software solutions needed to realise this vision for urgent decision making in various fields with high impact for the European community. VESTEC will build a flexible toolchain to combine multiple data sources, efficiently extract essential features, enable flexible scheduling and interactive supercomputing, and realise 3D visualization environments for interactive explorations by stakeholders and decision makers. VESTEC will develop and evaluate methods and interfaces to integrate high-performance data analytics processes into running simulations and real-time data environments. Interactive ensemble management will launch new simulations for new data,

www.vestec-project.eu/
: @VESTECproject

COORDINATING ORGANISATION

DLR - Deutsches Zentrum für Luft- und Raumfahrt EV, Germany

OTHER PARTNERS

- The University of Edinburgh, United Kingdom
- Kungliga Tekniska Hoegskolan (KTH), Sweden
- Sorbonne Université, France
- Kitware SAS, France
- Intel Deutschland GmbH, Germany
- Fondazione Bruno Kessler, Italy
- Université Paul Sabatier Toulouse III, France
- Tecnosylva SL, Spain



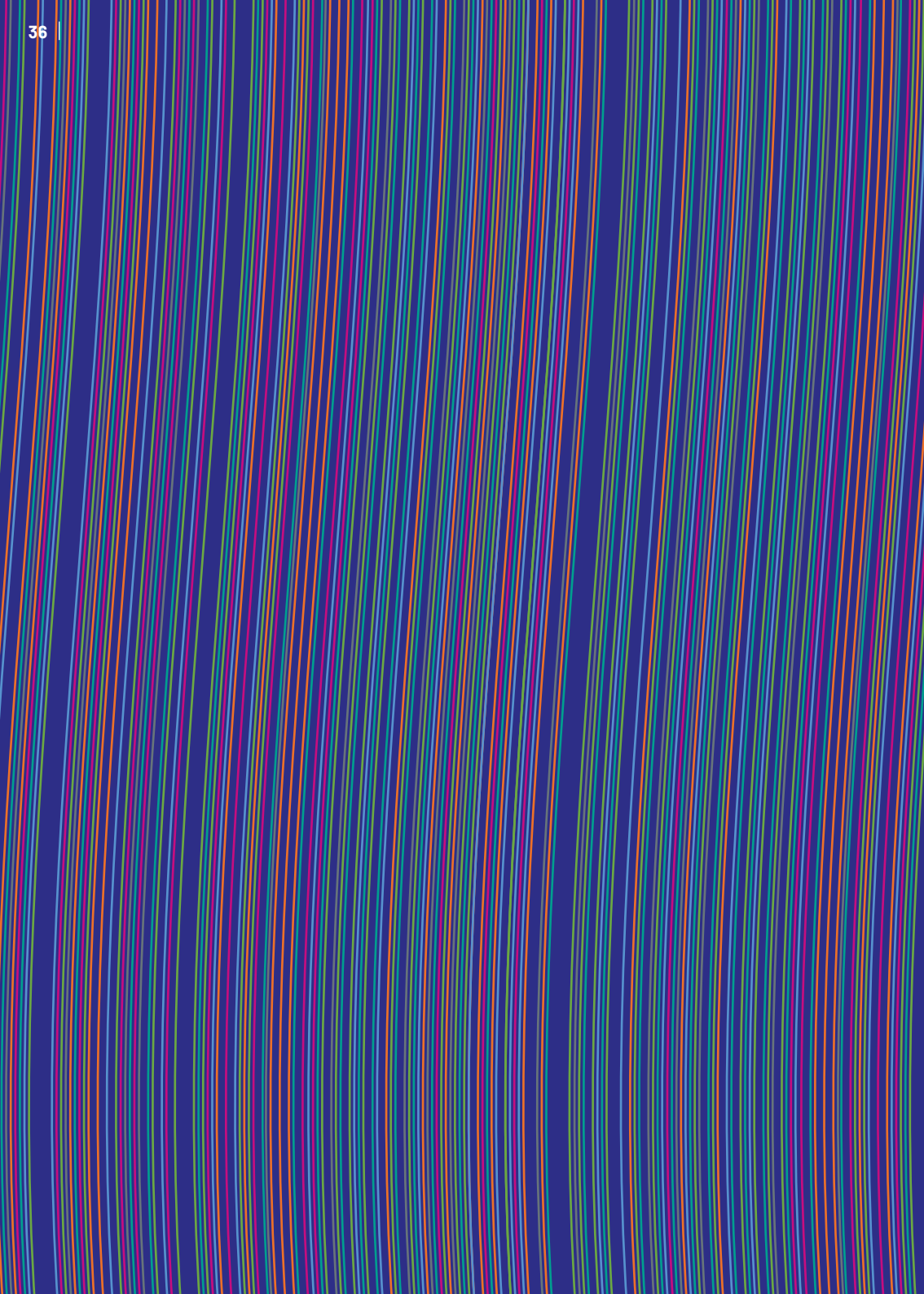
building up statistically more and more accurate pictures of emerging, time-critical phenomena. Innovative data compression approaches, based on topological feature extraction and data sampling, will result in considerable reductions in storage and processing demands by discarding domain-irrelevant data.

Three emerging use cases will demonstrate the immense benefit for urgent decision making: wildfire monitoring and forecasting; analysis of risk associated with mosquito-borne diseases; and the effects of space weather on technical supply chains. VESTEC brings together experts in each domain to address the challenges holistically.

CONTACT
Andreas Gerndt
andreas.gerndt@dlr.de

CALL
FETHPC-02-2017

PROJECT TIMESPAN
01/09/2018 - 31/08/2021



Centres of Excellence in computing applications

FocusCoE

Concerted action for the European HPC CoEs

Objective

FocusCoE contributes to the success of the EU HPC Ecosystem and the EuroHPC Initiative by supporting the EU HPC Centres of Excellence (CoEs) to more effectively fulfil their role within the ecosystem and initiative: ensuring that extreme scale applications result in tangible benefits for addressing scientific, industrial or societal challenges. It achieves this by creating an effective platform for the CoEs to coordinate strategic directions and collaboration (addressing possible fragmentation of activities across the CoEs and coordinating interactions with the overall HPC ecosystem) and provides support services for the CoEs in relation to both industrial outreach and promotion of their services and competences by acting as a focal point for users to discover those services.

The specific objectives and achievements of FocusCoE are

- The creation of the *HPC CoE Council* (HPC3) in May 2019 in Poznań that allows all European HPC CoEs to collectively define an overriding strategy and collaborative implementation for interactions with, and contributions to, the EU HPC Ecosystem.
- To support the HPC CoEs to achieve enhanced interaction with industry, and SMEs in particular, through concerted out-reach and business development actions. FocusCoE has already initiated

www.focus-coe.eu
: @FocusCoE
: @focus-coe

COORDINATING ORGANISATION

scapos AG,
Germany

OTHER PARTNERS

- CEA - Commissariat à l'Energie Atomique et aux Energies Alternatives, France
- Kungliga Tekniska Högskolan (KTH), Sweden
- Höchstleistungsrechenzentrum der Universität Stuttgart (HLRS), Germany
- Barcelona Supercomputing Center (BSC), Spain
- University College London, UK
- Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
- National University of Ireland, Galway, Ireland
- Teratec, France
- Forschungszentrum Jülich GmbH, Germany
- Partnership for advanced computing in Europe (PRACE), Belgium
- Max Planck Gesellschaft zur Forderung der Wissenschaft eV, Germany



contacts between CoEs and industry and presented CoES at sectorial events. A first tranche of industrial success stories from the CoEs is available.

- To instigate concerted action on training by and for the complete set of HPC CoEs: providing consolidating vehicle for user training offered by the CoEs and by PRACE (PATCs) and providing cross-area training to the CoEs (e.g. on sustainable business development). An HPC training stakeholder meeting was organised in October 2019 in Brussels, defining training and education needs and the assessing requirements for HPC training programmes in the EU. Access to a CoE Training registry is provided through the FocusCoE website.
- To promote the capabilities of, and services offered by, the HPC CoEs and development of the EU HPC CoE "brand", raising awareness with stakeholders and both academic and industrial users. This has been done by creating regular newsletters[1], highlighting CoE achievements in social media and handbooks. Amongst the next steps, a dedicated website presenting the set of service offerings by CoEs to industrial and academic users will be developed.

1. www.focus-coe.eu/index.php/newsletter/

CONTACT
Guy Lonsdale
guy.lonsdale@scapos.com

CALL
INFRAEDI-02-2018

PROJECT TIMESPAN
01/12/2018s - 30/11/2021

BioExcel

Centre of Excellence for Computational Biomolecular Research

BioExcel is the leading European Centre of Excellence for Computational Biomolecular Research. We develop advanced software, tools and full solutions for high-end and extreme computing for biomolecular research. The centre supports academic and industrial research by providing expertise and advanced training to end-users and promoting best practices in the field. The centre asprires to operate in the long-term as the core facility for advanced biomolecular modelling and simulations in Europe.

Overview

Much of the current Life Sciences research relies on intensive biomolecular modelling and simulation. As a result, both academia and industry are facing significant challenges when applying best practices for optimal usage of compute infrastructures. At the same time, increasing productivity of researchers will be of high importance for achieving reliable scientific results at faster pace.

High-performance computing (HPC) and *high-throughput computing* (HTC) techniques have now reached a level of maturity for many of the widely-used codes and platforms, but taking full advantage of them requires that researchers have the necessary training and access to guidance by experts. The necessary ecosystem of services in the field is presently inadequate. A suitable infrastructure needed to be set up in a sustainable, long-term operational fashion.

BioExcel CoE was thus established as the go-to provider of a full-range of software applications and training services. These cover fast and scalable software, user-friendly automation workflows and a support base of experts. The main services offered include hands-on training, tailored customization of code and personalized consultancy support. BioExcel actively

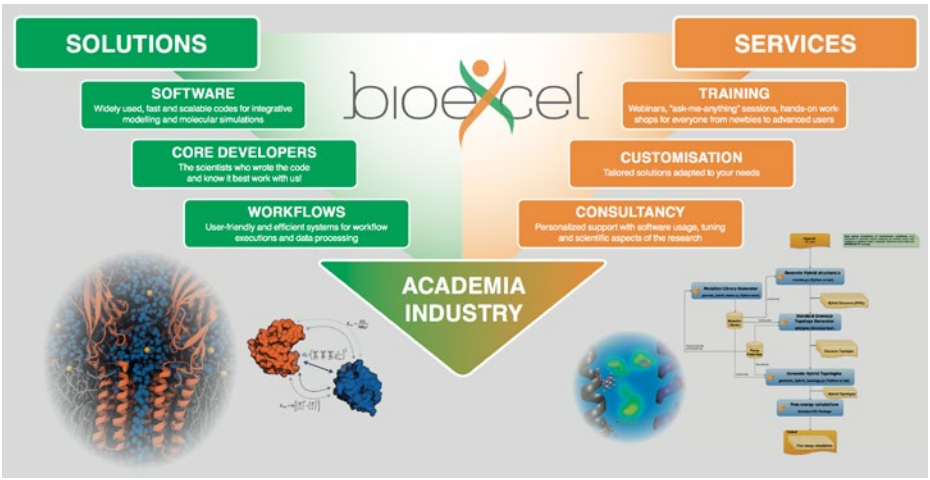
bioexcel.eu/
: @BioExcelCoE
: @bioexcel
: https://www.youtube.com/c/bioexcelcoe

COORDINATING ORGANISATION

KTH Royal Institute of Technology, Sweden

OTHER PARTNERS

- The University of Manchester, UK
- University of Utrecht, the Netherlands
- Institute of Research in Biomedicine (IRB), Spain
- European Molecular Biology Laboratory (EMBL-EBI), UK
- Forschungszentrum Jülich GmbH, Germany
- University of Jyväskylä, Finland
- The University of Edinburgh, UK
- Max Planck Gesellschaft, Germany
- Across Limits, Malta
- Barcelona Supercomputing Centre (BSC), Spain
- Ian Harrow Consulting, UK
- Norman Consulting, Norway
- Nostrum Biodiscovery, Spain



works with:

- **academic** and non-profit researchers,
- **industrial** researchers,
- **software vendors** and academic **code providers**,
- non-profit and commercial **resource providers**, and
- related international **projects and initiatives**.

The centre was established and operates through funding by the EC Horizon 2020 program (Grant agreements 675728 and 823830).

CONTACT
Rossen Apostolov
rossen@kth.se

CALL
INFRAEDI-02-2018

PROJECT TIMESPAN
01/01/2019 - 31/12/2021

ChEESE

Centre of Excellence for Exascale and Solid Earth

ChEESE addresses extreme computing scientific and societal challenges in Solid Earth by harnessing European institutions in charge of operational monitoring networks, tier-0 supercomputing centres, academia, hardware developers and third-parties from SMEs, industry and public-governance. The scientific challenge is to prepare 10 open-source flagship codes to solve Exascale capacity and capability problems on computational seismology, magnetohydrodynamics, physical volcanology, tsunamis, and data analysis and predictive techniques from monitoring earthquake and volcanic activity. The selected codes are periodically audited and optimized at both intranode level (including heterogeneous computing nodes) and internode level on heterogeneous hardware prototypes for the upcoming Exascale architectures, thereby ensuring commitment with a co-design approach. Preparation to Exascale considers also aspects like workflows like data management and sharing, I/O, post-process and visualization. Additionally, ChEESE has developed WMS-light, a free and open source workflow management system for the geoscience community with the goal to support the integration of different applications and services. Hence, WMS-light supports a wide range of typical HPC application scenarios and is designed for easy usage and integration of existing workflow setups.

In the illustration below are featured left, the simulation of a tsunami propagating from the Calabrian Arc towards southern Italy, and right, a tsunami inundation using a high-resolution map towards an area offshore Catania, Italy. In ChEESE, we will use High Performance Computing to simulate thousands of these kinds of scenarios and use these to represent the coastal

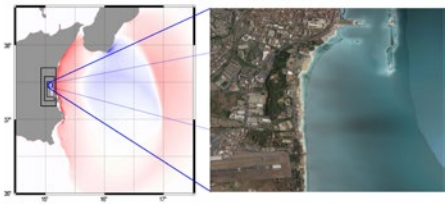
www.cheese-coe.eu
: @Cheese_CoE
: @ChEESE-CoE

COORDINATING ORGANISATION

Barcelona Supercomputing Centre (BSC), Spain

OTHER PARTNERS

- Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy
- Icelandic Meteorological Office (IMO), Iceland
- Swiss Federal Institute of Technology (ETH), Switzerland
- Universität Stuttgart - High Performance Computing Center (HLRS), Germany
- CINECA Consorzio Interuniversitario, Italy
- Technical University of Munich (TUM), Germany
- Ludwig-Maximilians Universität München (LMU), Germany
- University of Málaga (UMA), Spain
- Norwegian Geotechnical Institute (NGI), Norway
- Institut de Physique du Globe de Paris (IPGP), France
- CNRS - Centre National de la Recherche Scientifique, France
- Bull SAS (Atos Group), France



ChEESE

tsunami hazard at high resolution.
In parallel with these transversal activities, ChEESE supports three vertical pillars.
First, it develops pilot demonstrators for challenging scientific problems requiring of Exascale computing in alignment with the vision of European Exascale roadmaps. This includes near real-time seismic simulations and full-wave inversion, ensemble-based volcanic ash dispersal forecasts, faster than real-time tsunami simulations or physics-based hazard assessments for earthquakes, volcanoes and tsunamis.
Second, some pilots are also intended for enabling of operational services requiring of extreme HPC on urgent computing, early warning forecast of geohazards, hazard assessment and data analytics. Pilots with a higher Technology Readiness Level (TRL) will be tested in an operational environment in collaboration with a broader user's community. Additionally, and in collaboration with the European Plate Observing System (EPOS) and Collaborative Data Infrastructure (EUDAT), ChEESE will promote and facilitate the integration of HPC services to widen the access to codes and fostering transfer of know-how to Solid Earth community.
Finally, the third pillar of ChEESE acts as a hub to foster HPC across the Solid Earth Community and related stakeholders and to provide specialized training on services and capacity building measures. Training courses ChEESE has organized include: Modelling tsunamis and volcanic plumes using European flagship codes, Advanced training on HPC for computational seismology and Tools and techniques to quickly improve performances of HPC applications in Solid Earth.

CONTACT
Arnau Folch
arnau.folch@bsc.es
Rose Gregorio
rose.gregorio@bsc.es

CALL
INFRAEDI-02-2018

PROJECT TIMESPAN
01/11/2018 - 31/10/2021

CoEC

Center of Excellence in Combustion

The Centre of Excellence in Combustion (CoEC) is a collaborative effort to exploit Exascale computing technologies to address fundamental challenges encountered in combustion systems. The CoEC vision is aligned with the goals of decarbonization of the European power and transportation sectors and Europe´s vision to achieve net-zero greenhouse gas emissions (GHG) by 2050. The CoEC initiative is a contribution of the European HPC combustion community to a long-term GHG emissions reduction in accordance with the Paris Agreement. The consortium is composed by leading European institutions in the fields of computational combustion and High-Performance Computing and promotes a core of scientific and technological activities aiming to extend the state-of-the-art in combustion simulation capabilities through advanced methodologies enabled by Exascale computing. These advances will contribute to increase the TRL of representative codes from the EU combustion community and increase the EU competitiveness and leadership in power and propulsion technologies. The outcomes of the project will be the basis of a service portfolio to support the academic and industrial activities in the power and transportation sectors. The Centre will also stimulate the consolidation of the European combustion community, by combining the knowledge of representative actors from the scientific and industrial sectors with the capacity of HPC-community including research institutions and supercomputer centres. CoEC will promote the usage of combustion simulations through dissemination, training and user support services.

www.coec-project.eu
: @CoEC_EU
: @coec-eu

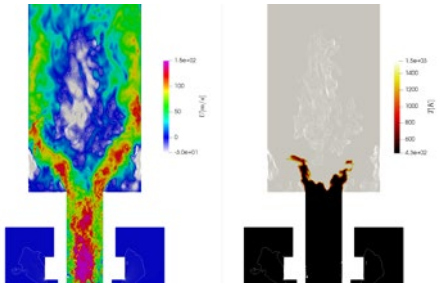
COORDINATING ORGANISATION

Barcelona Supercomputing Centre (BSC), Spain

OTHER PARTNERS

- CERFACS - Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique, France
- Rheinisch-Westfälische Technische Hochschule Aachen (RWTH-AACHEN), Germany
- Technische Universiteit Eindhoven, Netherlands
- University of Cambridge, United Kingdom
- CNRS - Centre National de la Recherche Scientifique, France
- Technische Universität Darmstadt, Germany
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- Aristotelio Panepistimio Thessalonikis, Greece
- Forschungszentrum Jülich GmbH, Germany
- Association «National Centre for Supercomputing Applications», Bulgaria

Large eddy simulation of hydrogen flames in practical configurations.



Center of Excellence in Combustion

Concept and approach

The technical activities integrated into the CoEC are defined from the fundamental challenges of relevant application areas where combustion is involved. These areas include transportation (aviation and automotive), energy and power generation, aerospace, fire and safety. All these sectors share common challenges that are associated to scientific and technological problems related with the combustion simulation; e.g: instabilities, emissions, noise, plasma, nanoparticles, multiphase flow, autoignition or the use of alternative fuels in practical applications. These research topics have large tradition in combustion science and fundamental progress has been made in the last decade to obtain further understanding on these phenomena using numerical simulations. However, the degree of integration in industry still remains low either because the incomplete fidelity/accuracy of the models, or due to insufficient computing power that hinders the maturity of the technology to be deployed with the level of industrial standards. Exascale computing technologies will enable a new paradigm in physical and numerical modelling, which requires a profound revision of models. For this purpose, two important building blocks regarding Simulation Technologies, and Exascale Methodologies will also be incorporated in the Centre of Excellence.

CONTACT
Daniel Mira
daniel.mira@bsc.es

CALL
INFRAEDI-05-2020

PROJECT TIMESPAN
01/10/2020 – 30/09/2023

CompBioMed2

Centre of Excellence in Computational Biomedicine

CompBioMed is a user-driven Centre of Excellence (CoE) in Computational Biomedicine, designed to nurture and promote the uptake and exploitation of high performance computing within the biomedical modelling community. Our user communities come from academia, industry and clinical practice.

The first phase of the CompBioMed CoE has already achieved notable successes in the development of applications, training and efficient access mechanisms for using HPC machines and clouds in computational biomedicine. We have brought together a growing list of HPC codes relevant for biomedicine which have been enhanced and scaled up to larger machines. Our codes (such as Alya, HemeLB, BAC, Palabos and HemoCell) are now running on several of the world's fastest supercomputers and investigating challenging applications ranging from defining clinical biomarkers of arrhythmic risk to the impact of mutations on cancer treatment.

Our work has provided the ability to integrate clinical datasets with HPC simulations through fully working computational pipelines designed to provide clinically relevant patient-specific models. The reach of the project beyond the funded partners is manifested by our highly effective Associate Partner Programme (all of whom have played an active role in our activities) with cost free, lightweight joining mechanism, and an Innovation Exchange Programme that has brought upward of thirty scientists, industrialists and clinicians into the project from the wider community.

Furthermore, we have developed and implemented a highly successful training programme, targeting the full range of medical students, biomedical engineers, biophysics, and computational scientists. This programme contains a mix of tailored

www.compbiomed.eu
: @bio_comp

COORDINATING ORGANISATION

University College London, UK

OTHER PARTNERS

- University of Amsterdam, Netherlands
- The University of Edinburgh, UK
- Barcelona Supercomputing Centre (BSC), Spain
- SURFsara, Netherlands
- University of Oxford, UK
- University of Geneva, Switzerland
- The University of Sheffield, UK
- CBK Sci Con Ltd, UK
- Universitat Pompeu Fabra, Spain
- Bayerische Akademie der Wissenschaften, Germany
- Acellera, Spain
- Evotec Ltd, UK
- Atos (Bull SAS), France
- Janssen Pharmaceutica, Belgium

courses for specific groups, webinars and winter schools, which is now being packaged into an easy to use training package. In CompBioMed2 we are extending the CoE to serve the community for a total of 7 years. CompBioMed has established itself as a hub for practitioners in the field, successfully nucleating a substantial body of research, education, training, innovation and outreach within the nascent field of Computational Biomedicine. This emergent technology will enable clinicians to develop and refine personalised medicine strategies ahead of their clinical delivery to the patient. Medical regulatory authorities are currently embracing the prospect of using in silico methods in the area of clinical trials and we intend to be in the vanguard of this activity, laying the groundwork for the application of HPC-based Computational Biomedicine approaches to a greater number of therapeutic areas.

The HPC requirements of our users are as diverse as the communities we represent. We support both monolithic codes, potentially scaling to the exascale, and complex workflows requiring support for advanced execution patterns. Understanding the complex outputs of such simulations requires both rigorous uncertainty quantification and the embrace of the convergence of HPC and high-performance data analytics (HPDA). CompBioMed2 seeks to combine these approaches with the large, heterogeneous datasets from medical records and from the experimental laboratory to underpin clinical decision support systems. CompBioMed2 will continue to support, nurture and grow our community of practitioners, delivering incubator activities to prepare our most mature applications for wider usage, providing avenues that will sustain CompBioMed2 well-beyond the proposed funding period.

CONTACT
Emily Lumley
e.lumley@ucl.ac.uk

CALL
INFRAEDI-02-2018

PROJECT TIMESPAN
01/10/2019 - 30/09/2023

E-cam

The E-CAM Centre of Excellence is an e-infrastructure for software development, training and industrial discussion in simulation and modelling. E-CAM is based around the Centre Européen de Calcul Atomique et Moléculaire (CECAM) distributed network of simulation science nodes, and the physical computational e-infrastructure of PRACE. We are a partnership of **13 CECAM Nodes, 4 PRACE** centres, 12 industrial partners and one Centre for Industrial Computing (Hartree Centre).

E-CAM aims at

- **Developing software** to solve important simulation and modelling problems in industry and academia, with applications from drug development, to the design of new materials
- **Tuning those codes to run on HPC**, through application co-design and the provision of HPC oriented libraries and services;
- **Training scientists from industry and academia ;**
- **Supporting industrial end-users** in their use of simulation and modelling, via workshops and direct discussions with experts in the CECAM community.

Our approach is focused on four scientific areas, critical for HPC simulations relevant to key societal and industrial challenges. These areas are classical molecular dynamics, electronic structure, quantum dynamics and meso- and multi-scale modelling. E-CAM develops new scientific ideas and transfers them to algorithm development, optimisation, and parallelization in these four respective areas, and delivers the related training. Postdoctoral researchers are employed under each scientific area, working closely with the scientific programmers to create, oversee and implement the different software codes, in collaboration with our industrial partners.

www.e-cam2020.eu
: @ECAM2020
: @e-cam

COORDINATING ORGANISATION

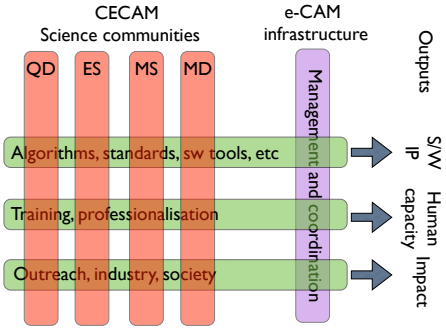
Ecole Polytechnique Fédérale de Lausanne, Switzerland

OTHER PARTNERS

- University College Dublin, Ireland
- Freie Universität Berlin, Germany
- Universita degli Studi di Roma La Sapienza, Italy
- CNRS - Centre National de la Recherche Scientifique, France
- Technische Universität Wien, AT
- University of Cambridge, UK
- Max-Planck-Institut für Polymerforschung, Germany
- ENS - École Normale Supérieure de Lyon, France
- Forschungszentrum Jülich, Germany
- Universitat de Barcelona, Spain
- Daresbury Laboratory, Scientific and Technology Facilities Council, UK
- Scuola Internazionale Superiore Di Trieste, Italy
- Universiteit van Amsterdam, Netherlands

So far E-CAM has

- Certified more than 160 software modules that are open access and easily available for the industrial and academic communities through our software repository
- Trained 300 people at our Extended Software Development Workshops in advanced computational methods, good practices for code development, documentation and maintenance
- Deployed an online training infrastructure to support the development of software for extreme-scale hardware
- Worked on 10 pilot projects in direct collaboration with our industrial partners
- Organized 8 State of the Art workshops and 6 Scoping workshops, that brought together industrialists, software developers and academic researchers, to discuss the challenges they face
- Worked on software development projects that enable an HPC practice with potential for transfer into industry. Examples include: GPU re-write of the DL_MESO code for mesoscale simulations; the development of a load-balancing library specifically targeting MD applications, and of an HTC library capable of handling thousands of tasks each requiring peta-scale computing; among other efforts.



Positioning of the e-CAM infrastructure

- Scuola Normale Superiore Pisa, Italy
- Aalto University, FI
- CSC-IT Centre for Science Ltd, Finland
- Irish Centre for High-End Computing, Ireland

CONTACT

Luke Drury
(Project Chair)
ld@cp.dias.ie
+353 1 6621333 ext 321

Ana Catarina Mendonça
(Project Coordinator)
ana.mendonca@epfl.ch
+41 21 693 0395

CALL

EINFRA-5-2015

PROJECT TIMESPAN

01/10/2015 - 31/03/2021

EoCoE-II

Energy Oriented Centre Of Excellence, Phase II

The Energy-oriented Centre of Excellence (EoCoE) applies cutting-edge computational methods in its mission to accelerate the transition to the production, storage and management of clean, decarbonized energy. EoCoE is anchored in the High Performance Computing (HPC) community and targets research institutes, key commercial players and SMEs who develop and enable energy-relevant numerical models to be run on exascale supercomputers, demonstrating their benefits for low-carbon energy technology. The present project draws on a successful proof-of-principle phase of EoCoE-I, where a large set of diverse computer applications from four such energy domains achieved significant efficiency gains thanks to its multidisciplinary expertise in applied mathematics and supercomputing. During this 2nd round, EoCoE-II channels its efforts into 5 scientific Exascale challenges in the low-carbon sectors of Energy Meteorology, Materials, Water, Wind and Fusion. This multidisciplinary effort harnesses innovations in computer science and mathematical algorithms within a tightly integrated co-design approach to overcome performance bottlenecks and to anticipate future HPC hardware developments. A world-class consortium of 18 complementary partners from 7 countries forms a unique network of expertise in energy science, scientific computing and HPC, including 3 leading European supercomputing centres. New modelling capabilities in selected energy sectors will be created at unprecedented scale, demonstrating the potential benefits to the energy industry, such as accelerated design of storage devices, high-resolution probabilistic wind and solar forecasting for the power grid and quantitative understanding of plasma core-edge interactions in ITER-scale tokamaks. These flagship

www.eocoe.eu
in: @hpc-energy

COORDINATING ORGANISATION

Maison de la Simulation (MdlS) and Institut de Recherche sur la Fusion par confinement Magnétique (IRFM) at CEA, France

OTHER PARTNERS

- Forschungszentrum Jülich (FZJ), with RWTH Aachen University, Germany
- Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
- Barcelona Supercomputer Centre (BSC), Spain
- Centre National de la Recherche Scientifique (CNRS) with Inst. Nat. Polytechnique Toulouse (INPT), France
- Institut National de Recherche en Informatique et Automatique (INRIA), France
- Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), France
- Max-Planck Gesellschaft (MPG), Germany
- Fraunhofer Gesellschaft, Germany
- Friedrich-Alexander Univ. Erlangen-Nürnberg (FAU), Germany



applications will provide a high-visibility platform for high-performance computational energy science, cross-fertilized through close working connections to the EERA and EUROfusion consortia.

EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 7 countries and 21 teams. Its partners are strongly engaged in both the HPC and energy fields. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. EoCoE resolves current bottlenecks in application codes; it develops cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries are established to leverage this expertise and to develop an ecosystem around HPC for energy.

We are interested in collaborations in the area of HPC (e.g. programming models, exascale architectures, linear solvers, I/O) and also with people working in the energy domain and needing expertise for carrying out ambitious simulation. See our service page for more details:
http://www.eocoe.eu/services

- Consiglio Nazionale delle Ricerche (CNR), with Univ. Rome, Tor Vergata (UNITOV), Italy
- Università degli Studi di Trento (UNITN), Italy
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (PSNC), Poland
- Université Libre de Bruxelles (ULB), Belgium
- University of Bath (UBAH), United Kingdom
- Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Spain
- IFP Energies Nouvelles (IFPEN), France
- DDN Storage

CONTACT

Edouard Audit
contact@eocoe.eu
+33 1 69 08 96 35

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INFRAEDI-02-2018

PROJECT TIMESPAN

01/01/2019 - 31/12/2021

ESiWACE2

Centre of Excellence in Simulation of Weather and Climate in Europe, Phase 2

ESiWACE2 will leverage the potential of the envisaged EuroHPC pre-exascale systems to push European climate and weather codes to world-leading spatial resolution for production-ready simulations, including the associated data management and data analytics workflows. For this goal, the portfolio of climate models supported by the project has been extended with respect to the prototype-like demonstrators of ESiWACE1. Besides, while the central focus of ESiWACE2 lies on achieving scientific performance goals with HPC systems that will become available within the next four years, research and development to prepare the community for the systems of the exascale era constitutes another project goal.

These developments will be complemented by the establishment of new technologies such as domain-specific languages and tools to minimise data output for ensemble runs. Co-design between model developers, HPC manufacturers and HPC centres is to be fostered, in particular through the design and employment of High-Performance Climate and Weather benchmarks, with the first version of these benchmarks feeding into ESiWACE2 through the FET-HPC research project ESCAPE-2. Additionally, training and dedicated services will be set up to enable the wider community to efficiently use upcoming pre-exascale and exascale supercomputers.

www.esiwace.eu
: @ESIWACE

COORDINATING ORGANISATION

Deutsches Klimarechenzentrum (DKRZ), Germany

OTHER PARTNERS

- CNRS - Centre National de la Recherche Scientifique, France
- ECMWF - European Centre for Medium-Range Weather Forecasts, United Kingdom
- Barcelona Supercomputing Center (BSC), Spain
- Max-Planck-Institut für Meteorologie, Germany
- Sveriges meteorologiska och hydrologiska institut, Sweden
- CERFACS - Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique, France
- National University of Ireland Galway (Irish Centre for High End Computing), Ireland
- Met Office, United Kingdom
- Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy
- The University of Reading, United Kingdom

esiwace
CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE

- STFC - Science and Technology Facilities Council, United Kingdom
- Atos (Bull SAS), France
- Seagate Systems UK Limited, United Kingdom
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- The University of Manchester, United Kingdom
- Netherlands eScience Centre, Netherlands
- Federal Office of Meteorology and Climatology, Switzerland
- DataDirect Networks, France
- Mercator Océan, France

CONTACT

Joachim Biercamp
esiwace@lists.dkrz.de

CALL

INFRAEDI-02-2018

PROJECT TIMESPAN

01/01/2019 - 31/12/2022

EXCELLERAT

Engineering applications will be among the first exploiting Exascale. Not only in academia but also in industry. In fact, the industrial engineering field is the field with the highest Exascale potential. Thus the goal of EXCELLERAT is to enable the European engineering industry to advance towards Exascale technologies and to create a single entry point to services and knowledge for all stakeholders (industrial end users, ISVs, technology providers, HPC providers, academics, code developers, engineering experts) of HPC for engineering. In order to achieve this goal, EXCELLERAT brings together key players from industry, research and HPC to provide all necessary services.. This is in line with the European HPC Strategy as implemented through the EuroHPC Joint Undertaking.

To fulfil its mission, EXCELLERAT focuses its developments on six carefully chosen reference applications (Nek5000, Alya, AVBP, TPLS, FEniCS, Coda), which were analysed on their potential to support the aim to achieve Exascale performance in HPC for Engineering. Thus, they are promising candidates to act as showcases for



Core competences of the EXCELLERAT Centre of Excellence

www.excellerat.eu
: @EXCELLERAT_CoE
: @excellerat

COORDINATING ORGANISATION

Universität Stuttgart (HLRS), Germany

OTHER PARTNERS

- The University of Edinburgh (EPCC), United Kingdom
- CINECA Consorzio Interuniversitario, Italy
- SICOS BW GmbH, Germany
- Kungliga Tekniska Hoegskolan (KTH), Sweden
- ARCTUR DOO, Slovenia
- DLR - Deutsches Zentrum für Luft- und Raumfahrt EV , Germany
- Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), France
- Barcelona Supercomputing Centre (BSC), Spain
- SSC-Services GmbH, Germany
- Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung E.V., Germany
- TERATEC, France
- Rheinisch-Westfälische Technische Hochschule Aachen, Germany



the evolution of applications towards execution on Exascale Demonstrators, Pre-Exascale Systems and Exascale Machines. EXCELLERAT addresses the setup of a Centre as an entity, acting as a single hub, covering a wide range of issues, from «non-pure-technical» services such as access to knowledge or networking up to technical services as e.g. co-design, scalability enhancement or code porting to new (Exa) Hardware.

As the consortium contains key players in HPC, HPDA, AI and experts for the reference applications, impact (e.g. code improvements and awareness raising) is guaranteed. The scientific excellence of the EXCELLERAT consortium enables evolution, optimisation, scaling and porting of applications towards disruptive technologies and increases Europe's competitiveness in engineering. Within the frame of the project, EXCELLERAT will prove the applicability of the results not only for the six chosen reference applications, but even going beyond. EXCELLERAT extends the recipients of its developments beyond the consortium and interacts via diverse mechanisms to integrate external stakeholders of its value network into its evolution.

CONTACT
Dr.-Ing. Bastian Koller
koller@hlrs.de

CALL
INFRAEDI-02-2018

PROJECT TIMESPAN
01/12/2018 - 30/11/2021

HiDALGO

HPC and Big Data Technologies for Global Challenges

OBJECTIVE

Developing evidence and understanding concerning Global Challenges and their underlying parameters is rapidly becoming a vital challenge for modern societies. Various examples, such as health care, the transition of green technologies or the evolution of the global climate up to hazards and stress tests for the financial sector demonstrate the complexity of the involved systems and underpin their interdisciplinary as well as their globality. This becomes even more obvious if coupled systems are considered: problem statements and their corresponding parameters are dependent on each other, which results in interconnected simulations with a tremendous overall complexity. Although the process for bringing together the different communities has already started within the Centre of Excellence for Global Systems Science (CoeGSS), the importance of assisted decision making by addressing global, multi-dimensional problems is more important than ever.

Global decisions with their dependencies cannot be based on incomplete problem assessments or gut feelings anymore, since impacts cannot be foreseen without an accurate problem representation and its systemic evolution. Therefore, HiDALGO bridges that shortcoming by enabling highly accurate simulations, data analytics

www.hidalgo-project.eu
: @EU_HiDALGO

COORDINATING ORGANISATION

Atos Spain,
Spain

OTHER PARTNERS

- Universität Stuttgart – High Performance Computing Center Stuttgart, Germany
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk – Poznan Supercomputing and Networking Center, Poland
- ICCS (Institute of Communication and Computer Systems), Greece
- Brunel University London, United Kingdom
- Know Center GmbH, Austria
- Szechenyi Istvan University, Hungary
- Paris-Lodron-Universität Salzburg, Austria
- European Centre for Medium-Range Weather Forecasts, United Kingdom
- MoonStar Communications GmbH, Germany



and data visualisation, but also by providing technology as well as knowledge on how to integrate the various workflows and the corresponding data.

- DIALOGIK Gemeinnützige Gesellschaft für Kommunikations- und Kooperationsforschung MBH, Germany
- Magyar Kozut Nonprofit Zrt., Hungary
- ARH Informatikai Zrt., Hungary

CONTACT

Francisco Javier Nieto
francisco.nieto@atos.net

CALL

INFRAEDI-02-2018

PROJECT TIMESPAN

01/12/2018 - 30/11/2021

MaX

Materials design at the Exascale

MaX - Materials design at the eXascale is a Centre of Excellence with focus on driving the evolution and exascale transition of materials science codes and libraries, and creating an integrated ecosystem of codes, data, workflows and analysis tools for high-performance (HPC) and high-throughput computing (HTC). Particular emphasis is on co-design activities to ensure that future HPC architectures are well suited for the materials science applications and their users.

The focus of MaX is on first principles materials science applications, i.e. codes that allow predictive simulations of materials and their properties from the laws of quantum physics and chemistry, without resorting to empirical parameters. The exascale perspective is expected to boost the massive use of these codes in designing materials structures and functionalities for research and manufacturing.

MaX works with code developers and experts from HPC centres to support such transition. It focuses on selected complementary open-source codes: BigDFT, CP2k, FLEUR, Quantum ESPRESSO, SIESTA, YAMBO. In addition, it contributes to the development of the AiiDA materials informatics infrastructure and the Materials Cloud environment.

The main actions of the project include:

1. code and library restructuring: including modularizing and adapting for heterogeneous architectures, as well as adoption of new algorithms;
2. co-design: working on codes and providing feedback to architects and integrators; developing workflows and turn-key solutions for properties calculations and curated data sharing;
3. enabling convergence of HPC, HTC and

www.max-centre.eu
: @max_center2
: @max_centre

COORDINATING ORGANISATION

CNR Nano, Modena, Italy

OTHER PARTNERS

- SISSA Trieste, *Italy* (Stefano Baroni)
- ICN2 Barcelona, *Spain* (Pablo Ordejón)
- FZJ Jülich, *Germany* (Stefan Blügel, Dirk Pleiter)
- EPFL Lausanne, *Switzerland* (Nicola Marzari)
- CINECA Bologna, *Italy* (Fabio Affinito)
- Barcelona Supercomputing Centre (BSC), *Spain* (Stephan Mohr)
- CSCS ETH Zürich, *Switzerland* (Joost VandeVondele)
- CEA Grenoble, *France* (Thierry Deutsch)
- UGent, *Belgium* (Stefaan Cottenier)
- E4 Computer Engineering, *Italy* (Fabrizio Magugliani)
- Arm, *UK* (Conrad Hillairet)
- ICTP UNESCO Trieste, *Italy* (Ivan Girotto)
- Trust-IT Pisa, *Italy* (Silvana Muscella)



high-performance data analytics;
4. addressing the skills gap: widening access to codes, training, and transferring know-how to user communities;
5. serving end-users in industry and research: providing dedicated services, support, and high-level consulting.

Results and lessons learned on MaX flagship codes and projects are made available to the developers and user communities at large.

CONTACT
Elisa Molinari
Director
elisa.molinari@max-centre.eu
+39 059 2055 629

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INFRAEDI-02-2018

PROJECT TIMESPAN
01/12/2018 - 30/11/2021

NOMAD

Novel Materials Discovery

Predicting novel materials with specific desirable properties is a major aim of ab initio computational materials science (aiCMS) and an urgent requirement of basic and applied materials science, engineering and industry. Such materials can have immense impact on the environment and on society, e.g. on energy, transport, IT, medical-device sectors and much more. Currently, however, precisely predicting complex materials is computationally infeasible.

NOMAD CoE will develop a new level of materials modelling, enabled by upcoming HPC exascale computing and extreme-scale data hardware.

In close contact with the R&D community, including industry, we will

- develop exascale algorithms to create accurate predictive models of real-world, industrially-relevant, complex materials;
- provide exascale software libraries for all code families (not just selected codes); enhancing today's aiCMS to take advantage of tomorrow's HPC computing platforms;
- develop energy-to-solution as a fundamental part of new models. This will be achieved by developing novel artificial-intelligence (AI) guided work-flow engines that optimise the modelling calculations and provide significantly more information per calculation performed;

www.nomad-coe.eu
: @NoMaDCoE

COORDINATING ORGANISATION

Max-Planck-Gesellschaft zur Förderung der Wissenschaften EV, Germany

OTHER PARTNERS

- Humboldt-Universität zu Berlin, Germany
- Danmarks Tekniske Universitet, Denmark
- Technische Universität Wien, Austria
- The University of Warwick, United Kingdom
- Université Catholique de Louvain, Belgium
- Barcelona Supercomputing Centre (BSC), Spain
- CSC – IT Center for Science Ltd., Finland
- University of Cambridge, United Kingdom
- CEA - Commissariat à l'Energie Atomique et aux Energies Alternatives, France
- Aalto University Helsinki, Finland
- University of Latvia, Latvia



- offer extreme-scale data services (data infrastructure, storage, retrieval and analytics/AI);
- test and demonstrate our results in two exciting use cases, solving urgent challenges for the energy and environment that cannot be computed properly with today's hard- and software (water splitting and novel thermoelectric materials);
- train the next generation of students, also in countries where HPC studies are not yet well developed.

NOMAD CoE is working closely together with POP, and it is synergistically complementary to and closely coordinated with the EoCoE, ECAM, BioExcel and MaX CoEs.

NOMAD CoE will push the limits of aiCMS to unprecedented capabilities, speed and accuracy, serving basic science, industry and thus society.

CONTACT
contact@nomad-coe.eu

CALL
INFRAEDI-05-2020

PROJECT TIMESPAN
01/10/2020 – 30/09/2023

PerMedCoE

HPC /Exascale Center of Excellence in Personalised Medicine

Personalised Medicine (PerMed) opens unexplored frontiers to treat diseases at the individual level combining clinical and omics information. However, the performances of the current simulation software are still insufficient to tackle medical problems such as tumour evolution or patient-specific treatments. The challenge is to develop a sustainable roadmap to scale-up the essential software for the cell-level simulation to the new European HPC/Exascale systems. Simulation of cellular mechanistic models are essential for the translation of omic data to medical relevant actions and these should be accessible to the end-users in the appropriate environment of the PerMed-specific big confidential data.

The goal of the HPC/Exascale Centre of Excellence in Personalised Medicine (PerMedCoE) is to provide an efficient and sustainable entry point to the HPC/Exascale-upgraded methodology to translate omics analyses into actionable models of cellular functions of medical relevance. It will accomplish so by

1. optimising four core applications for cell-level simulations to the new pre-exascale platforms;
2. integrating PerMed into the new European HPC/Exascale ecosystem, by offering access to HPC/Exascale-adapted and optimised software;
3. running a comprehensive set of PerMed use cases;

www.permedcoe.eu
: @PerMedCoE
: @permedcoe
: youtube.com/channel/UCIZV7lul2oU-TV-jKtEPzKw

COORDINATING ORGANISATION

Barcelona Supercomputing Centre (BSC), Spain

OTHER PARTNERS

- CSC-IT Centre for Science Ltd, Finland
- Université du Luxembourg, Luxembourg
- Institut Curie, France
- Universitätsklinikum Heidelberg, Germany
- IBM Research GmbH, Switzerland
- Atos Spain, Spain
- Kungliga Tekniska Hoegskolan (KTH), Sweden
- European Molecular Biology Laboratory, Germany
- Fundacio Centre de Regulacio Genomica, Spain
- Max Delbrück Centre for Molecular Medicine, Germany
- University of Ljubljana, Slovenia
- ELEM BIOTECH SL, Spain



4. building the basis for the sustainability of the PerMedCoE by coordinating PerMed and HPC communities, and reaching out to industrial and academic end-users, with use cases, training, expertise, and best practices.

The PerMedCoE cell-level simulations will fill the gap between the molecular- and organ-level simulations from the CompBioMed and BioExcel CoEs with which this proposal is aligned at different levels. It will connect methods' developers with HPC, HTC and HPDA experts (at POP and HiDALGO CoEs). Finally, the PerMedCoE will work with biomedical consortia (i.e. ELIXIR, LifeTime initiative) and pre-exascale infrastructures (BSC and CSC), including a substantial co-design effort.

CONTACT
Alfonso Valencia
alfonso.valencia@bsc.es

CALL
INFRAEDI-05-2020

PROJECT TIMESPAN
01/10/2020 – 30/09/2023

POP2

Performance Optimisation and Productivity 2

The growing complexity of parallel computers is leading to a situation where code owners and users are not aware of the detailed issues affecting the performance of their applications. The result is often an inefficient use of the infrastructures. Even in the cases where the need to get further performance and efficiency is perceived, the code developers may not have insight enough on its detailed causes so as to properly address the problem. This may lead to blind attempts to restructure codes in a way that might not be the most productive ones.

POP2 extends and expands the activities successfully carried out by the POP Centre of Excellence since October 2015. The effort in the POP and POP2 projects resulted up to now in more than 200 assessment services provided to customers in academia, research and industry helping them to better understand the behaviour and improve the performance of their applications. The external view, advice, and help provided by POP have been extremely useful for many of these customers to significantly improve the performance of their codes by factors of 20% in some cases but up to 2x or even 10x in others. The POP experience was also extremely valuable to identify issues in methodologies and tools that if improved will reduce the assessment cycle time.

www.pop-coe.eu
: @POP_HPC

COORDINATING ORGANISATION

Barcelona Supercomputing Centre (BSC), Spain

OTHER PARTNERS

- Universität Stuttgart HLRS, Germany
- Forschungszentrum Jülich GmbH, Germany
- Numerical Algorithms Group Ltd, UK
- Rheinisch-Westfälische Technische Hochschule Aachen (RWTH-AACHEN), Germany
- Teratec, France
- Université de Versailles Saint Quentin, France
- Vysoka Skola Banska - Technicka Univerzita Ostrava, Czech Republic



POP2 continues to focus on a transversal (horizontal) service to offer highly specialized expertise and know-how to all other CoEs facilitating cross-fertilisation between them and other sectors. This could lead to wider access to codes, including specific and targeted measures for industry & SMEs. Collaborations with other CoEs and Projects will help to reach potential users for services and promote support to the governance of HPC Infrastructures. Centres could adopt the POP methodology, helping it embed in the wider HPC community, leveraging the use of existing infrastructures.

CONTACT

Jesus Labarta
jesus.labarta@bsc.es
Judit Gimenez
judit@bsc.es

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PROJECT TIMESPAN

01/12/2018 - 30/11/2021

TREX

Targeting Real chemical accuracy at the EXascale

TREX federates European scientists, HPC stakeholders, and SMEs to develop and apply quantum mechanical simulations in the framework of stochastic quantum Monte Carlo methods. This methodology encompasses various techniques at the high-end in the accuracy ladder of electronic structure approaches and is uniquely positioned to fully exploit the massive parallelism of the upcoming exascale architectures. The marriage of these advanced methods with exascale will enable simulations at the nanoscale of unprecedented accuracy, targeting a fully consistent description of the quantum mechanical electron problem. TREX's main focus will be the development of a user-friendly and open-source software suite in the domain of stochastic quantum chemistry simulations, which integrates TREX community codes within an interoperable, high-performance platform. In parallel, TREX will work on show-cases to leverage this methodology for commercial applications as well as develop and implement software components and services that make it easier for commercial operators and user communities to use HPC resources for these applications.

trex-coe.eu/
: @trex_eu
: @trex-eu

COORDINATING ORGANISATION

University of Twente, Netherlands

OTHER PARTNERS

- CNRS - Centre National de la Recherche Scientifique, France
- Scuola Internazionale Superiore Di Studi Avanzati Di Trieste, Italy
- CINECA Consorzio Interuniversitario, Italy
- Forschungszentrum Jülich GmbH, Germany
- Max-Planck-Gesellschaft zur Förderung der Wissenschaften EV, Germany
- Université de Versailles Saint Quentin-en-Yvelines, France
- Megware Computer Vertrieb und Service GmbH, Germany
- Slovenska Technicka Univerzita V Bratislave, Slovakia
- Universität Wien, Austria
- Politechnika Lodzka, Poland
- TRUST-IT SRL, Italy



CONTACT

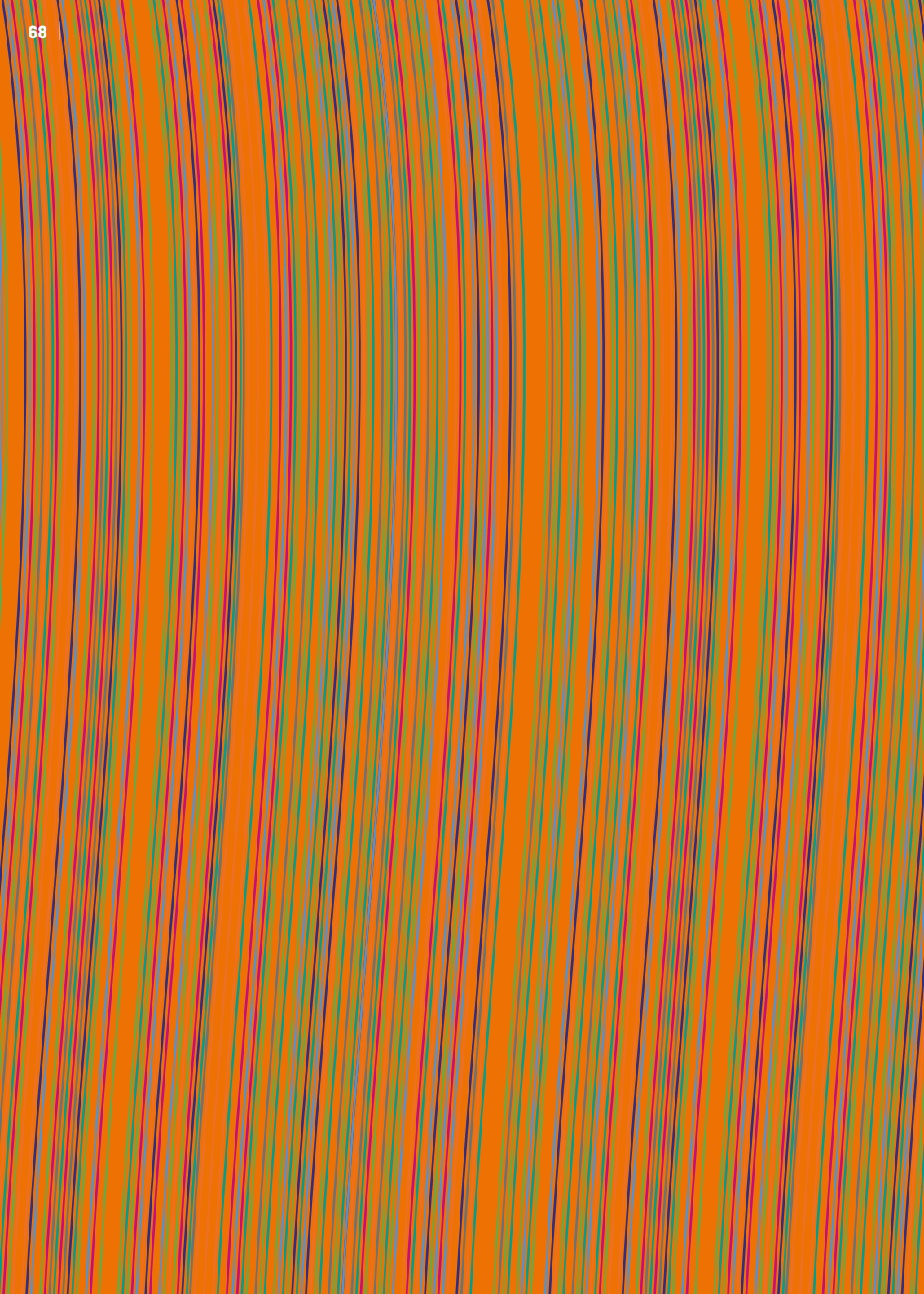
Claudia Filippi
Project Coordinator
c.filippi@utwente.nl

CALL

INFRAEDI-05-2020

PROJECT TIMESPAN

01/10/2020 – 30/09/2023



European Processor

EPI

European Processor Initiative

Europe has an ambitious plan to become a main player in supercomputing. One of the core components for achieving that goal is a processor. The European Processor Initiative (EPI) is a part of a broader strategy to develop and independent European HPC industry based on domestic and innovative technologies as presented in the EuroHPC Joint Undertaking proposed by the European Commission. The general objective of EPI is to design a roadmap and develop the key Intellectual Property for future European low-power processors addressing extreme scale computing (exascale), high-performance, big-data and emerging verticals (e.g. automotive computing) and other fields that require highly efficient computing infrastructure. More precisely, EPI aims at establishing the key technologies to reach three fundamental goals:

1. Developing low-power processor technology to be included in an advanced experimental pilot platforms towards exascale systems for Europe in 2021-2022;
2. Ensuring that a significant part of that technology and intellectual property is European;
3. Ensuring that the application areas of the technology are not limited only to HPC, but cover other areas, such as automotive and data centers, thus ensuring the economic viability of the initiative.

EPI gathers 27 partners from 10 European countries, with a wide range of expertise and background: HPC, supercomputing centers, automotive computing, including researchers and key industrial players. The fact that the envisioned European processor is planned to be based on already existing tools either owned by the partners or



being offered as open-source with a large community of users, provides three key exploitation advantages: (1) the time-to-market will be reduced as most of these tools are already used in industry and well known. (2) It will enable EPI partners to incorporate the results in their commercial portfolio or in their scientific roadmap. (3) it fundamentally reduces the technological risk associated to advanced technologies developed and implemented in EPI.

EPI covers a complete range of expertise, skills, and competencies needed to design and execute a sustainable roadmap for research and innovation in processor and computing technology, fostering future exascale HPC and emerging applications, including Big Data, and automotive computing for autonomous vehicles. Development of a new processor to be at the core of future computing systems will be divided into several streams:

- Common Platform and global architecture [stream 1]
- HPC general purpose processor [stream 2]
- Accelerator [stream 3]
- Automotive platform [stream 4]

The results from the two streams related to the general-purpose processor and accelerator chips will generate a heterogeneous, energy-efficient CPU for use in both standard and non-traditional and compute-intensive segments, e.g. automotive where SoA in autonomous driving requires significant computational resources.

The EPI timeline



EPI strives to maximize the synergies between the two streams and will work with existing EU initiatives on technology, infrastructure and applications, to position Europe as a world leader in HPC and emerging markets for exascale era such as automotive computing for autonomous driving.

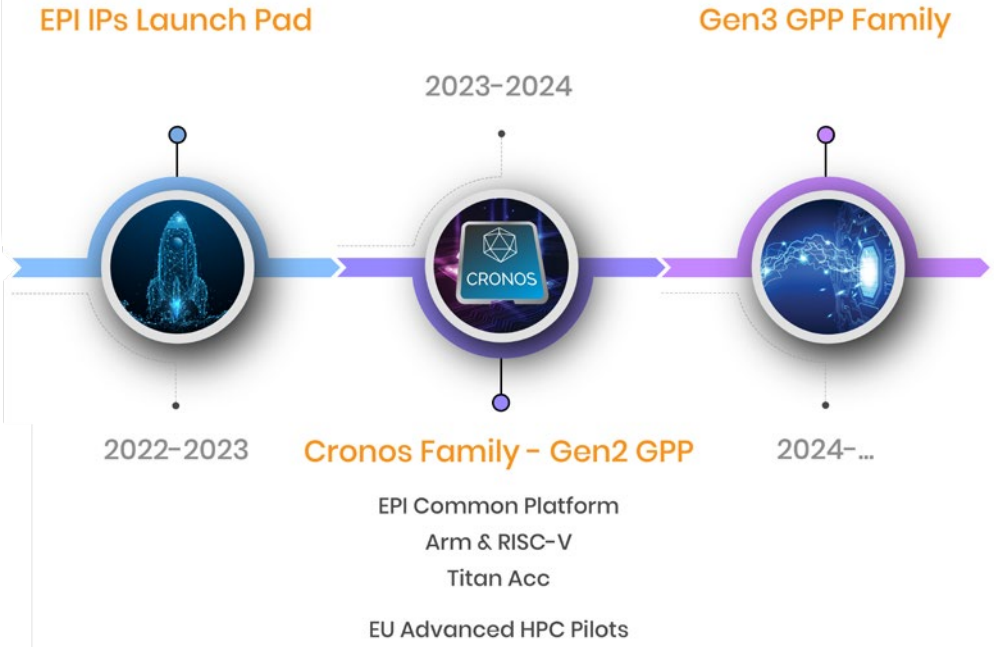
www.european-processor-initiative.eu
: @EUProcessor
: @european-processor-initiative
: www.youtube.com/channel/UCGvQcTosJdWhd013SHnIbpA/featured

COORDINATING ORGANISATION

Bull SAS (Atos group), France

OTHER PARTNERS

- BSC, Barcelona supercomputing center – centro nacional de supercomputacion, Spain
- IFAG, Infineon Technologies AG, Germany
- SemiDynamics, SemiDynamics technology services SL, Spain
- CEA, Commissariat à l'Energie Atomique et aux énergies alternatives, France
- CHALMERS, Chalmers tekniska högskola, Sweden
- ETH Zürich, Eidgenössische Technische Hochschule Zürich, Switzerland
- FORTH, Foundation for Research and Technology Hellas, Greece
- GENCI, Grand Equipement National de Calcul Intensif, France
- IST, Instituto Superior Technico, Portugal
- JÜLICH, Forschungszentrum Jülich GmbH, Germany
- UNIBO, Alma mater studiorum - Universita di Bologna, Italy
- UNIZG-FER, Sveučilište u



Zagrebu, Fakultet elektrotehnike i računarstva, Croatia
- Fraunhofer, Fraunhofer Gesellschaaft zur Förderung der angewandten Forschung E.V., Germany
- ST-I, STMICROELECTRONICS SRL, Italy
- E4, E4 Computer Engineering SPA, Italy
- UNIPI, Universita di Pisa, Italy
- SURFsara BV, Netherlands
- Kalray SA, France
- Extoll GmbH, Germany
- CINECA, Cineca Consorzio Interuniversitario, Italy
- BMW Group, Bayerische Motoren Werke Aktiengesellschaft, Germany
- Elektrobit, Automotive GmbH, Germany
- KIT, Karlsruher Institut für Technologie, Germany
- Menta SAS, France
- Prove & Run, France
- SIPEARL SAS, France

CONTACT

contact@european-processor-initiative.eu

CALL

SGA-LPMT-01-2018

PROJECT TIMESPAN

01/12/2018 - 30/11/2021

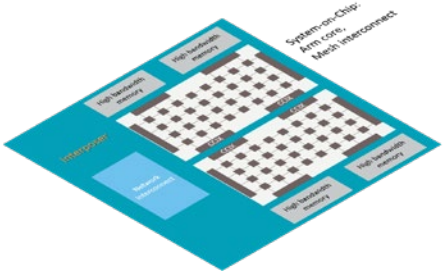
Mont-Blanc 2020

European scalable, modular and power-efficient HPC processor

Following on from the three successive Mont-Blanc projects since 2011, the three core partners Arm, Barcelona Supercomputing Center and Atos have united again to trigger the development of the next generation of industrial processor for Big Data and High Performance Computing. The Mont-Blanc 2020 consortium also includes CEA, Forschungszentrum Jülich, Kalray, and SemiDynamics.

The Mont-Blanc 2020 project intends to pave the way to the future low-power European processor for Exascale. To improve the economic sustainability of the processor generations that will result from the Mont-Blanc 2020 effort, the project includes the analysis of the requirements of other markets. The project's strategy based on modular packaging would make it possible to create a family of SoCs targeting different markets, such as "embedded HPC" for autonomous driving. The project's actual objectives are to:

- define a low-power System-on-Chip architecture targeting Exascale;
- implement new critical building blocks (IPs) and provide a blueprint for its first-generation implementation;
- deliver initial proof-of-concept demonstration of its critical components on real life applications;



The Mont-Blanc 2020 physical architecture

montblanc-project.eu
: @MontBlanc_Eu
: @mont-blanc-project

COORDINATING ORGANISATION

Atos (Bull SAS), France

OTHER PARTNERS

- Arm, United Kingdom)
- Barcelona Supercomputing Centre (BSC), Spain
- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- Jülich Forschungszentrum, Germany
- Kalray, France
- SemiDynamics, Spain

MONT-BLANC 2020



A Key Output: the MB2020 demonstrator

- explore the reuse of the building blocks to serve other markets than HPC, with methodologies enabling a better time-predictability, especially for mixed-critical applications where guaranteed execution & response times are crucial.

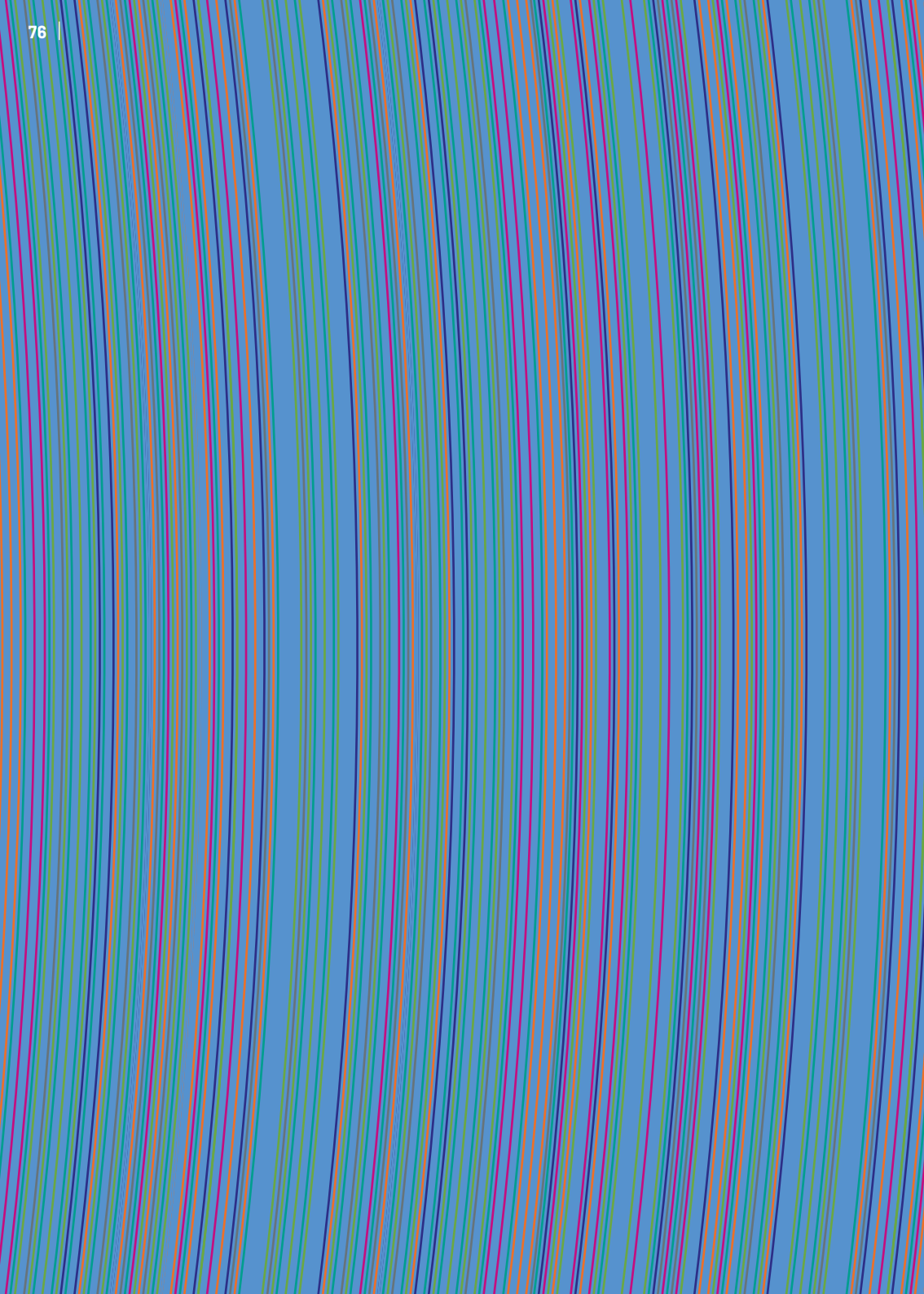
Mont-Blanc 2020 will provide new IPs, such as a new low-power mesh interconnect based on the Coherent Hub Interface (CHI) architecture. Mont-Blanc 2020 will demonstrate the performance with a prototype implementation in RTL for some of its key components, and demonstration on an emulation platform.

The Mont-Blanc 2020 project is at the heart of the European exascale supercomputer effort, since most of the IP developed within the project will be reused and productized in the European Processor Initiative (EPI).

CONTACT
Etienne Walter
Etienne.walter@atos.net

CALL
ICT-05-2017

PROJECT TIMESPAN
01/12/2017 - 31/03/2021



Applications in the HPC Continuum

AQMO

Air Quality and Mobility

Many metropolises are struggling to reduce air pollution. At the core of this issue are two important requirements: getting a better temporal and spatial measurement coverage, and having the ability to use simulations to answer "what-if" questions. The AQMO project provides an **end-to-end urban platform based on an edge-to-HPC and cloud hybrid computing model fuelled by Open Data**.

The AQMO platform is deployed in the Rennes metropolitan area (Brittany, France) which consists of 43 cities and is the 12th largest metropolis in France in terms of population.

A **transversal approach** was chosen for the design, that spans from sensors to supercomputers in order to deliver day-to-day data as well as capabilities to help catastrophic event handling, denoted as **"urgent computing"**. The AQMO project explores the use of High-Performance Computing (HPC) both centrally in supercomputing centres and distributed on enhanced sensors (Edge computing) or cloud resources. HPC capabilities are necessary to perform accurate numerical simulations of pollution dispersion, including sensors data assimilation.

The dissemination of the platform and its use by other cities will be eased by its modular design: transferable and replicable systems, and addition data and capabilities can be added thanks to open Application Program Interfaces.

To achieve, in a cost-effective manner, rigorous air quality measurements in a wide area, **the local transportation bus network is enhanced with mobile sensors**. In the case of measurements for catastrophic event, the use of drones is explored, in connection with the UAV-Retina project

aqmo.irisa.fr
: @aqmoproject

COORDINATING ORGANISATION

Université Rennes 1, France

OTHER PARTNERS

- Air Breizh
- AmpliSIM
- GENCI
- IDRIS (CNRS)
- Keolis Rennes
- Neovia Innovation
- Rennes Métropole
- Ryax Technologies
- UCit





supported by the EIT-Digital. AQMO is implementing **HPC as a service as a mean to provide both routinely and also on-demand air quality simulations.** The resulting data will be made available to citizens thanks to the Open-Data Metropolitan Service that is being developed by Rennes Métropole. Metadata will be published on the French national Open Data Portal and the European Data Portal.

The AQMO platform has been under test for over a year now in a few of the Rennes Metropolis' buses and has remained stable during the full experiment. The design choices have been proven to fit the project needs, with new sensors needed to get a measurement context. For instance, the team wants to be able to explain the detection of peaks of particles. The partners have implemented a smart camera that will be added to the platform to help with these detections.

The year 2020 is dedicated to deploying the platform in 20 buses to start the monitoring of the air quality (based on AlphaSense OPC-N3 sensors) in the whole Rennes metropolis.

CONTACT
François BODIN

CALL
INEA/CEF/ICT/A2017

PROJECT TIMESPAN
01/09/2018 – 31/12/2020

CYBELE

Fostering precision agriculture and livestock farming through secure access to large-scale HPC-enabled virtual industrial experimentation environment empowering scalable big data analytics

CYBELE generates innovation and creates value in the domain of agri-food, and its verticals in the sub-domains of Precision Agriculture (PA) and Precision Livestock Farming (PLF) in specific. This will be demonstrated by the real-life industrial cases, empowering capacity building within the industrial and research community. CYBELE aims at demonstrating how the convergence of HPC, Big Data, Cloud Computing and the Internet of Things can revolutionise farming, reduce scarcity and increase food supply, bringing social, economic, and environmental benefits.

CYBELE intends to safeguard that stakeholders have integrated, unmediated access to a vast amount of large-scale datasets of diverse types from a variety of sources. By providing secure and unmediated access to large-scale HPC infrastructures supporting data discovery, processing, combination and visualisation services, Stakeholders shall be enabled to generate more value and deeper insights in operations.

CYBELE develops large scale HPC-enabled test beds and delivers a distributed big data management architecture and a data management strategy providing:

www.cybele-project.eu
: @CYBELE_H2020
: @cybeleh2020
: @Cybele-project-766977186/

COORDINATING ORGANISATION

Waterford Institute of Technology, Ireland

OTHER PARTNERS

- Barcelona Supercomputing Centre (BSC), Spain
- Bull SAS (Atos group), France
- CINECA Consorzio Interuniversitario, Italy
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk, Poland
- RYAX Technologies, France
- Universität Stuttgart, Germany
- EXODUS Anonymos Etaireia Pliroforikis, Greece
- LEANXCALE SL, Spain
- ICCS (Institute of Communication and Computer Systems), Greece
- Centre for Research and Technology Hellas - Information Technologies Institute (ITI), Greece
- Tampereen Korkeakoulusaatio SR, Finland
- UBITECH, Greece
- University of Piraeus Research Center, Greece
- SUITE5 Data Intelligence Solutions Ltd, Cyprus
- INTRASOFT International SA, Luxembourg
- ENGINEERING - Ingegneria Informatica SPA, Italy



CYBELE

1. integrated, unmediated access to large scale datasets of diverse types from a multitude of distributed data sources,
2. a data and service driven virtual HPC-enabled environment supporting the execution of multi-parametric agri-food related impact model experiments, optimising the features of processing large scale datasets and
3. a bouquet of domain specific and generic services on top of the virtual research environment facilitating the elicitation of knowledge from big agri-food related data, addressing the issue of increasing responsiveness and empowering automation-assisted decision making, empowering the stakeholders to use resources in a more environmentally responsible manner, improve sourcing decisions, and implement circular-economy solutions in the food chain.

- Wageningen University, Netherlands
- Stichting Wageningen Research, Netherlands
- BIOSENSE Institute, Serbia
- Donau Soja Gemeinnutzige GmbH, Austria
- Agroknow IKE, Greece
- GMV Aerospace and Defence SA, Spain
- Federacion de Cooperativas Agroalimentares de la Comunidad Valenciana, Spain
- University of Strathclyde, United Kingdom
- ILVO - Instituut voor Landbouw- en Visserrijonderzoek, Belgium
- VION Food Nederland BV, Netherlands
- Oloklіromena Pliroforiaka Sistimataae, Greece
- Kobenhavns Universitet, Denmark
- EVENFLOW, Belgium
- Open Geospatial Consortium (Europe) Ltd, United Kingdom

CONTACT

cybele.h2020@gmail.com
sdavy@tssg.org

CALL

ICT-11-2018-2019

PROJECT TIMESPAN

01/01/2019 - 31/12/2021

DeepHealth

Deep-Learning and HPC to Boost Biomedical Applications for Health

The main goal of the DeepHealth project is to put HPC computing power at the service of biomedical applications; and apply Deep Learning (DL) and Computer Vision (CV) techniques on large and complex biomedical datasets to support new and more efficient ways of diagnosis, monitoring and treatment of diseases.

The DeepHealth toolkit: A key open-source asset for Health AI-based solutions

At the centre of the proposed innovations is the DeepHealth toolkit, a free open source software that will provide a unified framework to exploit heterogeneous HPC and big data architectures assembled with DL and CV capabilities to optimise the training of predictive models. The toolkit will be ready to be integrated in current and new biomedical software platforms or applications.

The toolkit is composed of two core libraries, the European Distributed Deep Learning Library (EDDLL) and the European Computer Vision Library (ECVL), plus a back-end offering a RESTful API to other applications, and a dedicated front-end that interacts with the back-end for facilitating the use of the libraries to computer and data scientists without the need of writing code.

DeepHealth will also develop HPC infrastructure support for an efficient execution of the libraries, with a focus on usability and portability.

The DeepHealth concept – application scenarios

The DeepHealth concept focuses on scenarios where image processing is needed for diagnosis. In the training environment IT experts work with image datasets for training predictive models. In the production

deephealth-project.eu
: @DeepHealthEU
: @DeepHealthEU
: @deephealtheu

COORDINATING ORGANISATION

Everis Spain SL, Spain

OTHER PARTNERS

- Azienda Ospedaliera Citta della Salute e della Scienza di Torino, Italy
- Barcelona Supercomputing Centre (BSC), Spain
- Centre Hospitalier Universitaire Vaudois, Switzerland
- Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna SRL, Italy
- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- EPFL - Ecole Polytechnique Fédérale de Lausanne, Switzerland
- Fundacion para el Fomento de la Investigacion Sanitaria y Biomedica de la Comunitat Valenciana, Spain
- Karolinska Institutet, Sweden
- Otto-von-Guericke-Universität Magdeburg, Germany
- Philips Medical Systems Nederland BV, Netherlands
- Pro Design Electronic GmbH, Germany

environment the medical personnel ingests an image coming from a scan into a platform or biomedical application that uses predictive models to get clues to support them during diagnosis. The DeepHealth toolkit will allow the IT staff to train models and run the training algorithms over hybrid HPC + big data architectures without a profound knowledge of DL, CV, HPC or big data and increase their productivity reducing the required time to do it.

14 pilots and seven platforms to validate the DeepHealth proposed innovations

The DeepHealth innovations will be validated in 14 pilot test-beds through the use of seven different biomedical and AI software platforms that integrate and exploit the libraries: everis Lumen, PHILIPS Open Innovation Platform, THALES PIAF, CEA's ExpressIFTM, CRS4's Digital Pathology, WINGS MigraineNet and UNITO's OpenDeepHealth.

The use cases cover three main areas: (1) Neurological diseases, (2) Tumour detection and early cancer prediction and (3) Digital pathology and automated image annotation. The pilots will evaluate the performance of the proposed solutions in terms of the time needed for pre-processing images, the time needed to train models and the time to put models in production. In some cases, it is expected to reduce these times from days or weeks to just hours. This is one of the major expected impacts of the DeepHealth project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

- SIVECO Romania SA, Romania
- Spitalul Clinic Prof Dr Theodor Burghele, Romania
- STELAR Security Technology Law Research UG, Germany
- Thales SIX GTS France SAS, France
- TREE Technology SA, Spain
- Università degli Studi di Modena e Reggio Emilia, Italy
- Università degli Studi di Torino, Italy
- Universitat Politècnica de València, Spain
- WINGS ICT Solutions Information & Communication Technologies IKE, Greece

CONTACT

PROJECT MANAGER:
Monica Caballero
monica.caballero.galeote@everis.com
TECHNICAL MANAGER:
Jon Ander Gómez
jon@dsic.upv.es

CALL

ICT-11-2018-2019

PROJECT TIMESPAN

01/01/2019 - 31/12/2021

EVOLVE

HPC and Cloud-enhanced Testbed for Extracting Value from Diverse Data at Large Scale

EVOLVE is a pan European Innovation Action with 19 key partners from 10 European countries introducing important elements of High-Performance Computing (HPC) and Cloud in Big Data platforms taking advantage of recent technological advancements to enable cost-effective applications in 7 different pilots to keep up with the unprecedented data growth we are experiencing.

EVOLVE aims to build a large-scale testbed by integrating technology from:

The HPC world: An advanced computing platform with HPC features and systems software.

The Big Data world: A versatile big-data processing stack for end-to-end workflows.

The Cloud world: Ease of deployment, access, and use in a shared manner, while addressing data protection.

EVOLVE aims to take concrete and decisive steps in bringing together the Big Data, HPC, and Cloud worlds, and to increase the ability to extract value from massive and demanding datasets. EVOLVE aims to bring the following benefits for processing large and demanding datasets:

Performance: Reduced turn-around time for domain-experts, industry (large and SMEs), and end-users.

Experts: Increased productivity when designing new products and services, by processing large datasets.

Businesses: Reduced capital and operational costs for acquiring and maintaining computing infrastructure.

Society: Accelerated innovation via faster design and deployment of innovative services that unleash creativity.

At its mid-term, EVOLVE has successfully delivered a heterogeneous platform with CPU, GPU, FPGA and a deep storage

www.evolve-h2020.eu
: @Evolve_H2020
: @evolve-h2020

COORDINATING ORGANISATION

Datadirect Networks France, France

OTHER PARTNERS

- AVL LIST GmbH, Austria
- BMW - Bayerische Motoren Werke AG, Germany
- Atos (Bull SAS), France
- Cybeletech, France
- Globaz S.A., Portugal
- IBM Ireland Ltd, Ireland
- Idryma Technologias Kai Erevnas, Greece
- ICCS (Institute of Communication and Computer Systems), Greece
- KOOLA d.o.o., Bosnia and Herzegovina
- Kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft mbH, Austria
- MEMEX SRL, Italy
- MEMOSCALE AS, Norway
- NEUROCOM Luxembourg SA, Luxembourg



evolve

Leading the Big Data Revolution

architecture from local NVMe to dis-aggregated burst-buffer and capacity oriented parallel file system. The platform is online with more than 50 active users. The system is accessible with notebook and runs complex containerized workflows using big data components such as Kafka or Spark which are accelerated with HPC grade improvements. Activities from CPU to storage is monitored at the CPU or job granularity thanks to an extended version of Prometheus.
Currently 5 out of the 7 pilot applications are ported on the platform, and run on a daily basis with a speed-up over x100 for some cases.

As a first step toward broader market penetration, on the top of its initial set of 7 pilots, Evolve has attracted additional Proof-of-Concepts (PoCs) applications. These PoCs take advantage of Evolve technology and allow Evolve to enlarge and optimize its portability aspects. Some of these PoCs are already running on the platform.
In the coming months Evolve plans to fulfil its vision of user centric converged platform: new grade of GPUs, improved containerization and deeper workflow implementation.

- ONAPP Ltd, Gibraltar
- Space Hellas SA, Greece
- Thales Alenia Space France SAS, France
- TIEMME SPA, Italy
- WEBLYZARD Technology GmbH, Austria

CONTACT

Catarina Pereira
catarina@loba.pt
Jean-Thomas Acquaviva
jtacquaviva@ddn.com

CALL

ICT-11-2018-2019

PROJECT TIMESPAN

01/12/2018 - 30/11/2021

LEXIS

Large-scale EXecution for Industry & Society

The ever-increasing quantity of data generated by modern industrial and business processes poses an enormous challenge for organisations seeking to glean knowledge and understanding from the data. Combinations of HPC, Cloud and Big Data technologies are key to meeting the increasingly diverse needs of large and small organisations alike, however, access to powerful computing platforms for SMEs which has been difficult due to both technical and financial considerations may now be possible.

The LEXIS (Large-scale EXecution for Industry & Society) project is building an advanced engineering platform at the confluence of HPC, Cloud and Big Data, which leverages large-scale geographically-distributed resources from the existing HPC infrastructure, employs Big Data analytics solutions and augments them with Cloud services. Driven by the requirements of several pilot test cases, the LEXIS platform relies on best-in-class data management solutions (EUDAT) and advanced, distributed orchestration solutions (TOSCA), augmenting them with new, efficient hardware and platform capabilities (e.g. in the form of Data Nodes and federation, usage monitoring and accounting/billing support). Thus, LEXIS realises an innovative solution aimed at stimulating the interest of the European industry and at creating an ecosystem of organisations that benefit from the LEXIS platform and its well-integrated HPC, HPDA and Data Management solutions.

The consortium is thus developing a demonstrator with a significant Open Source dimension, including validation, test and documentation. It will be validated in large-scale pilots – in industrial and scientific sectors (Aeronautics, Earthquake and Tsunami, Weather and Climate), where

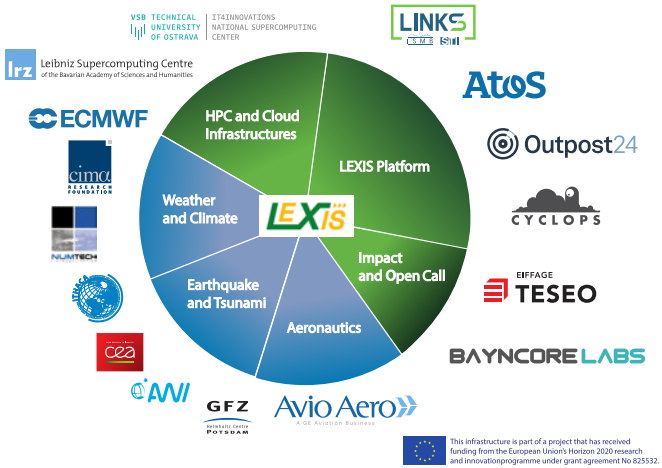
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: @LexisProject
: @LEXIS2020
: @lexis-project
: bit.ly/youtube_LEXIS

COORDINATING ORGANISATION

IT4Innovations, VSB – Technical University of Ostrava, Czechia

OTHER PARTNERS

- Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany
- Atos BDS (Bull), France
- Bayerische Akademie der Wissenschaften / Leibniz Rechenzentrum der BAdW, Germany
- Bayncore Labs Ltd, Ireland
- CEA, Commissariat à l'Energie Atomique et aux énergies alternatives, France
- CYCLOPS Labs GmbH, Switzerland
- Centro Internazionale in Monitoraggio Ambientale - Fondazione CIMA, Italy
- ECMWF, European Centre for Medium Range Weather Forecasts, United Kingdom
- GE AVIO SRL, Italy
- Helmholtz Zentrum Potsdam Deutsches Geoforschungs Zentrum GFZ, Germany



significant improvements in KPIs including job execution time and solution accuracy are anticipated. LEXIS will organise a specific call that will stimulate adoption of the project framework, increasing stakeholders' engagement with the targeted pilots. LEXIS will promote this solution to the HPC, Cloud and Big Data sectors, maximising impact through targeted and qualified communication. LEXIS brings together a consortium with the skills and experience to deliver a complex multi-faceted project, spanning a range of complex technologies across seven European countries, including large industry, flagship HPC centres, industrial and scientific compute pilot users, technology providers and SMEs.

- Information Technology for Humanitarian Assistance Cooperation and Action, Italy
- LINKS Foundation, Italy
- NUMTECH SARL, France
- OUTPOST24, France
- Teseo Eiffage Energie Systèmes, Italy

CONTACT

Jan Martinovic
jan.martinovic@vsb.cz

CALL

ICT-11-2018-2019

PROJECT TIMESPAN

01/01/2019 - 31/12/2021

Phidias

Prototype of HPC/Data Infrastructure for On-demand Services

PHIDIAS intends to develop consolidated and shared HPC and Data service by building on existing and emerging infrastructure in order to create a coordinated system of systems and a federation of "infrastructure to infrastructure" and "user to infrastructure" services. Coordinated actions of this kind respond to the needs of harmonizing existing resources, remove existing silos, and leverage, collectively, established e-infrastructure to support excellence and global impact of European science and research through AI and High-performance cloud computing and data management facilities. The project, with its development of HPC and Data services and use cases from the scientific communities in the Earth, Ocean, and Atmospheric sciences, will demonstrate how an HPC workflow-based suite of component can address and provide solutions to support data-drive science throughout the research lifecycle, from data acquisition, to research data management, to Open Data sharing. By engaging with the EOSC as service provider, promoting the results from the use cases and leveraging the extensive collective and individual expertise and networks of the project partners, PHIDIAS will expand its range of stakeholder and users to other scientific communities where HPC and Data play a pivotal role in delivering excellence in science and research. In this framework, PHIDIAS aims to become a reference point for the Earth science community enabling them to discover, manage and process spatial and environmental data, through the development of a set of High-Performance Computing based services and tools exploiting large satellite datasets. In order to do that, the project foresees the development of three Use Cases:

Intelligent screening of large amount of satellite data for detection and identification of anomalous atmospheric composition events, aiming to use HPC and high-performance data management services for the development of intelligent screening

www.phidias-hpc.eu
: @PhidiasHpc
: @phidias-hpc

COORDINATING ORGANISATION

Centre Informatique National de l'Enseignement Supérieur (CINES),
France

OTHER PARTNERS

- Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), France
- Centre National de la Recherche Scientifique (CNRS), France
- IT Centre for Science Ltd. (CSC), Finland
- Geomatys, France
- Institut de Recherche pour le Développement (IRD), France
- Institut Français de Recherche pour l'exploitation de la Mer (IFREMER), France
- Mariene Informatie Service MARIS BV (MARIS), Netherlands
- Néovia Innovation, France
- SPASCIA, France
- Finnish Environment Institute (SYKE), Finland
- Trust-IT, Italy
- Université de Liege, Belgium



approaches for the exploitation of large amounts of satellite atmospheric data in an operational context, implementing a prototype service on the already available Sentinel 5 Precursor (S5P) European atmospheric sounding mission.

Processing on-demand services for environmental monitoring, aiming to provide the academic and land management community with an interactive environment to ensure systematic or on-demand production of new knowledge useful for the environmental monitoring of territories. This will be achieved relying on the algorithmic developments carried out within the THEIA land data centre, machine and deep learning techniques adapted to spatial data, and taking advantage of the complementarities (spatial and temporal resolution) of large spatial data sets from very high-resolution sensors (SPOT, PLEIADES) and SENTINEL 1 and 2-time series.

PHIDIAS
Prototype of HPC/Data Infrastructure for On-demand Services

Improving the use of cloud services for marine data management, aiming to improve data service to user in a FAIR perspective and data processing on demand, and taking into account the European Open Science Cloud (EOSC) challenge and the Copernicus Data and Information Access Services (DIAS). In those terms, this use case can be seen as one of the prototypes, for marine environmental data, of the future Blue Cloud foreseen by the European Commission.

In line with the European strategy for Open Science, the data generated and services created will be available on relevant EU portals, such as EU Open Data Portal, EUDAT, and EOSC, and will be preserved using the long-term preservation services of the EOSC. The participation in the EOSC is essential to promote the uptake of the PHIDIAS services across a broad range of scientific communities and initiate partnerships with the public and private sectors.

CONTACT

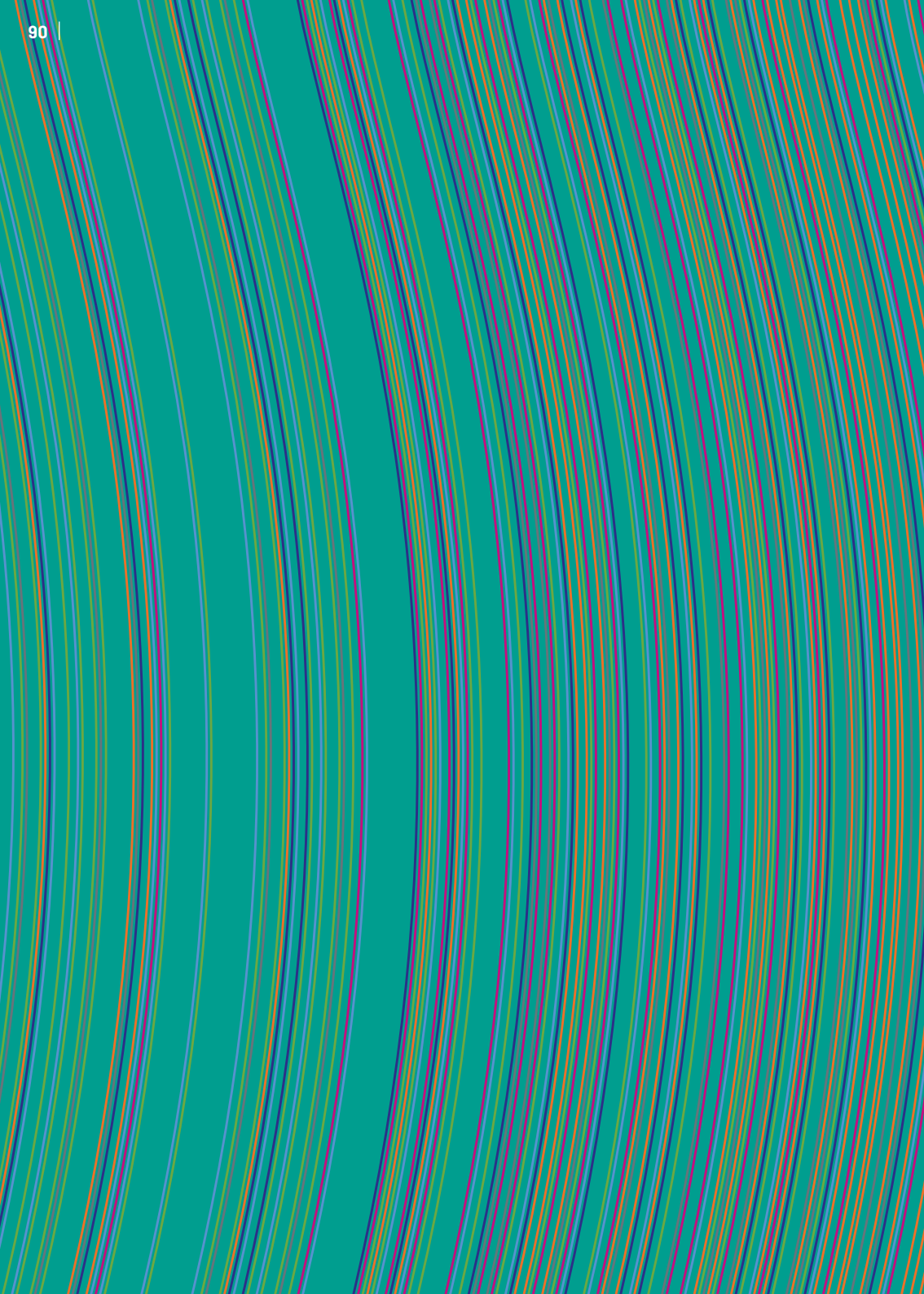
Boris Dintrans
Project Coordinator
boris.dintrans@cines.fr
info@phidias-hpc.eu

CALL

CEF-TC-2018-5

PROJECT TIMESPAN

01/09/2019 - 30/09/2022



International Cooperation

ENERXICO

Supercomputing and Energy for Mexico

The ENERXICO project applies exascale HPC techniques to different energy industry simulations of critical interest for Mexico. ENERXICO will provide solutions for the oil and gas industry, improve wind energy performance and increase the efficiency of biofuels for transportation. Composed of some of the best academic and industrial institutions in the EU and Mexico, ENERXICO demonstrates the power of cross-border collaboration to put supercomputing technologies at the service of the energy sector. The specific objectives of the project are:

- To develop beyond state-of-the-art high performance simulation tools for the energy industry
- To increase oil & gas reserves using geophysical exploration for subsalt reservoirs
- To improve refining and transport efficiency of heavy oil
- To develop a strong wind energy sector to mitigate oil dependency
- To improve fuel generation using biofuels
- To improve the cooperation between industries from the EU and Mexico.
- To improve the cooperation between the leading research groups in the EU and Mexico

www.enerxico-project.eu
: @ENERXICOproject
: @enerxico-project

COORDINATING ORGANISATIONS

- Barcelona Supercomputing Centre (BSC), Spain
- Instituto Nacional de Investigaciones Nucleares (ININ), Mexico

OTHER PARTNERS

- Atos (Bull SAS), France
- Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional (CINVESTAV), Mexico
- Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Spain
- Instituto Mexicano del Petroleo (IMP), Mexico
- Instituto Politecnico Nacional (IPN-ESUA), Mexico
- Technische Universität München (TUM), Germany
- Universidad Autonoma Metropolitana (UAM-A), Mexico
- Instituto de Ingenieria de la Universidad Nacional Autonoma de Mexico (UNAM-IINGEN), Mexico
- Universitat Politecnica de Valencia (UPV), Spain

ENERXICO



- Université Grenoble Alpes (UGA), France
- IBERDOLA , Spain
- REPSOL SA, Spain
- PROJECT OBSERVER
- Petroleos Mexicanos (PEMEX), Mexico

CONTACT

Jose Maria Cela
josem.cela@bsc.es
Rose Gregorio
rose.gregorio@bsc.es

CALL

FETHPC-01-2018

PROJECT TIMESPAN

01/06/2019 - 31/05/2021

HPCWE

High performance computing for wind energy

Wind energy has become an increasingly important as a clean and renewable alternative to fossil fuels in the energy portfolios of both Europe and Brazil. At almost every stage in wind energy exploitation ranging from wind turbine design, wind resource assessment to wind farm layout and operations, the application of HPC is a must.

The goal of HPCWE is to address the following key open challenges in applying HPC on wind energy:

1. Efficient use of HPC resources in wind turbine simulations, via the development and implementation of novel algorithms. This leads to the development of methods for verification, validation, uncertainty quantification (VVUQ) and in-situ scientific data interpretation.
2. Accurate integration of meso-scale atmosphere dynamics and micro-scale wind turbine flow simulations, as this interface is the key for accurate wind energy simulations. In HPCWE a novel scale integration approach will be applied and tested through test cases in a Brazil wind farm.
3. Adjoint-based optimization, which implies large I/O consumption as well as storing data on large-scale file systems. HPCWE research aims at alleviating the bottlenecks caused by data transfer from memory to disk.

The HPCWE consortium consists of 11 partners representing the top academic institutes, HPC centres and industries in Europe and Brazil. By exploring this collaboration, this consortium will develop novel algorithms, implement them in state-of-the-art codes and test the codes in academic and industrial cases to benefit the wind energy industry and research in both Europe and Brazil.

hpcwe-project.eu
: @HPCWE_project

COORDINATING ORGANISATION

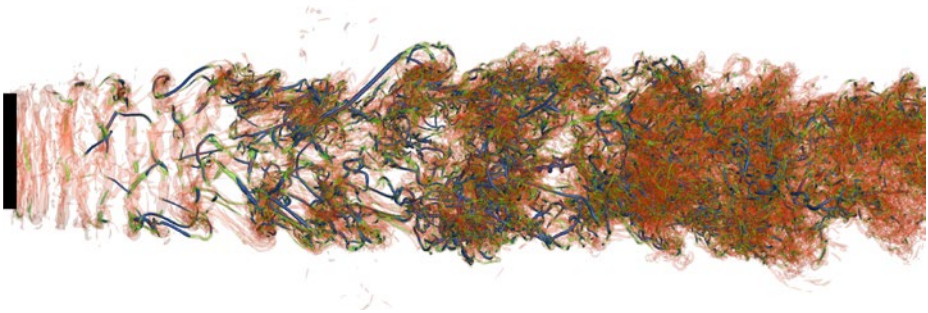
The University of Nottingham, United Kingdom

OTHER PARTNERS

- Danmarks Tekniske Universitet, Denmark
- Electricité de France (EDF), France
- Imperial College of Science Technology and Medicine, United Kingdom
- The University of Edinburgh (EPCC), United Kingdom
- Universidade de Sao Paulo, Brazil
- Universidade Estadual de Campinas, Brazil
- Universidade Federal de Santa Catarina, Brazil
- Universität Stuttgart, Germany
- Universiteit Twente, Netherlands
- VORTEX Factoria de Calculs SL, Spain

EU and Brazil -
Together Bringing Wind Energy Simulation towards Exascale

HPC WE



Simulation of the wake flow downstream of a wind turbine

CONTACT

Xuerui Mao
Project Coordinator
Xuerui.Mao@nottingham.ac.uk
+441157486020

CALL

FETHPC-01-2018

PROJECT TIMESPAN

01/06/2019 - 31/05/2021

Quantum Computing for HPC

NEASQC

NExt ApplicationS of Quantum Computing

The NEASQC project brings together academic experts and industrial end-users to investigate and develop a new breed of Quantum-enabled applications that can take advantage of NISQ (Noise Intermediate-Scale Quantum) systems in the near future. NEASQC is use-case driven, addressing practical problems such as drug discovery, CO2 capture, smart energy management, natural language processing, breast cancer detection, probabilistic risk assessment for energy infrastructures or hydrocarbon well optimisation. NEASQC aims to initiate an active European community around NISQ Quantum Computing by providing a common toolset that will attract new industrial users.

NEASQC aims at demonstrating that, though the millions of qubits that will guarantee fully fault-tolerant quantum computing are still far away, there are practical use cases for the NISQ (Noise Intermediate-Scale Quantum) devices that will be available in the near future. NISQ computing can deliver significant advantages when running certain applications, thus bringing game-changing benefits to users, and particularly industrial users.

The NEASQC consortium has chosen a wide selection of NISQ-compatible industrial and financial use-cases, and will develop new quantum software techniques to solve those use-cases with a practical quantum advantage. To achieve this, the project brings together a multidisciplinary consortium of academic and industry experts in Quantum Computing, High Performance Computing, Artificial Intelligence, chemistry, etc.

The ultimate ambition of NEASQC is to encourage European user communities to investigate NISQ quantum computing. For this purpose, the project consortium will define and make available a complete and

neasqc.eu
: @neasqc
: @neasqc-project

COORDINATING ORGANISATION

Atos (Bull SAS), France

OTHER PARTNERS

- AstraZeneca AB, Sweden
- CESGA (Fundación Publica Gallega Centro Tecnológico de Supercomputación de Galicia), Spain
- Electricité de France (EDF), France
- HQS Quantum Simulations GmbH, Germany
- HSBC Bank Plc, United Kingdom
- Irish Centre for High-End Computing (ICHEC), Ireland
- Leiden University, Netherlands
- TILDE SIA, Latvia
- TOTAL S.A., France
- Universidade da Coruña – CITIC, Spain
- Université de Lorraine (LORIA), France



common toolset that new industrial actors can use to start their own practical investigation and share their results.
NEASQC also aims to build a much-needed bridge between Quantum Computing hardware activities, particularly those of the Quantum Technologies flagship, and the end-user community. Even more than in classical IT, NISQ computing demands a strong cooperation between hardware teams and software users. We expect our work in use cases will provide strong directions for the development of NISQ machines, what will be very valuable to the nascent quantum hardware industry.

NEASQC OBJECTIVES

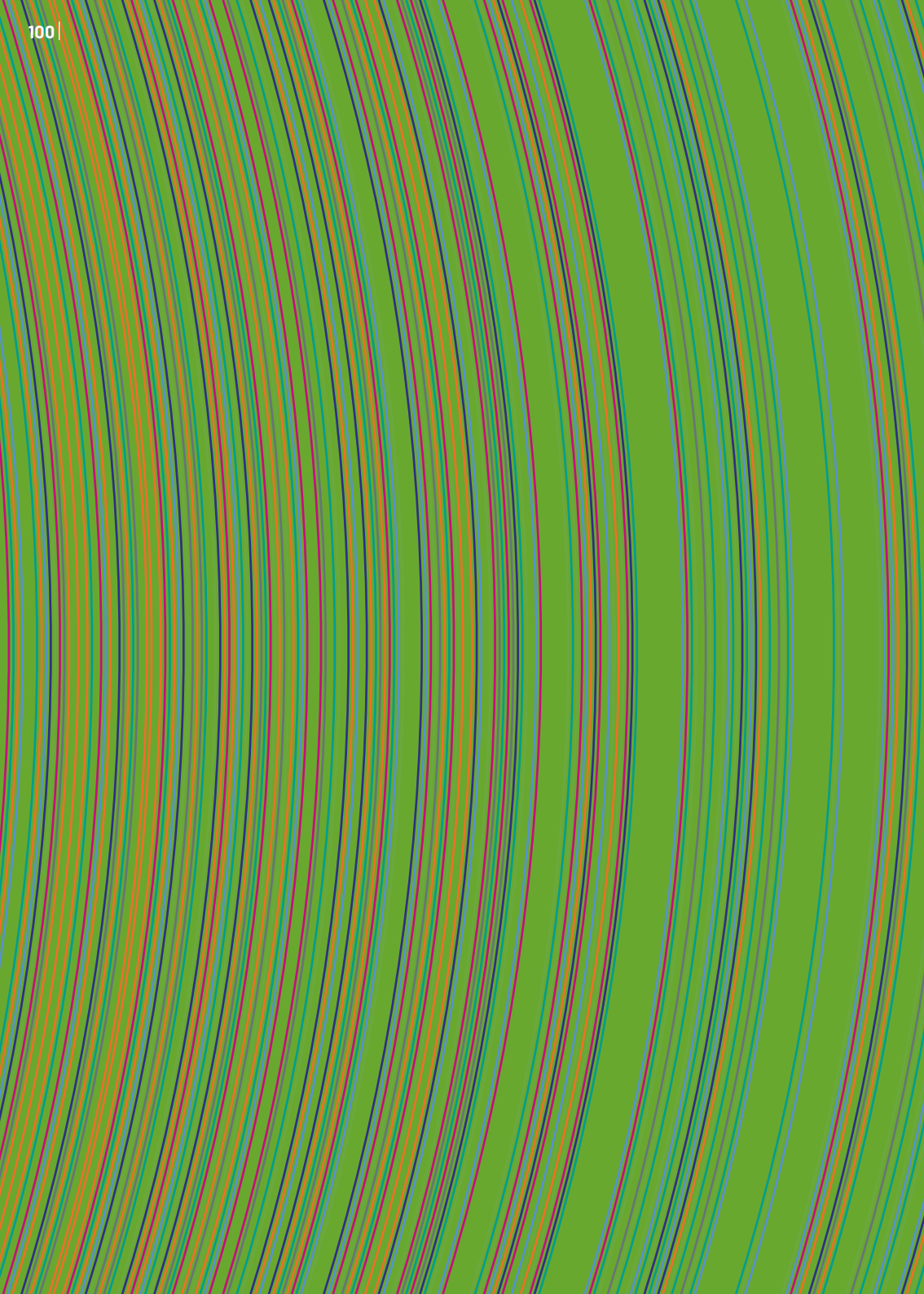
1. Develop 9 industrial and financial use cases with a practical quantum advantage for NISQ machines.
2. Develop open source NISQ programming libraries for industrial use cases, with a view to facilitate quantum computing experimentation for new users.
3. Build a strong user community dedicated to industrial NISQ applications.
4. Develop software stacks and benchmarks for the Quantum Technology Flagship hardware platforms.

NEASQC is one of the projects selected within the second wave of Quantum Flagship projects.

CONTACT
Cyril Allouche
cyril.allouche@atos.net

CALL
FETFLAG-05-2020

PROJECT TIMESPAN
01/09/2020 – 31/08/2024



Other projects

EXA MODE

EXtreme-scale Analytics via Multimodal Ontology Discovery & Enhancement

Exascale volumes of diverse data from distributed sources are continuously produced. Healthcare data stand out in the size produced (production 2020 >2000 exabytes), heterogeneity (many media, acquisition methods), included knowledge (e.g. diagnostic reports) and commercial value. The supervised nature of deep learning models requires large labelled, annotated data, which precludes models to extract knowledge and value. ExaMode solves this by allowing easy & fast, weakly supervised knowledge discovery of heterogeneous exascale data provided by the partners, limiting human interaction. Its objectives include the development and release of extreme analytics methods and tools that are adopted in decision making by industry and hospitals. Deep learning naturally allows to build semantic representations of entities and relations in multimodal data. Knowledge discovery is performed via semantic document-level networks in text and the extraction of homogeneous features in heterogeneous images. The results are fused, aligned to medical ontologies, visualized and refined. Knowledge is then applied using a semantic middleware to compress, segment and classify images and it is exploited in decision support and semantic knowledge management prototypes.

www.examode.eu
: @examode
: @examode.eu

COORDINATING ORGANISATION

University of Applied Sciences Western Switzerland, HES-SO, Sierre, Switzerland

OTHER PARTNERS

- Azienda Ospedaliera per l'Emergenza Cannizzaro, Italy
- MicroscopeIT Sp. z o.o., Poland
- SIRMA AI, Bulgaria
- Radboud University Medical Center, Nijmegen
- SURFsara BV, Netherlands
- Università degli Studi di Padova, Italy



ExaMode is relevant to ICT12 in several aspects:

1. Challenge: it extracts knowledge and value from heterogeneous quickly increasing data volumes.
2. Scope: the consortium develops and releases new methods and concepts for extreme scale analytics to accelerate deep analysis also via data compression, for precise predictions, support decision making and visualize multi-modal knowledge.
3. Impact: the multi-modal/media semantic middleware makes heterogeneous data management & analysis easier & faster, it improves architectures for complex distributed systems with better tools increasing speed of data throughput and access, as resulting from tests in extreme analysis by industry and in hospitals

CONTACT

Dr. Manfredo Atzori
manfredo.atzori@hevs.ch
Prof. Henning Müller
henning.mueller@hevs.ch

CALL

ICT-12-2018-2020

PROJECT TIMESPAN

01/01/2019 - 31/12/2022

EXSCALATE4COV

EXaSCale smArt pLatform Against paThogEns for Corona Virus

The EXSCALATE4CoV (E4C) project aims to exploit the most powerful computing resources currently based in Europe to empower smart in-silico drug design. Advanced Computer-Aided Drug Design (CADD) in combination with the high throughput biochemical and phenotypic screening will allow the rapid evaluation of the simulations results and the reduction of time for the discovery of new drugs. Against a pandemic crisis, the immediate identification of effective treatments has a paramount importance. First, E4C will select through the EXSCALATE platform, the most promising commercialized and developing drugs safe in man. Second, select from >500 billion molecules new pan coronavirus inhibitors. Huge computational resources are needed, therefore the activities will be supported and empowered by four of the most powerful computer centres in Europe: CINECA, BSC and JÜLICH and Eni HPC5. The Swiss Institute of Bioinformatics (SIB) will provide the homology 3D models for the viral proteins. The Fraunhofer IME will provide the BROAD Repurposing Library and biochemical assays for the most relevant viral proteins. Phenotypic screenings will be run by KU LUEVEN to identify molecules capable of blocking virus replication in in vitro models. IIMCB and ELECTRA will determine the crystal structure of at least one coronavirus functional proteins to evaluate

exscalate4cov.eu
: @exscalate4cov
: @exscalate4cov
: @exscalate4cov

COORDINATING ORGANISATION

Dompé farmaceutici S.p.A., Italy

OTHER PARTNERS

- CINECA Consorzio Interuniversitario, Italy
- Politecnico di Milano, Italy
- Universita degli Studi di Milano, Italy
- Katholieke Universiteit Leuven, Belgium
- International Institute of Molecular and Cell Biology, Poland
- Elettra – Sincrotrone Trieste S.C.p.A., Italy
- Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung E.V.
- Barcelona Supercomputing Center, Spain
- Forschungszentrum Jülich GmbH, Germany
- Universita degli Studi di Napoli Federico II., Italy
- Universita degli Studi di Cagliari, Italy

EXSCALATE 4COV

the structural similarities with other viral proteins. All the other partners support the project by studying the mechanism of action, synthetizing the most relevant candidate drugs and enhancing the HPC and AI infrastructure of the consortium.

EXSCALATE4CoV consortium will identify safe in man drugs repurposed as 2019-nCoV antiviral and will propose to the EMA innovation task force (ITF) to define a preliminary development strategy and a proposal for a registration path. The E4C project will share promptly its scientific outcomes with the research community by using established channels: ChEMBL portal for the biochemical data, the SWISS-MODEL portal for the homology models of viral proteins WT and mutants, the Protein Data Bank for the experimentally resolved protein structures, the EUDAT for the data generated by in-silico simulations and the E4C project website. Combining HPC simulations and AI driven system pharmacology E4C has identified and in vitro experimentally validated a first promising drug for the treatment of mildly symptomatic Covid19 patients. Raloxifene clinical trial application have been already submitted for approval. The Spallanzani hospital will be the Coordinating Investigator in the clinical trial.

- SIB Institut Suisse de Bioinformatique, Switzerland
- Kungliga Tekniska Hoegskolan, Sweden
- Istituti Nazionale per le Malattie Infettive Lazzaro Spallanzani – Istituto di Ricovero e Cura a Carattere Scientifico, Italy
- Associazione Big Data, Italy
- Istituto Nazionale di Fisica Nucleare, Italy
- Chelonia SA, Switzerland

CONTACT

info@exscalte4cov.eu

CALL

SC1-PHE-CORONAVIRUS-2020

PROJECT TIMESPAN

01/10/2020 – 30/09/2023

OPRECOMP

Open transPREcision COMPuting

Guaranteed numerical precision of each elementary step in a complex computation has been the mainstay of traditional computing systems for many years. This era, fueled by Moore's law and the constant exponential improvement in computing efficiency, is at its twilight: from tiny nodes of the Internet-of-Things, to large HPC computing centers, sub-picoJoule/operation energy efficiency is essential for practical realizations. To overcome the "power wall", a shift from traditional computing paradigms is now mandatory.

OPRECOMP aims at demolishing the ultra-conservative "precise" computing abstraction and replacing it with a more flexible and efficient one, namely transprecision computing. OPRECOMP will investigate the theoretical and practical understanding of the energy efficiency boost obtainable when accuracy requirements on data being processed, stored and communicated can be lifted for intermediate calculations. While approximate computing approaches have been used before, in OPRECOMP for the first time ever, a complete framework for transprecision computing, covering devices, circuits, software tools, and algorithms, along with the mathematical theory and physical foundations of the ideas will be developed. It not only will provide error bounds with respect to full precision results, but it will also enable major energy efficiency improvements even when there is no freedom to relax end-to-end application quality-of-results.

The mission of OPRECOMP is to demonstrate, by using physical demonstrators, that this idea holds in a huge range of application scenarios in the domains of IoT, Big Data Analytics, Deep Learning, and HPC simulations: from the sub-milliWatt to the

www.oprecomp.eu
: @oprecompProject

COORDINATING ORGANISATION

IBM Research GmbH, Switzerland

OTHER PARTNERS

- Alma Mater Studiorum - Università di Bologna, Italy
- CINECA Consorzio Interuniversitario, Italy
- CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- Greenwavs Technologies, France
- Technische Universität Kaiserslautern, Germany
- The Queen's University of Belfast, United Kingdom
- Università degli Studi di Perugia, Italy
- Universitat Jaume I de Castellon, Spain

OPRECOMP
Open Transprecision Computing



MegaWatt range, spanning nine orders of magnitude. In view of industrial exploitation, we will prove quality and reliability and demonstrate that transprecision computing is the way to think about future systems.

CONTACT
Cristiano MALOSSI,
PhD acm@zurich.ibm.com

CALL
FETPROACT-01-2016

PROJECT TIMESPAN
01/01/2017 - 31/12/2020

PROCESS

PROviding Computing solutions for ExaScale ChallengeS

The PROCESS demonstrators will pave the way towards exascale data services that will accelerate innovation and maximise the benefits of these emerging data solutions. The main tangible outputs of PROCESS are very large data service prototypes, implemented using a mature, modular, generalizable open source solution for user friendly exascale data. The services will be thoroughly validated in real-world settings, both in scientific research and in advanced industry deployments.

To achieve these ambitious objectives, the project consortium brings together the key players in the new data-driven ecosystem: top-level HPC and big data centres, communities – such as LOFAR – with unique data challenges that the current solutions are unable to meet and experienced e-Infrastructure solution providers with an extensive track record of rapid application development. In addition to provide the service prototypes that can cope with very large data, PROCESS addresses the work programme goals by using tools and services with heterogeneous use cases, including exascale learning on medical images, airline revenue management and agricultural simulations based on Copernicus data, also enabling a SME to use the PROCESS ecosystem. This diversity from academic and industry ensures that in addition to supporting communities that push the envelope, the solutions will also ease the learning curve for broadest possible range of user communities. In addition, the chosen open source strategy maximises the potential for uptake and reuse, together with mature software engineering practices that minimise the efforts needed to set up and maintain services based on the PROCESS software releases.

www.process-project.eu
: @PROCESS_H2020

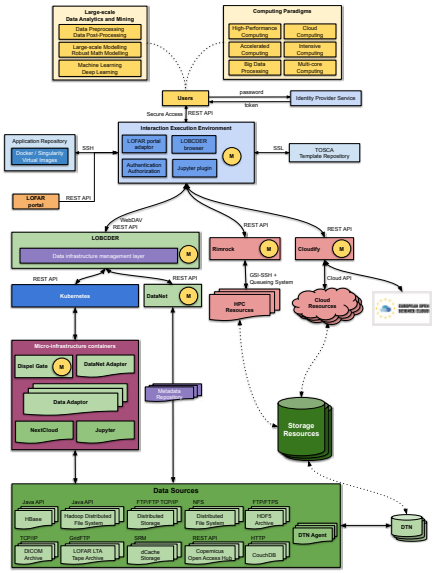
COORDINATING ORGANISATION

Ludwig-Maximilians-Universität München,
Germany

OTHER PARTNERS

- Universiteit van Amsterdam, Netherlands
- Stichting Netherlands EScience Centre, Netherlands
- Haute Ecole Spécialisée de Suisse Occidentale, Switzerland
- Lufthansa Systems GmbH & CO KG, Germany
- Inmark Europa SA, Spain
- Ustav Informatiky, Slovenska Akademia Vied, Slovakia
- Akademia Gorniczo-Hutnicza IM. Stanislawa Staszica W Krakowie, Poland

PROCESS



The PROCESS project has achieved its objectives and accelerated the development in the use case's communities. Implementations for LOFAR will also be valuable for the upcoming Square Kilometre Array (SKA) project, which increases the underlying challenge in the next years to Exa- and Zettabytes. The PROCESS solutions are deployed in three supercomputing centres across Europe, in Munich, Amsterdam and Krakow, enabling already today a testbed for exascale applications of tomorrow.

The figure shows the detailed PROCESS architecture, with the main components end-user portal, orchestration, data and compute service. The heart of the data service is LOBCDER and its Micro-Infrastructure-Containers, enabling a low-overhead solution for the data processing challenge. The already connected centres allow PROCESS to include applications based on HPC, Cloud and Accelerator-systems, and enable deployments also on resources available through the European Open Science Cloud.

CONTACT

Dieter Kranzlmüller
Coordinator
Maximilian Höb
Technical-Coordinator
and Contact
contact@process-project.eu

CALL

EINFRA-21-2017

PROJECT TIMESPAN

01/11/2017 - 31/10/2020

SODALITE

SOftware Defined AppLication Infrastructures managemenT and Engineering Empowering the DevOps World

In recent years the global market has seen a tremendous rise in utility computing, which serves as the back-end for practically any new technology, methodology or advancement from healthcare to aerospace. We are entering a new era of heterogeneous, so ware-defined, high-performance computing environments.

In this context, SODALITE aims to address this heterogeneity by considering environments that comprise accelerators/GPUs, configurable processors, and non-x86 CPUs such as ARMv8. General purpose GPUs are becoming common currency in data-centers while specialized FPGA accelerators, ranging from deep-learning specific accelerators to burst buffers technologies, are becoming "the big coin", enormously speeding up applications execution and likely to become common in the near future.

OUR MODAK SOLUTION ON HPC

Developing and deploying applications across heterogeneous infrastructures like HPC or Cloud with diverse hardware is a complex problem. SODALITE targets complex applications and workflows that are deployed on heterogeneous environments such as virtual machines, containerized HPC clusters, Cloud and Edge devices. In this context, deploying the application in infrastructures usually requires command-line-based access and expert knowledge in the application domain. Even further, optimizing HPC applications also requires a good background in networking technologies and parallel programming. With SODALITE, there is a stack on top of the low-level layer which makes it easier for non-experts to use VMs, HPC and get optimal performance.

www.sodalite.eu
: @SODALITESW
: @sodalite-eu

COORDINATING ORGANISATION

XLAB,
Slovenia

OTHER PARTNERS

- Atos Spain, Spain
- IBM, Israel
- Politecnico di Milano (POLIMI), Italy
- CRAY-HPE, Switzerland
- ITI-CERTH, Greece
- Adaptant, Germany
- Jheronimus Academy of Data Science (JADS), Netherlands
- High Performance Computing Center -Universität Stuttgart (HLRS), Germany



THE APPLICATION OF SODALITE TO REAL-CASE SCENARIOS

Water availability prediction with mountains images

An innovative tool demonstrator which enables the capillary observation of the continuous health status of mountain environments.

SODALITE semantic IDE is key to mastering configuration heterogeneity and complexity, SODALITE Machine Learning optimization for fast classifiers retraining as more data are available and dynamic provision of resources (GPUs) > speed-up in the 20% range for image processing throughput.

In-silico clinical trials for spinal operations

Assessment and decision-support system for spinal operations consisting of a data store component, capable of providing efficient data access from heterogeneous compute resources and simulation process chain facilitating comprehensive data analytics for in-silico clinical trials. SODALITE will enhance the app by increasing the effectiveness of component deployment with the IDE and to Ease the adaptation to different hardware/software platforms.

IoT autonomous vehicle

An innovative system demonstrator that enables data from heterogeneous sources (principally IoT devices) to be spread across a distributed processing architecture in line with end-user expectations.

SODALITE image variants enable application containers to be generated for multiple accelerator types, which refactoring, and redeployment can switch between at run-time.

SODALITE enables service continuity across heterogeneous resources, minimizing service disruption.

SODALITE leverages node monitoring at the Edge to trigger reconfiguration and redeployment based on application-defined alerting.

CONTACT

Project Coordinator:
Daniel Vladušič
daniel.vladusic@xlab.si
+38640352527
Communications Manager:
María Carbonell,
maria.carbonell@atos.net
+34 910 476 494

CALL

H2020-ICT-2018-2

PROJECT TIMESPAN

01/01/2019 - 01/01/2022



Ecosystem development

CASTIEL

Connecting the countries NCCs to each other and the European Ecosystem

WHAT IS CASTIEL?

The Coordination and Support Action (CSA) CASTIEL leads to cross-European networking activities between National Competence Centres (NCCs) in HPC-related topics addressed through the EuroCC project. CASTIEL emphasises training, industrial interaction and cooperation, business development, raising awareness of high-performance computing (HPC)-related technologies and expertise. As a hub for information exchange and training, CASTIEL promotes networking among NCCs and strengthens idea exchange by developing best practices. The identification of synergies, challenges, and possible solutions is implemented through the close cooperation of the NCCs at a European level.

WHAT IS THE RELATIONSHIP BETWEEN CASTIEL AND EUROCC?

CASTIEL, the Coordination and Support Action (CSA) closely associated with EuroCC, combines the National Competence Centres (NCC) formed in EuroCC into a pan-European network. The aggregation of HPC, high-performance data analytics (HPDA), and artificial intelligence (AI) competencies demonstrates the global competitiveness of the EU partners. The two activities are the beginning of a strategic positioning of the European HPC competence and will contribute to the comprehensive independence of the mentioned technologies in Europe.

www.castiel-project.eu
: @CASTIEL_project
: @castiel-project

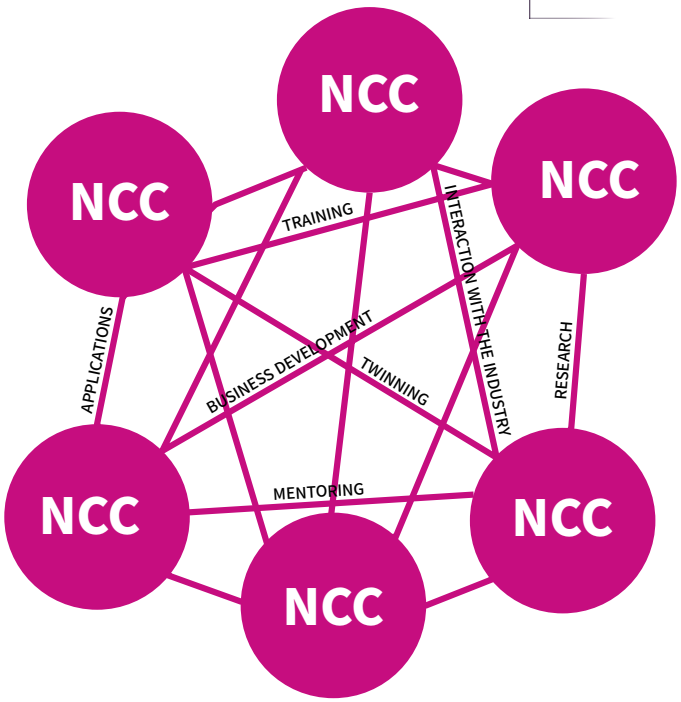
COORDINATING ORGANISATION

High-Performance Computing Center Stuttgart (USTUTT/HLRS), Germany

OTHER PARTNERS

- Gauss Centre for Super computing e.V. (GCS), Germany
- Consorzio Interuniversitario (CINECA), Italy
- TERATEC, France
- Barcelona Supercomputing Center – Centro Nacional De Supercomputación (BSC), Spain
- Partnership for Advanced Computing in Europe AISBL (PRACE), Belgium

CASTIEL



CONTACT
Dr.-Ing. Bastian Koller
castiel@hlrs.de

CALL
EuroHPC-04-2019

PROJECT TIMESPAN
01.09.2020 – 31.08.2022

EuroCC

European Competence Centres

Within the EuroCC project under the European Union's Horizon 2020 (H2020), participating countries are tasked with establishing a single National Competence Centre (NCC) in the area of high-performance computing (HPC) in their respective countries. These NCCs will coordinate activities in all HPC-related fields at the national level and serve as a contact point for customers from industry, science, (future) HPC experts, and the general public alike. The EuroCC project is funded 50 percent through H2020 (EuroHPC Joint Undertaking [JU]) and 50 percent through national funding programs within the partner countries.

WHAT ARE THE NCCS' TASKS?

The tasks of the National Competence Centres include mapping existing HPC, high-performance data analytics (HPDA) and artificial intelligence (AI) competences, HPC training and the identification of HPC, HPDA and AI experts, as well as the coordination of services such as business development, application support, technology transfer, training and education, and access to expertise. Researchers from academia and industry both benefit from this competence concentration, and more efficient research ultimately benefits state and national governments and society as a whole.

www.eurocc-project.eu
: @EuroCC_project
: @eurocc

COORDINATING ORGANISATION

High-Performance Computing Center Stuttgart (USTUTT/HLRS), Germany

OTHER PARTNERS

- Gauss Centre for Supercomputing (GCS) Germany
- Institute of Information and Communication Technologies at Bulgarian Academy of Sciences (IICT-BAS), Bulgaria
- Universität Wien (UNIVIE), Austria
- University of Zagreb University Computing Centre (SRCE), Croatia
- Computation-based Science and Technology Research Centre, The Cyprus Institute (CaSToRC-CyI), Cyprus
- IT4Innovations National Supercomputing Centre, VSB – Technical University of Ostrava (IT4I), Czech Republic
- Technical University of Denmark (DTU), Denmark
- University of Tartu HPC Center (UTHPC), Estonia
- CSC – IT Center for Science Ltd (CSC), Finland
- National Infrastructures for Research and Technology S.A. (GRNET S.A.), Greece
- Kormányzati Informatikai Fejlesztési Ügynökség (KIFÜ), Hungary
- National University of Ireland, Galway (NUI Galway), Ireland
- CINECA – Consorzio Interuniversitario (CINECA), Italy
- Vilnius University (LitGrid-HPC), Lithuania
- Riga Technical University (RTU), Latvia
- UNINETT Sigma2 AS (Sigma2), Norway
- Norwegian Research Centre AS (NORCE), Norway

The National Competence Centres will act as the first points of contact for HPC, HPDA and AI in their respective countries. The NCCs will bundle information and provide experts, offer access to expertise and HPC training and education.
The overall objective of EuroCC — to create a European base of excellence in HPC by filling existing gaps — comes with a clear vision: offering a broad portfolio of services in all HPC, HPDA, and AI-related areas, tailored to the needs of industry, science, and public administrations.

COLLABORATION BETWEEN EUROCC AND CASTIEL

EuroCC works closely together with the Coordination and Support Action (CSA) CASTIEL, which links the national centres throughout Europe and ensures successful transfer and training possibilities between the participating countries.

- SINTEF AS (SINTEF), Norway
- Academic Computer Centre Cyfronet AGH (CYFRONET), Poland
- Fundação para a Ciência e a Tecnologia (FCT), Portugal
- National Institute for Research-Development in Informatics – ICI Bucharest (ICIB), Romania
- Academic and Research Network of Slovenia (ARNES), Slovenia
- Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC), Spain
- Uppsala University (UU), Sweden
- Eidgenössische Technische Hochschule Zürich (ETH Zurich), Switzerland
- The Scientific and Technological Research Council of Turkey (TUBITAK), Turkey
- The University of Edinburgh (EPCC), United Kingdom
- TERATEC (TERATEC), France
- SURFSARA BV (SURFSARA), Netherlands
- Centre de recherche en aéronautique a.s.b.l. (Cenaero), Belgium
- Luxinnovation GIE (LXI), Luxembourg
- Center of Operations of the Slovak Academy of Sciences (CC SAS), Slovak Republic
- University of Ss. Cyril and Methodius, Faculty of computer science and engineering (UKIM), Republic of North Macedonia
- Háskóli Íslands – University of Iceland (UICE),
- Iceland
- University of Donja Gorica (UDG), Montenegro

CONTACT

Dr.-Ing. Bastian Koller
eurocc@hlrs.de

CALL

EuroHPC-04-2019

PROJECT TIMESPAN

01.09.2020 – 31.08.2022

EUROLAB-4-HPC-2

Consolidation of European Research Excellence in Exascale HPC Systems

Europe has made significant progress in becoming a leader in large parts of the HPC ecosystem: from industrial and scientific application providers via system software to Exascale systems, bringing together technical and business stakeholders. Despite such gains, excellence in research in high performance computing systems is fragmented across Europe and opportunities for synergy are missed.

At this moment, there is fierce international competition to sustain long-term leadership in HPC technology and there remains much to do. Since high-performance computing (HPC) is a vital technology for European economic competitiveness and scientific excellence, it is indispensable for innovating enterprises, scientific researchers, and government agencies while it generates new discoveries and breakthrough products and services. By uniting the HPC community, Eurolab4HPC aims to build a robust ecosystem, hence building a sustainable foundation for HPC innovation in Europe.

This will be realised by means of four short-term objectives:



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: @eurolab4hpc

COORDINATING ORGANISATION

Chalmers University of Technology, Sweden

OTHER PARTNERS

- Barcelona Supercomputing Centre (BSC), Spain
- Ecole Polytechnique Fédérale de Lausanne, Switzerland
- ETHZ - Eidgenössische Technische Hochschule Zürich, Switzerland
- FORTH Institute for Computer Science, Greece
- INRIA, Institut National de Recherche en Informatique et Automatique, France
- RWTH-AACHEN Rheinisch-Westfälische Technische Hochschule Aachen, Germany
- TECHNION - Israel Institute of Technlogy, Israel
- The University of Edinburgh, United Kingdom
- The University of Manchester, United Kingdom
- Universität Augsburg, Germany
- Universität Stuttgart, Germany
- Universiteit Gent, Belgium



OPEN SOURCE

Another mission of Eurolab4HPC is to bring together researchers, industry and users for the development and the use of open source hardware and software creating a community to work on long-term projects.
We believe that open source projects provide a natural forum for testing ideas and discovering innovation opportunities thereby promoting promote entrepreneurship, fostering industry take-up, and providing an avenue to train more experts in Exascale hardware and software.

LONG-TERM VISION ON HPC

Radical changes in computing are foreseen for the near future. The next Eurolab4HPC Long-Term Vision on High-Performance Computing, planned release in January 2020, will present an assessment of potential changes for High-Performance Computing in the next decade. You will be able to download it here: https://www.eurolab4hpc.eu/vision/.

CONTACT

info@eurolab4hpc.eu
Per Stenström
per.stenstrom@chalmers.se

CALL

FETHPC-03-2017

PROJECT TIMESPAN

01/05/2018 - 30/04/2020

EXDCI-2

European eXtreme Data and Computing Initiative – 2

The project EXDCI-2 builds upon the success of EXDCI and will continue the coordination of the HPC ecosystem with important enhancements to better address the convergence of big data, cloud and HPC.

The strategic objectives of EXDCI-2 are:

a) Development and advocacy of a competitive European HPC Exascale Strategy
b) Coordination of the stakeholder community for European HPC at the Exascale.

EXDCI-2 mobilizes the European HPC stakeholders through the joint action of PRACE and ETP4HPC. It will promote global community structuring and synchronization in HPC, Big Data, Cloud and embedded computing, for a more competitive related value chain in Europe. It will develop an HPC technology roadmap addressing the convergence with HPDA and the emergence of new HPC uses. It will deliver application and applied mathematics roadmaps that will pave the road towards exascale simulation in academic and industrial domains. It will develop a shared vision for the future of HPC that increases the synergies and prepares for targeted research collaborations.

EXDCI-2 will work to increase the impact of the H2020 HPC research projects, by identifying synergies and supporting market

exdci.eu
: @exdci_eu

COORDINATING ORGANISATION

Partnership for Advanced Computing in Europe (PRACE) AISBL, Belgium

OTHER PARTNERS

- European Technology Platform for High Performance Computing (ETP4HPC), Netherlands



acceptance of the results.
At the international level, EXDCI-2 will contribute to the international visibility of Europe, develop contacts with the world leading HPC ecosystems and increase European impact on HPC standards.

EXDCI-2 will improve the HPC awareness by developing international event such as the EuroHPC Summit Week and by targeting specific audience through dedicated media by disseminating the achievements of the European HPC ecosystem.

CONTACT
Marjolein Oorsprong
M.Oorsprong@staff.prace-ri.eu

CALL
FETHPC-03-2017

PROJECT TIMESPAN
01/03/2018 - 31/12/2020

FF4EUROHPC

Connecting SMEs with HPC



BASE PILLARS OF THE FF4EUROHPC PROJECT

FF4EuroHPC has the general objective of supporting the EuroHPC initiative to promote the industrial uptake of high-performance computing (HPC) technology, in particular by small and medium-sized enterprises (SMEs), and thus increase the innovation potential of European industry. In order to achieve that general objective, FF4EuroHPC has defined a set of specific objectives.

THE FF4EUROHPC GENERAL OBJECTIVES ARE:

- Realise a portfolio of business-oriented application "experiments" that are driven

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SCOORDINATING ORGANISATION

High Performance Computing Centrer Stuttgart (USTUTT/HLRS), Germany

OTHER PARTNERS

- Gauss Centre for Supercomputing e.V. (GCS), Germany
- Consorzio Interuniversitario (CINECA), Italy
- Teratec (TERATEC), France
- Fundacion publica gallega centro tecnologico de supercomputacion de galicia (CESGA), Spain
- ARCTUR racunalniski inzeniring doo (ARCTUR), Slovenia



by the SME end-users needs and executed by teams covering all required actors in the value-chain, with the innovation potential for HPC use and service provision of utmost priority.
- Support the future national HPC Competence Centres (resulting from the call EuroHPC-04-2019) to more effectively collaborate with SMEs through involvement in the FF4EuroHPC experiment portfolio and integration in related outreach activities.
- Support the participating SMEs in the establishment of HPC-related innovation either by using HPC infrastructures or services for their business needs or by providing new HPC-based services.
- Facilitate the widening of industrial HPC user communities and service providers in Europe by delivering compelling success stories for the use of HPC by SMEs; ensuring maximal awareness via communication and dissemination in collaboration with relevant Digital Innovation Hubs (DIHs) and industry associations.

CONTACT
Dr.-Ing. Bastian Koller,
ff4eurohpc@hlrs.de

CALL
EuroHPC-04-2019

PROJECT TIMESPAN
01.09.2020 – 31.08.2023

HPC-EUROPA3

Pan-European Research Infrastructure on High Performance Computing

TRANSNATIONAL ACCESS

The core activity of HPC-Europa3 is the Transnational Access programme, which funds short collaborative research visits in any scientific domain using High Performance Computing (HPC).

Visitors gain access to some of Europe's most powerful HPC systems, as well as technical support from the relevant HPC centre to enable them to make the best use of these facilities.

Applicants identify a "host" researcher working in their own field of research, and are integrated into the host department during their visit. Visits can be made to any research institute in Finland, Germany, Greece, Ireland, Italy, the Netherlands, Spain, Sweden or the UK. (Note that project partner CNRS does not participate in the Transnational Access activity and therefore it is not possible to visit research groups in France).

HPC-Europa3 visits can last between 3 and 13 weeks. The programme is open to researchers of any level, from academia or industry, working in any area of computational science. Priority is given to researchers working in the EU and Associated States (see http://bit.ly/AssociatedStates), but limited places are available for researchers from third countries.

HPC-Europa3 has introduced a "Regional Access Programme" to encourage applications from researchers working in the Baltic and South-East Europe regions. The Regional Access Programme specifically targets researchers with little or no HPC experience who need more powerful computing facilities than they have, but not the most powerful systems offered by HPC-Europa3. Such researchers can apply respectively to KTH-PDC in Sweden or GRNET in Athens, and will be given priority over more experienced applicants.

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: @hpc-europa3-eu-project
: www.youtube.com/channel/UC9uOpFQGP9V0T0PXFUOgs_A

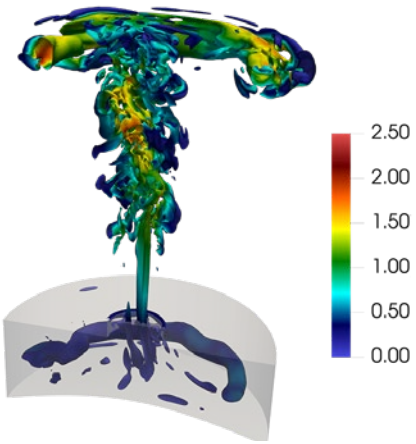
COORDINATING ORGANISATION

CINECA Consorzio Interuniversitario, Italy

OTHER PARTNERS

- Barcelona Supercomputing Centre (BSC), Spain
- CNRS - Centre National de la Recherche Scientifique, France
- CSC – IT Center for Science Ltd., Finland
- Ethniko Diktyo Erevnas Technologias AE (GRNET), Greece
- Kungliga Tekniska Hoegskolan (KTH), Sweden
- National University of Ireland Galway (ICHEC), Ireland
- SURFsara BV, Netherlands
- The University of Edinburgh (EPCC), United Kingdom
- Universität Stuttgart (HLRS), Germany

Infrastructure on High Performance Computing
Pan-European Research
HPC Europa3



NETWORKING AND JOINT RESEARCH ACTIVITIES

The main HPC-Europa3 Networking Activity, External co-operation for enhancing the best use of HPC, aims to build stronger relationships with other European HPC initiatives, e.g. PRACE, ETP4HPC, and the HPC Centres of Excellence. The goal is to provide HPC services in a more integrated way across Europe. This activity also aims to increase awareness of HPC within SMEs. A series of workshops targeted at SMEs has been organised to encourage their uptake of HPC.

The Joint Research Activity, Container-as-a-service for HPC, aims to enable easy portability of end-user applications to different HPC centres, providing clear benefits for HPC-Europa3 visitors. This approach enables different applications and runtime environments to be supported simultaneously on the same hardware resources with no significant decrease in performance. It also provides the capability to fully capture and package all dependencies of an application so that the application can be migrated to other machines or preserved to enable a reproducible environment in the future.

The results from this JRA can be found in various deliverables which are available at http://www.hpc-europa.eu/public_documents.

CONTACT
staff@hpc-europa.org

CALL
INFRAIA-01-2016-2017

PROJECT TIMESPAN
01/05/2017 - 31/10/2021

Appendix Completed projects

Projects completed before 1 January 2020 are not featured in this edition of the Handbook, but you can find the descriptions of these projects in the 2018 or 2019 Handbooks, available on our website:

ALLScale	An Exascale Programming, Multi-objective Optimisation and Resilience Management Environment Based on Nested Recursive Parallelism
ANTAREX	AutoTuning and Adaptivity appRoach for Energy efficient eXascale HPC systems
ARGO	WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems
BioExcel	Centre of Excellence for Biomolecular Research
COEGSS	Centre of Excellence for Global Systems Science
ComPat	Computing Patterns for High Performance Multiscale Computing
CompBioMed	A Centre of Excellence in Computational Biomedicine
ECOSCALE	Energy-efficient heterogeneous COmputing at exaSCALE
EoCoE	Energy oriented Centre of Excellence for computer applications
ESCAPE	Energy-efficient SCalable Algorithms for weather Prediction at Exascale
ESIWACE	Centre of Excellence in Simulation of Weather and Climate in Europe
ExaFLOW	Enabling Exascale Fluid Dynamics Simulations
ExaHyPE	An Exascale Hyperbolic PDE Engine
ExaNeST	European Exascale System Interconnect and Storage
ExaNoDe	European Exascale Processor and Memory Node Design
ExCAPE	Exascale Compound Activity Prediction Engine
EXTRA	Exploiting eXascale Technology with Reconfigurable Architectures
greenFLASH	Green Flash, energy efficient high performance computing for real-time science
INTERTWINE	Programming Model INTERoperability ToWards Exascale (INTERTWinE)
MANGO	Exploring Manycore Architectures for Next-GeneratiOn HPC systems
MaX	Materials design at the eXascale
M2DC	Modular Microserver DataCentre

Mont-Blanc 3	Mont-Blanc 3, European scalable and power efficient HPC platform based on low-power embedded technology
NEXTGenIO	Next Generation I/O for the Exascale
NLAFET	Parallel Numerical Linear Algebra for Future Extreme Scale Systems
NoMaD	The Novel Materials Discovery Laboratory
POP	Performance Optimisation and Productivity
READEX	Runtime Exploitation of Application Dynamism for Energy-efficient eXascale computing
SAGE	Percipient StorAGe for Exascale Data Centric Computing

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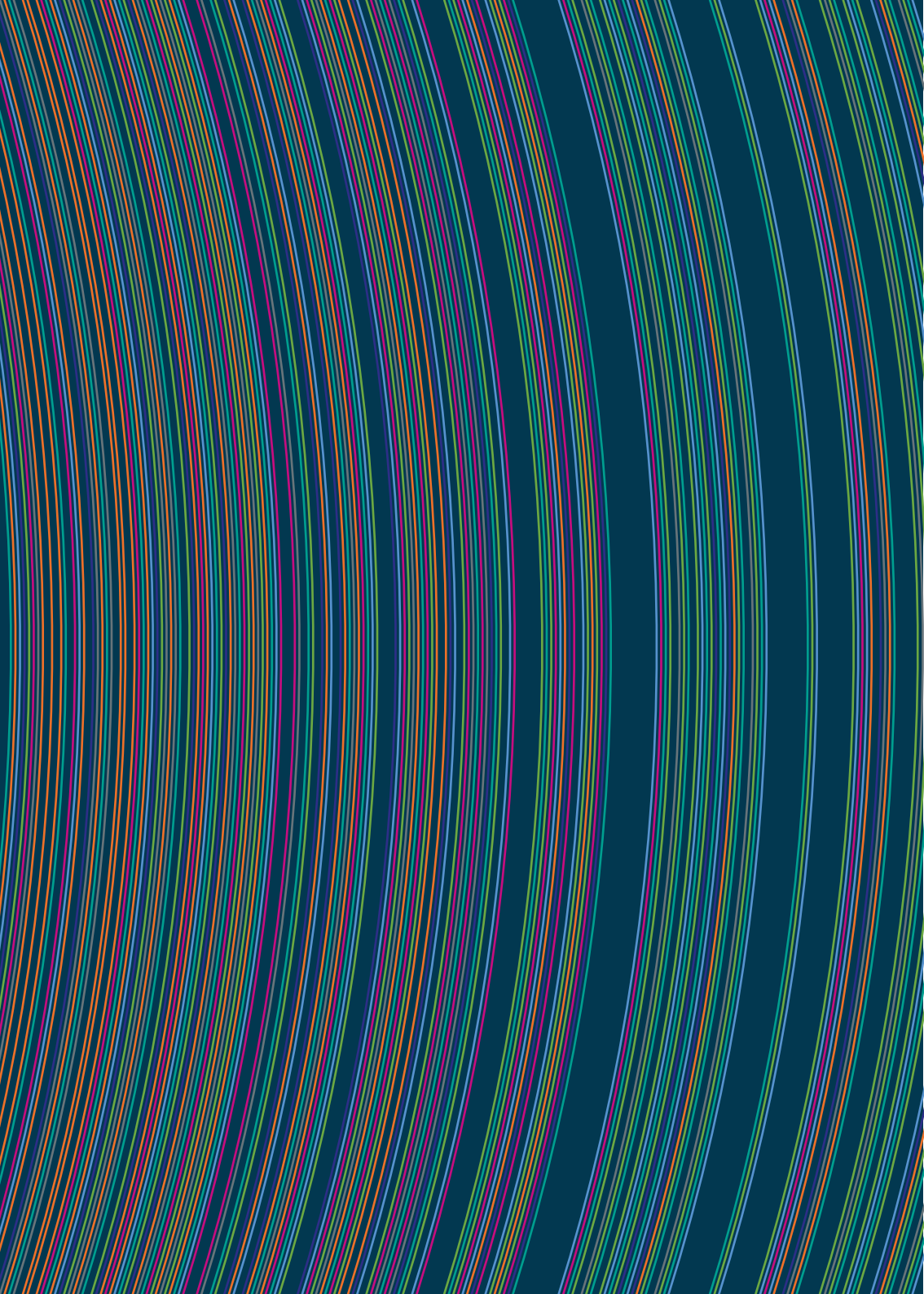
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Contact
contact@etp4hpc.eu



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: @ETP4HPC
Contact: contact@etp4hpc.eu