FORTISSIMO

Fortissimo Case Studies

Enabling Manufacturing SMEs to benefit from High-Performance-Computing-Cloud-based Simulations

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www.fortissimo-project.eu

The Fortissimo Project

Enabling Manufacturing SMEs to benefit from Cloud-based, High-Performance-Computing Simulations

Fortissimo is a collaborative project that enables European SMEs to be more competitive globally through the use of simulation services running on a High Performance Computing cloud infrastructure. The project is coordinated by the University of Edinburgh and involves 123 partners (74 SMEs) including Manufacturing Companies, Application Developers, Domain Experts, IT Solution Providers and HPC Cloud Service Providers from 14 countries. These partners are engaged in 53 experiments (case studies) where business relevant simulations of industrial processes are implemented and evaluated.

The project is funded by the European Commission within the 7th Framework Programme and is part of the I4MS Initiative.

The Challenge

The importance of advanced simulation to the competitiveness of both large and small companies is well established. However, the simulation of, for example, high-pressure gas cylinders or the moulding of plastics requires enormous computing power and specialized software tools and services. Generally, large companies have easier access to advanced simulation than SMEs, which are facing both technological hurdles and financial challenges. This means that SMEs are often not able to take advantage of advanced simulation, even though it would clearly make them more competitive.

The Goal

The goal of Fortissimo is to overcome this impasse through the provision of simulation services and tools running on a cloud infrastructure. A “one-stop-shop” will greatly simplify access to advanced simulation, particularly to SMEs. This will make hardware, expertise, applications, visualisation and tools easily available and affordable on a pay-per-use basis. In doing this Fortissimo will create and demonstrate a viable and sustainable commercial ecosystem.

The Experiments

Fortissimo will be driven by end-user requirements: 53 business-relevant application experiments will serve to develop, test and demonstrate both the infrastructure and the “one-stop pay-per-use shop”. 20 experiments - all HPC-cloud-based - have already been completed in fields such as the simulation of continuous casting and die casting, environmental control and urban planning, and aerodynamic design and optimisation.

A second wave of 22 new experiments has been added as a result of the first open call followed by a third wave of 11 additional experiments. These two new sets of experiments complement those currently active within Fortissimo and broadens the engineering and manufacturing applications from an extended range of industrial sectors including: Automotive, Aerospace, Construction, Energy & Renewable Energy, Environmental, Maritime, Metal Processing, Oil & Gas, Pharmaceutical & Biotech, Plastics. Amongst the new partners who joined the project are a total of 51 SMEs, solving core business challenges with the support of application-domain and HPC experts and resources.

The Impact

Fortissimo contributes to the increased competitiveness of European manufacturing industry through the innovative infrastructure that is developed and tested. It also creates commercial opportunities for European Independent Software Vendors and for service and High Performance Computing infrastructure providers, through the creation of a new market for their products and services. Fortissimo places emphasis on the exploitation of opportunities at all levels of the value chain all the way from the SME end-users to the providers of High Performance Computing infrastructure.

This booklet contains a collection of 15 case studies from the first wave of initial experiments. They demonstrate the wide verity of HPC-cloud solutions and the impact these solutions had on the business of manufacturing SMEs as Fortissimo experiment partners.

www.fortissimo-project.eu

More information on Fortissimo is available at

Fortissimo Partners

Coordinator

THE UNIVERSITY OF EDINBURGH

EPCC is a leading European centre of excellence in advanced research, technology transfer and the provision of high-performance computing services to academia and industry. Based at The University of Edinburgh, it is one of Europe's leading supercomputing centres.
http://www.epcc.ed.ac.uk/

Core Partners

ARCTUR D.O.O.

Arctur prides itself in not being just another HPC infrastructure provider, but rather one which always provides personal support even to users which are not so knowledgeable of HPC, so ensuring that every HPC project achieves or even surpasses user expectations. Our motto is "More than just HPC." We work closely with all our partners from the request for HPC resources and support them through their whole project ensuring smooth progress. As an SME, we understand the issues that other SMEs face when dealing with HPC.
http://hpc.arctur.net

Bull SAS

The only truly European IT company capable of designing, integrating and implementing supercomputers, Bull has made Extreme Computing one of its key strategic priorities. Many prestigious companies and research centers, most notably in France, Germany, UK, Spain and Brazil have chosen Bull Extreme Computing solutions, based on bullx, a range of innovative systems designed for uncompromised performance.
http://www.bull.com/extreme-computing/

CONSORZIO INTERUNIVERSITARIO

CINECA, the Italian supercomputing center, is equipped with the most advanced hardware resources used for academic and industrial research. CINECA's mission is to provide computational resources satisfying present and future research needs and to follow technology advances closely.
http://www.cineca.it

FUNDACION CENTRO TECNOLOGICO DE SUPERCOMPUTACION DE GALICIA

CESGA is a public foundation committed to the advancement of Science and Technical Knowledge, by means of research and application of high performance computing and communications, as well as other information technologies resources, in collaboration with other institutions, for the benefit of society.
CESGA promotes research into and use of HPC, advanced communications and the development of information and communications technologies, as an instrument for sustainable socioeconomic development, devoting special attention to cooperation between research centres, whether public or private, and the manufacturing sector.
https://www.cesga.es/en/cesga

GOMPUTE

Gompute is a leading HPC and HPC Cloud company, based in Sweden which offers HPC services to a large number of users worldwide. Gompute delivers comprehensive solutions for High Performance Computing, both in-house and as a service. Gompute delivers a collaborative and highly productive work environment for geographically distributed engineering teams.
http://www.gompute.com

GRAND EQUIPEMENT NATIONAL DE CALCUL INTENSIF

GENCI was created in 2007 by the Public authorities with the aim of placing France among the leading countries within Europe and on the international stage in terms of high performance computing. GENCI's role is to help implement the national strategy for high performance computing in support of scientific research within France, in close liaison with the three national computing centres; to be a player in the creation of an integrated European high performance computing ecosystem; to work to promote numerical simulation and high performance computing within the academic and industrial communities and in combination with Inria and Bpifrance, as part of a specific initiative for the SME sector.
http://www.genci.fr

INTEL DEUTSCHLAND GMBH

Intel (NASDAQ: INTC) is a world leader in computing innovation. The company designs and builds the essential technologies that serve as the foundation for the world's computing devices. Additional information about Intel is available at newsroom.intel.com and blogs.intel.com.
http://www.intel.com

SCAPOS AG

scapos was founded in 2009 for the sales, marketing and support of technical computing software. The business of scapos is the distribution of advanced software solutions, particularly from research and academic institutes. Its product portfolio includes: optimisation software (the Autonester product suite and PackAssistant), the co-simulation environment MpCCI and the SAMG scalable solver libraries from Fraunhofer-SCAI; the HPC library GPI from Fraunhofer-ITWM; the FEMZIP simulation-data compression tool from SIDACT (an SME). Its customers range from large research institutes and industrial corporations to SMEs. In addition to its own sales and marketing activities, scapos works with more than 20 distribution beneficiaries world-wide.
http://www.scapos.com

SICOS BW GmbH

SICOS BW has been founded by HLRS (UoStuttgart) and SCC (KIT) to support SMEs in the usage of HPC. Its tasks are to support industrial users when they want to use the HPC-systems and to support the computing centres to provide their services in a way that is suitable for industrial users.
http://www.sicos-bw.de

SURFSARA BV

SURFsara supports research, education and industry in the Netherlands in the areas of high performance computing and big data. SURFsara accomplishes this through the development and provisioning of advanced ICT infrastructure, services and expertise. SURFsara provides expertise and services in the areas of High Performance Computing, e-Science & Cloud Services, Data Services, Network support and Visualisation.
http://www.surfsara.nl

UNIVERSITAET STUTTGART

The High Performance Computing Centre (HLRS) is one of three national computing centers in Germany affiliated to the University of Stuttgart. As such it operates a variety of large computing clusters and provides compute resources to European research groups and industry.
http://www.hlrs.de

XLAB D.O.O.

XLAB Research is recognized as one of the strongest computer science research teams outside the academic world in Slovenia. Expertise: security and distributed systems. Additionally we are working in the field of Computer vision, Computer visualization, and Artificial intelligence.
http://xlab.si

Experiment Partners

ASOCIACION DE INVESTIGACION METALURGICA DEL NOROESTE

AIMEN is a non-profit private association, founded in 1967 and based in Spain, whose prime objective is to develop and increase technological competitiveness and innovation capacity of companies. AIMEN provides industry with technological services and RDI activities focused in wide range of sectors.
http://www.aimen.es/

GESTAMP AUTOMOCIÓN, S.A

Gestamp is an international group dedicated to the design, development and manufacture of metal components and structural systems for the automotive industry. Gestamp is located in 19 countries with 93 plants, 15 R&D centers, 28.500 employees. In 2012, Gestamp reached 5.6 billion € of turnover.
http://www.gestamp.com

AVL LIST GMBH

AVL is the world's largest independent company for the development, simulation and testing technology of powertrains (hybrid, combustion engines, transmission, electric drive, batteries and software) for passenger cars, trucks and large engines. AVL develops all kinds of powertrain systems as well as all the instruments, systems and software required for powertrain and vehicle testing.
In addition AVL develops and markets simulation tools and methods which are necessary for the development of powertrains. The developed simulation software focuses on the design and optimization of powertrain systems and covers all powertrain components and phases of the development process.
http://www.avl.com

BINKZ INCORPORATED

Binkz Inc is an SME specializing in CFD consulting. Among the services offered at Binkz are CFD analysis for aircraft ground and in-flight icing, aerodynamics, wind engineering, process engineering and marine hydrodynamics. Binkz clients come from the aerospace and aeronautical industries, the automotive industry, the marine industry, the oil and gas industry, and the construction industry. Binkz uses an array of proprietary commercial, open-source and internally developed software for consulting. The small size of the company and its high expertise allow it to offer high-end CFD consulting services at very competitive rates.
http://www.binkz.ca

CAMBRIDGE ENVIRONMENTAL RESEARCH CONSULTANTS LTD

CERC is an SME with over 25 years of expertise in environmental software development and consultancy, specialising in air quality modelling. The best known products are the world-leading ADMS suite of models, including versions for modelling Industrial areas, Urban areas, Roads and Airports.
http://www.cerc.co.uk/

MIKROSAM A.D.

Mikrosam is a design consulting company, building electronic components and designing machines for production. Throughout the years, by integrating advanced mechanical, electrotechnical and IT knowledge, it has grown into a world-renowned composite machine manufacturer. Nowadays, Mikrosam designs and produces high-tech computer controlled machines for production of composite materials.
http://mikrosam.com/

ENGINSOFT SPA

EnginSoft is a consulting company operating in the field of computer aided engineering, virtual prototyping and advanced simulation. Founded in 1984, EnginSoft has around 120 employees and 5 sites in Italy and partner offices in various parts of Europe and North America.
Fields of application include mechanics, fluid-dynamics, fast dynamics and crash, metallurgy, process simulation, porous media, environmental engineering, off-shore engineering, acoustic process integration and design optimization and, more generally, scientific IT targeted at the optimization of design and production processes.
http://www.enginsoft.com

ERGOLINES LAB SRL

Ergolines is a company established in 1998, committed to developing cutting-edge technologies for the steelmaking industry, with its main focus on continuous casting, where liquid steel becomes a solid mechanical structure. Ergolines has developed a wide range of products specifically designed for the production of specialty steels, including Electro Magnetic Stirrers (EMS) and special instruments designed around the requirements of a continuous-casting facility, which is then personalized for each individual customer. It is this custom-made approach that makes Ergolines unique in its market and guarantees tailor-made solutions, extreme design flexibility and personalized engineering. The developments of special equipment oriented toward the control and improvement of steel quality in the continuous-casting process necessarily requires a continuous effort in research and development activities, that has brought Ergolines to play an important global role.
http://www.ergolines.it/?lang=en

ESI GROUP S.A.

ESI is a pioneer and world-leading provider in Virtual Prototyping that takes into account the physics of materials. ESI boasts a unique know-how in Virtual Product Engineering, based on an integrated suite of coherent, industry-oriented applications. Addressing manufacturing industries, Virtual Product Engineering aims to replace physical prototypes by realistically simulating a product's behavior during testing, to fine-tune fabrication and assembly processes in accordance with desired product performance, and to evaluate the impact on product use under normal or accidental conditions. ESI's solutions fit into a single collaborative and open environment for End-to-End Virtual Prototyping. These solutions are delivered using the latest technologies, including immersive Virtual Reality, to bring products to life in 3D; helping customers make the right decisions throughout product development. The company employs about 1000 high-level specialists worldwide covering more than 40 countries.
http://www.esi-group.com

FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.

Fraunhofer SCAI is a national research organization and contributes to FORTISSIMO with its expertise in two technology domains:
- multi-physics co-simulation environment for applications in electrical engineering area and
- flexible licensing mechanisms for pay-per-use models in clouds.

http://www.scai.fraunhofer.de

ICON TECHNOLOGY & PROCESS CONSULTING LIMITED

ICON was established as a private limited company in May 1992. Although originally a Computational Fluid Dynamics (CFD) services provider, subsequent demand for complimentary expertise resulted in new business units developing. These included a broad spectrum of Computer Aided Engineering (CAE) services as well as IT/web/multimedia capabilities to manage and present data. This evolution of the company continues today with recent growth in the fields of automatic optimisation and open source technology, with which we continue to revolutionise industrial processes.
The company was originally founded upon computational and experimental engineering expertise gained at Imperial College, London. During the eighties and nineties, the intense research and development efforts into CFD methods resulted in two of today's major codes. The expertise accumulated during that period was increasingly demanded by industry and as a result ICON was setup to supply CFD services to OEM's, SME's and research organisations worldwide.
ICON's strategy is as pertinent today as it was in 1992: To provide high-quality independent advice and expertise in process, technology and services.
http://www.iconcfd.com

IMR ENGINEERING & TECHNOLOGIES SPA

IMR Engineering&Technologies Spa has achieved world leadership in the production of equipment for both ferrous and non-ferrous casting, the design and construction of machine tools.
The company has also international commercial and production structures: IMR Usa, IMR India and IMR Shanghai.
http://www.imr.it/

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Working at the crossroads of computer sciences and mathematics, over the last 40 years Inria's researchers have been developing the scientific foundations for a new field of learning: computational sciences.
When associated with other scientific disciplines, computational sciences can be used to offer new concepts, languages, methods and teaching aids which open up new avenues for exploration and understanding of complex phenomena. Working in project-teams, Inria researchers mix fundamental and applied research in an innovative blend to produce their results.
The institute's 179 teams, the majority of which are joint teams with other major French or international research bodies, are comprised of around twenty researchers working on a shared project for a period of 4 to 8 years.
Inria is France's only public research body fully dedicated to computational sciences. It hosts over 1000 young researchers each year.
http://www.inria.fr/en

INTEGRATED ENVIRONMENTAL SOLUTIONS LIMITED

IES is a global innovator of integrated 3D sustainable analysis for measuring and managing energy-efficient, healthy, affordable buildings. Its technology and consulting supports smarter sustainable choices across new buildings, operation and refurbishments. Its unique tools assist regulatory agencies, building owners/FMs, sustainability/energy managers, architects and engineers.
http://www.iesve.com

KE-WORKS BV

KE-works is a high-tech startup active in in new product development for engineering intensive manufacturing companies. KE-works is founded in 2008 as a spin-out from the Delft University of Technology, has a background in the fields of knowledge based engineering and multidisciplinary design optimisation applied to aircraft design. Its core competences are in the fields of knowledge management, systems engineering, and software engineering.

The mission of KE-works is to improve significantly the operational efficiency of manufacturing companies through flexible and efficient product development processes. KE-works' vision of new product development is centred on a multidisciplinary design control room, where highly integrated and automated design engineering processes enable a multidisciplinary project team to evaluate possible design options in real-time. To realise this vision there is a need for both integration and automation of different users, methods and technologies. In Fortissimo, KE-works will act as an end-user SME and will provide engineering process workflow in experiment 9. KE-works will provide the use-case and applications that are to be included in the cloud-based HPC environment for the License as a Service (LAAS) experiment. The experiment will provide an industrial use case within the Aerospace Engineering domain, especially for the optimised design of electrical wiring systems in aircraft.
http://www.ke-works.com/en

KOENIGSEGG AUTOMOTIVE AB

Koenigsegg, an SME founded in 1994 and based in Sweden, develops and manufactures high-performance, high-quality, limited-edition motor vehicles. The initial model, the Koenigsegg CC8S, was first delivered in 2001 followed by a series of upgraded models. Koenigsegg is able to produce some of the world's fastest cars by adopting a product development strategy driven by lean, optimised work procedures and the use of the best hardware and software on the market. In developing its vehicles, Koenigsegg makes significant use of computer simulations.
http://www.koenigsegg.com

LONZA AG

Lonza is one of the world's leading and most-trusted suppliers to the pharmaceutical, biotech and specialty ingredients markets. We harness science and technology to create products that support safer and healthier living and that enhance the overall quality of life. Not only are we a custom manufacturer and developer, Lonza also offers services and products ranging from active pharmaceutical ingredients and stem-cell therapies to drinking water sanitizers, from the vitamin B compounds and organic personal care ingredients to agricultural products, and from industrial preservatives to microbial control solutions that combat dangerous viruses, bacteria and other pathogens.
http://www.www.lonza.com

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

The DSSLab of NTUA is a multidisciplinary unit which carries out R&D activities and provides solutions on a wide range of complex Scientific & Business problems. Areas of expertise include Process & Data Modelling, Interoperability Frameworks, Service-oriented IS and Enterprise Services Composition.
http://www.epu.ntua.gr

NOESIS SOLUTIONS

Noesis Solutions is a simulation innovation partner to manufacturers in automotive, aerospace and other engineering-intense industries. Specialized in simulation process integration and numerical design optimization (PIDO), its flagship software Optimus helps customers adopt an 'Engineer by Objective' development strategy.
http://www.noesissolutions.com

NUMERICAL ALGORITHMS GROUP LTD

The Numerical Algorithms Group (NAG) delivers trusted, high quality numerical computing software and HPC services. NAG are experts in adapting software to take advantage of modern HPC architectures, whether manycore or accelerator-based, as well as offering a broad range of training courses.
http://www.nag.co.uk

NUMTECH SARL

NUMTECH is a French company specialised in the field of air quality and meteorological calculations. For this, NUMTECH has developed and use effective and innovative digital tools. NUMTECH currently has 19 employees. NUMTECH is the market leader in France for modeling the weather and atmospheric dispersion. Its customers are mainly large companies such as TOTAL, EDF, Suez Environment, Rhodia-Solvay and Michelin, local and regional authorities and research institutes such as CEA, INERIS, InVS and DGA. Main area of expertise : simulation of meteorology and air-quality, specially at local-scale (industrail site, city-scale).
http://www.numtech.eu

PIPISTREL D.O.O.

Pipistrel is a Slovenian SME manufacturer of light aircraft, renowned for innovation, pioneering, performance and efficiency. Pipistrel's main products are one to four-seater single engine piston aircraft. Its main R&D activities are aerodynamics, structures, CAD design, mechanical design, rapid prototyping, electronics design and structural and flight testing.
http://www.pipistrel.si/

POWERSYS SARL

POWERSYS provides global solutions of engineering software and services for industry, research and education in the field of Electrical & Electromechanical power systems.
POWERSYS is the exclusive distributor of JMAG (Electromagnetic FEA simulation software) in Europe. Electromagnetic FEA analysis is a key technology for Electromechanical Design and JMAG offers a comprehensive and extremely efficient solution for those applications.
http://www.powersys-solutions.com/

PRINCIPIA SAS

PRINCIPIA is an independent scientific engineering company offering for the energy (Oil&Gas and Nuclear) and Naval sectors: design and analysis of structures, marine operations, riser & pipelines, mooring; Core expertise is in structural analysis, CFD, hydrodynamics, structure monitoring and integrity management and Software editor for offshore applications: Diodore, NSO, DeeplinesTM;
PRINCIPIA worldwide: France, Kuala-Lumpur, Malaysia, Denmark, Brazil, Nigeria.
http://www.principia.fr/

PRYSMIAN

Prysmian Group is world leader in the energy and telecom cables and systems industry. With sales of some €8 billion in 2012, about 20,000 employees across 50 countries, 91 plants, 17 research & development centers the Group is strongly positioned in high-tech markets and provides the widest range of products, services, technologies and know-how.
http://prysmiangroup.com/en/index.html

RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN

The Software and Tools for Computational Engineering (STCE) group at RWTH Aachen University, Germany, is a leading expert in Algorithmic Differentiation of numerical simulation code. For example, STCE develops discrete adjoint solvers for OpenFOAM facilitating robust first- and higher-order optimisation methods using adjoint sensitivities.
http://www.stce.rwth-aachen.de

SCIENTIFIC COMPUTING & MODELLING N.V.

Scientific Computing & Modelling N.V. (SCM) is an independent software vendor operating in the fields of computational chemistry and materials science. It develops software packages for electronic structure calculations (using DFT and DFTB) as well as (reactive) Molecular Dynamics software (ReaxFF) in collaboration with many academic partner groups. The software runs efficiently on parallel supercomputers and is being optimised for hybrid CPU-GPU usage. A graphical user interface is available for all these software modules in atomistic computer simulations.
http://www.scm.com

SCILAB ENTERPRISES SAS

Scilab Enterprises is the official publisher and professional services provider of Scilab software, the worldwide open source reference software for numerical computation and simulation with more than 80,000 downloads per month from 150 countries.
http://www.scilab-enterprises.com

SDI SAS SOCIETE DE DEVELOPPEMENT INDUSTRIEL

SDI is an engineering company specializing in testing, mechatronics and embedded systems. It has a broad industrial experience gained over the last twenty years and has major industrial accounts. Founded in 1990, SDI designs test, measurement and control systems and related equipment.
http://www.sdi-tech.com

TEXAS CONTROLS SL

Texas Controls is a company specialized in tightening and sealing solutions, bolted joint auditing and calculation, with main customers in the PetroChemical sector, with a long experience achieving critical safe mechanical joints and implementing solutions for a non-leaking and safe flanged joints.
http://www.texascontrols.com

UNIVERSITAET PADERBORN

The chair of Thermodynamics and Energy Technology (ThEt) is part of the Mechanical Engineering Department at the University of Paderborn (UPB) in Germany. It is specialized in providing predictive molecular simulation data on thermodynamic properties of fluids for process engineering applications.
http://thet.uni-paderborn.de

VORTECH BV

VORtech is a combination of a software development house and an engineering firm in applied mathematics. We combine a thorough knowledge of mathematical modeling, simulation techniques and computational algorithms with state-of-the-art software development methods.
http://www.vortech.nl/en/home

HPC-Cloud-based simulation of light-aircraft aerodynamics

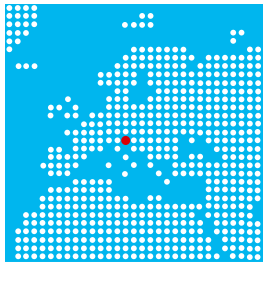
The Company

Pipistrel is an SME based in Slovenia. It was established in 1989 and is a leading designer and manufacturer of light aircraft. In order to develop its product line, Pipistrel needs to understand how air flows over its aircraft. There are two ways of doing this: the first is a wind tunnel test of a physical body and the second is to simulate the flow of air in a computer using Computational Fluid Dynamics (CFD). Although both methods have pros and cons, the standard practice for large companies in the aerospace industry is to use both in a consecutive manner. Computational simulations are usually used throughout the whole design phase, whereas wind tunnel tests are used only at certain phases of the design, since they are much more expensive from the cost and time point of view.
For an SME, it is virtually impossible to use wind tunnel tests during the design phase of a new aircraft, because such tests are simply too expensive. The only option an SME has is to simulate the flow of air as accurately as possible using a high-performance computer. To replace wind-tunnel tests satisfactorily, aerodynamic models, which accurately simulate real airflows, need to be deployed. Such models require significant compute cycles and memory. Before Fortissimo, Pipistrel had made some limited simulations using in-house computing resources, but these did not give the required fidelity and did not run sufficiently quickly. The objective of this case study was to examine the cost-benefits, feasibility and effectiveness of performing these simulations on a Cloud-based HPC system.

The Challenge

The challenge facing Pipistrel was to perform simulations of the flow over its aircraft which were sufficiently detailed to model real physical effects accurately. Such simulations require expensive computer resources which are normally beyond the means of an SME. However, the use of Cloud-based HPC offers the possibility of running such simulations on a pay-per-use basis which is financially viable for an SME. The challenge was therefore to demonstrate the feasibility of such an approach.

Pipistrel d.o.o.
Slovenia



The Solution

The use of Cloud-based HPC allowed Pipistrel to run simulations of a higher fidelity than was possible with its in-house systems. These simulations closely modelled real-world behaviour and gave accurate information on how the aircraft would behave in flight. To simulate the flow with the required degree of accuracy, a large computer model was used for the case studies. In doing this, Pipistrel learned how to run, handle and post-process big computations on a Cloud-based HPC system. A typical large model would run in approximately 2 to 3 days on the HPC system. Such a problem would either be too big for the in-house systems or would take too long to run (around 20 to 30 days) to be part of an effective design process. The use of HPC therefore enabled Pipistrel to obtain results of much more complex simulations in a reasonable time. It also offered a cost-effective solution to running such large simulations.

The Business Case

Pipistrel needs to simulate the flow of air over the body of an aircraft only occasionally during the design process. It estimates that it is 10 times cheaper to use Cloud-based HPC simulations than have a suitably powerful in-house system which is only used for part of the time. The indicative annual costs of using Cloud-based HPC simulations are approximately €30k compared with an in-house costs of €300,000, which shows that this saving is considerable.

The Benefits

This case study allowed Pipistrel to use HPC for the first time and to learn about its capabilities. Pipistrel ran more demanding, higher fidelity simulations. It gained considerable experience in the use of HPC-based simulation. This experience will help Pipistrel to estimate the time and the cost of such simulations better. This will help them to decide if the use of HPC is justified or not in future projects.
Pipistrel learned that the use of HPC will be very valuable during a design phase of future aircraft. HPC can be used to run much more demanding simulations that improve the fidelity of results. The time needed for such simulations running on an HPC system is roughly the same as the coarser simulations currently run on Pipistrel's in-house cluster. The higher-resolution simulations give more and better data that can be incorporated into each design phase. This both accelerates the design phase and reduces the number of the design cycles.

Organisations Involved

- End User: Pipistrel
- HPC Expert: XLAB
- HPC Provider: Arctur

Pipistrel Award

Arctur's partner Pipistrel received the IDC Innovation excellence award in the field of High Performance Computing. https://www.arctur.si/news/pipistrel/

IDC is a worldwide analysis organization providing business intelligence information about leading-edge of IT technologies. At the ISC'14 Conference in Leipzig IDC proclaimed the winners of The Innovation Excellence award for achievement in the field of High Performance Computing (HPC). Pipistrel received this award for the use of HPC in the development of the Taurus G4 aircraft in record time and were presented the award alongside prestigious companies such as Rolls Royce, Westinghouse and Caterpillar.

Pipistrel received their award for implementing HPC technologies in the development of the Taurus G4 aircraft which was completed in a record time. Pipistrel's R&D department headed by Dr. Gregor Veble is using Arctur's HPC infrastructure to speed up the development of Pipistrel's aircraft and for rapid prototyping of different components. Arctur and Pipistrel are working together in Fortissimo which is part of the ICT Innovation for Manufacturing SMEs (I4MS) initiative.

The challenge facing Pipistrel is to perform simulations of the flow over its aircraft which are sufficiently detailed to model real physical effects accurately.

This experiment allowed Pipistrel to use HPC for the first time and to learn about its capabilities. Pipistrel ran more demanding, higher fidelity simulations. It gained considerable experience in the use of HPC-based simulation.

HPC-Cloud-based simulation of steel casting

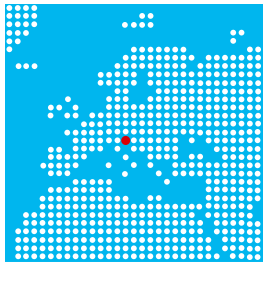
The Company

Ergolines, an SME, is a world leader in the manufacture of a wide range of products specifically designed for the production of speciality steels, including electro-magnetic stirrers and special instrumentation designed around the requirements of a continuous casting facility. Ergolines' goal is the development of equipment supporting the production of flawless steel alloys with metallurgical properties able to satisfy an ever increasingly quality-oriented market. In the development of such equipment, Ergolines routinely simulates the flow of liquid steel, as it becomes a solid mechanical structure, using in-house computational resources. This case study addresses the problem of slag carry-over from the ladle to the tundish which is a serious problem in steel casting and which can lead impurities in steel or poor ladle yield. Slag carry-over is a complex phenomenon which cannot be observed directly. The simulation of slag carry-over requires the use of HPC which has not previously been used by Ergolines.

The Challenge

In the field of continuous casting there is an increasing industrial demand for the development of new technologies for preventing slag transfer from the ladle to the tundish. Such an event may cause a breakout, that is the breaking of the solid skin of the solidifying cast products, which results in hazardous dispersion of liquid steel within the industrial plant. Ladle-slag monitoring is currently performed by operators on an empirical basis. Given the relevance of both safety and the economic implications of a breakout, there is a significant demand for an effective, automated system for ladle-slag monitoring. While passing through the ladle shroud, liquid slag induces characteristic vibrations which can be measured. In order to develop an effective detection system, it is necessary to correlate the vibrational signal with the fluid dynamics of the system. Such a correlation requires a complex, detailed simulation, which can only be carried out on an HPC system

Ergolines
Italy



The Solution

Dedicated HPC-based simulations followed by case experimental validation have provided Ergolines with key insights into the physics of the system and into different ladle-emptying mechanisms. As a result, it has been possible to establish a correlation between the shroud vibrational signal and the fluid dynamics of the system. The results obtained constitute the basis for the development of an innovative slag monitoring technology based on vibrational analysis, which would significantly contribute to both better occupational safety and greater productivity of steel plants. Previously Ergolines was using simulation in its design process. However this case study was their first experience of HPC and the benefits it could bring.

The Benefits

Given the complexity of the phenomenon to be simulated, a very fine discretization in terms of geometry and time is needed in order to obtain accurate results. Such a fine discretization involves a significant computational load and therefore requires adequate computational capabilities. As the company does not possess the necessary computational infrastructure, the possibility of using Cloud-based HPC resources proved fundamental in addressing this specific industrial and scientific challenge. In fact, the availability of a cloud-based HPC system allowed Ergolines to exploit supercomputing resources and reduce computational times without having to sustain the high costs of a dedicated infrastructure, used for only part of the time. The use of such an HPC resource can contribute to a significant reduction in time to market and improved product design. The results attained by the HPC-based fluid-dynamic analysis set the stage for the development of a new product for automatic slag detection in steel continuous casting, a promising technology envisioned to bring significant benefits to the end-users both in terms of occupational safety and productivity of steelworks.

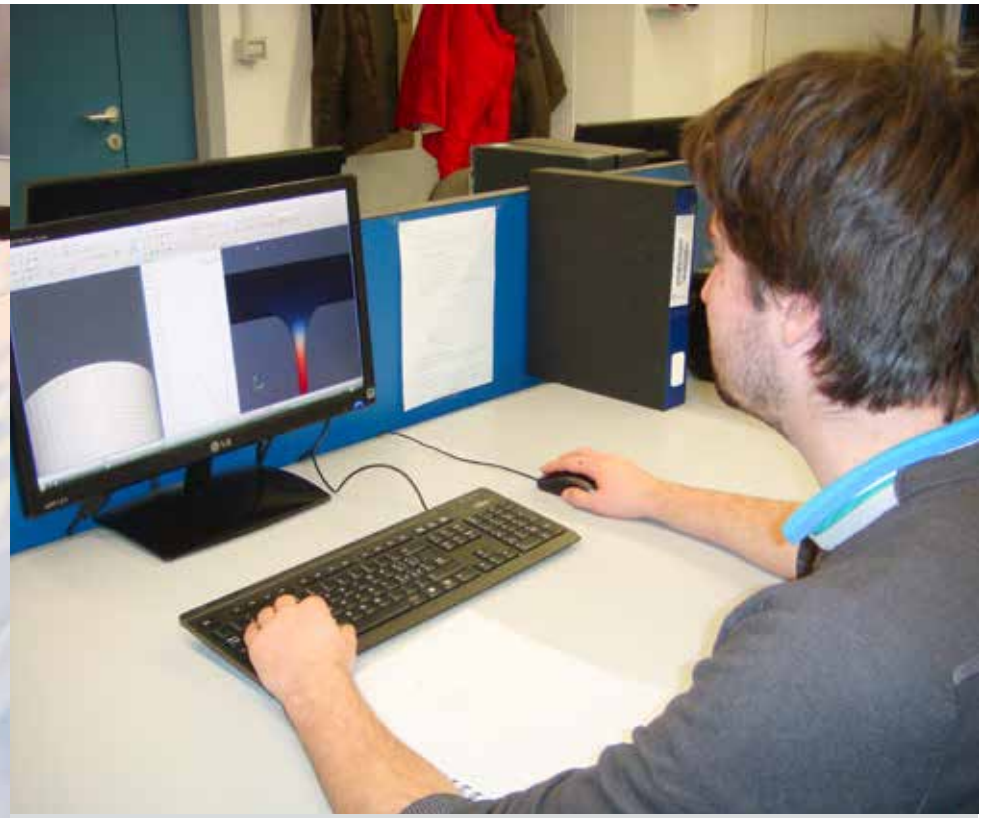
The ability to detect slag while it is passing through the shroud would enable a steel plant to control the closing of the ladle better and so increase the steel yield. For an average ladle size of 100 tons, usually 0.5 to 1% of steel remains in the ladle. Using the proposed slag monitoring technology, 60% of that lost steel can be saved. On an average production of 1 million tonnes of per year, a medium-size factory could then save 6,000 tonnes of steel that do not need to be re-melted.

The re-melting of 6,000 tonnes of steel would cost approximately €70 to €100 per tonne, namely 420,000€ to 600,000€. Additionally the loss of a further 300 tonnes of steel for a cost of 70,000€ could be avoided. This means a total saved amount up to 670,000€ saved per year per medium sized steel plant.

Casting is a high energy-consuming process. It is very easy to see what this means in terms of energy saving for the re-melting of 6,000 tons of steel of each steel plant equipped with the proposed monitoring technology.

Companies Involved

- End User: Ergolines
- HPC Expert and Centre: Arctur



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HPC-Cloud-based design of high-pressure vessels

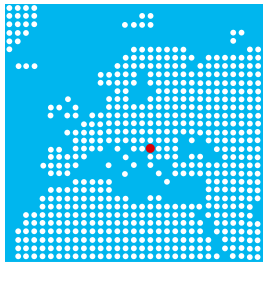
The Company

Founded in 1990, Mikrosam is an SME which manufactures equipment and associated software for the production of artefacts from composite materials. Mikrosam is the only company that offers custom-made solutions for all core, composite technologies: filament/tape winding, prepreg making, prepreg slitting, automated fibre placement, tape laying (AFP/ATL), and composite machining. Mikrosam's portfolio covers, amongst others, solutions for the design and manufacturing of composite pressure vessels for transportation and storage of gas as an automotive fuel. Mikrosam develops the cylinder and the composite laminate of pressure vessels and subsequently adapts the design and the construction of the filament winding equipment on which the vessels are to be produced.
Advanced composite material products are significantly lighter (60-80% lighter than steel, and 20-50% lighter than aluminium), but as strong as or even stronger than widely used metal counterparts. By choosing an appropriate combination of matrix and reinforcement material, specific composite laminates, that meet particular application requirements, can be produced. Advanced composites provide design flexibility and can be moulded into complex shapes. Composite pressure vessels can take full advantage of the extremely high tensile strength and high elastic modulus of the fibres from which they are made.
Composite design is a painstaking process which was previously done by Mikrosam on a desktop computer. This involved many time-consuming computations and physical tests of potential designs. Such simulations require significant computing resources and need to be carried out using an HPC system in order to get results in a reasonable time frame.

The Challenge

The challenge was to develop a model for the simulation of composite materials and to implement it on an HPC system. The goal was to improve Mikrosam's capability to satisfy the principal ISO 11439 standard and the ECE R 110 normative for Gas cylinders "High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles" by developing a model for the design and simulation of composite laminates that could be implemented on an HPC system and obtain accurate results in an acceptable time.

Mikrosam
FYR Macedonia



The Solution

A computer model was developed to design composite laminates and simulate their properties using an open-source software package, Octave. This model was adapted to be run on an HPC system. HPC-based simulations reduce both computation time and the number of physical tests, which need to be made in the design of composite laminates. This case study has shown that using parallel computation on an HPC system can reduce composite-design time by about 30% and testing time by nearly 10%. Through this case study, Mikrosam had the opportunity to use and benefit from HPC for the first time.

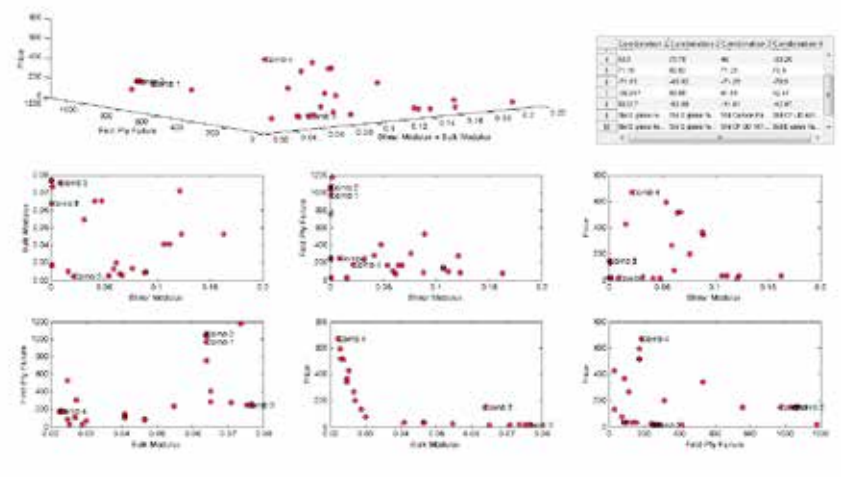
The Benefits

For each filament winding machine used in the production of high-pressure vessels, different combinations of materials and winding angles for the composite, need to be considered. With the simulation code developed in this case study it is possible to shorten the design time and to reduce the number of physical tests and prototyping costs. As a result of the FORTISSIMO experiment, MIKROSAM will be able reduce its production costs by about €30,000 per year for the next 5 years. More importantly its product offer (production machines for high-pressure vessels) will give each of its customers an advantage in production costs of around €300,000 per year per machine for machines that are currently on the market. The considerable advantage of MIKROSAM's products over those of its competitors will, as a conservative estimate, lead to an increased revenue for the company of around €400,000 per year for the next 5 years. This is a significant amount for this SME. The experience gained in this experiment together with reduced production costs for both Mikrosam and its customers constitutes a base for further growth of the company and the resultant creation of new jobs.

Organisations Involved

- End User: Mikrosam
- HPC Provider: Arctur

The challenge was to develop a modelfor the simulation of composite materials and to implement it on an HPC system which would enable accurate results to be obtained in a time frame allowing an acceptable development time.



HPC-Cloud-based simulation of flange tightening

The Company

Texas Controls is a Spanish SME that offers tightening and sealing solutions to large industrial facilities in the industrial, power generation and oil & gas sectors. The mechanical division of Texas Controls is the only engineering company in Spain specialising in tightening and sealing. Its long experience over many years of achieving critical safe mechanical joints, and its ongoing research projects (mechanical simulations, FEM analysis and empirical testing) allow Texas Controls to address critical tasks, offering its customers the highest confidence in the implementation and operation of leak-free and safe flanged joints.

These solutions are especially important to customers in the oil and gas industry, where it is imperative to avoid leaks in pipes and pressure vessels or reactors that could occur under extreme pressure and temperature. The costs of preventing leaks are much lower than those of their consequences. Therefore, it is crucial to study and predict the behaviour of flanged joints and to understand how the elastic interactions between their elements take place.

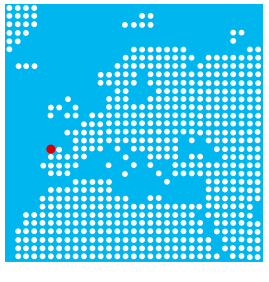
Previously Texas Controls had used computer simulations. However, the computational demands of modelling the behaviour of flanges were such that an HPC-based solution was necessary and this was the first time that they had used such technology.

The Challenge

This case study addressed flanged joints that are used for high-pressure and hot gases or liquids. To seal a joint, a gasket is placed inside a groove, which is located on both flanges. During the process of closing and tightening the joint, the gasket and the flanges may suffer damage through deformations and high levels of stress. Even worse, if the closing process is not performed correctly, workers at the plant could suffer serious or fatal accidents accompanied by damage to the surrounding community and the environment.

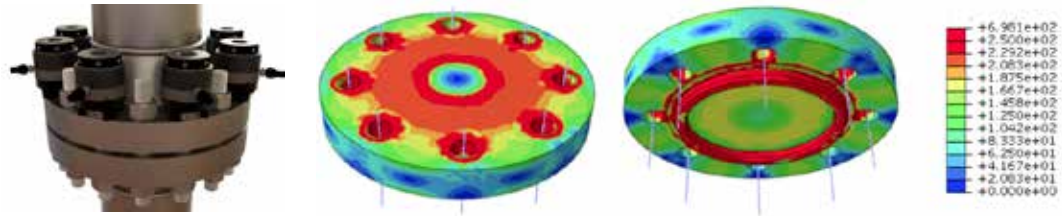
The challenge of this case study was to simulate and optimise the tightening of flanges. This required the development of a computer model for simulating the tightening process and a front-end application to control the simulations in order to improve the design of the tightening process. Given the complexity of the problem, HPC resources were needed to model the tightening process accurately.

Texas Controls
Spain



The Solution

A computer model was developed which represented all the functional parts of a flange including the gasket and the tightening bolts. This model was driven by a user interface, which enabled different tightening scenarios to be evaluated. The model was implemented using both open-source and proprietary simulation codes. Several sizes of case studies were run.



The Benefits

The industrial case addressed in Fortissimo, involving a flange with 24 large diameter bolts, exemplifies the real-world problems faced by Texas Controls during their normal business activities related to industrial projects. Such flanges are typically used, for example, in high-pressure heat exchangers used in various refinery processing units, such as “hydrocrackers” (a critical unit in terms of safety and performance).

Based on previous experience in the field (when no simulations were carried out), a non-optimised tightening of a 24 stud bolt flange took 108 man-hours while Texas Controls can reduce this type of process to 72 man-hours using simulation. In all this comprises a 33% time saving per flange. Whilst this represents considerable savings in labour costs, the most important outcome is the reduction in downtime of industrial installations such as refineries. Using advanced simulation a flange can be tightened in 18 hours as opposed to 27 without advanced simulation.

During the shut-down of a hydrocracker, the maintenance and tightening of such heat exchangers are included in the critical path of the shutdown and maintenance projects, so any delay in these operations has a major impact on the final completion date of the commissioning of the hydrocracker unit.

The cost of “down time” for a medium-sized hydrocracker is about €21k per hour ($500k per day). This means a saving to the end-user of ~€180k because the critical path is shortened to the same extent that the tightening process is optimized.

A further benefit of HPC-based simulation is that it allows technicians to avoid damage to flanges during the tightening which is not possible using the usual experience-based method. Again this can have very significant cost implications.

These benefits previously mentioned give to Texas Controls a significant competitive advantage for their current business activity: the increased differentiation from competitors and the enhanced standing in what is a highly technical industrial sector should result in the acquisition of more major, international commissioning contracts .This is expected to result in an increased revenue of €2 million in total over the next 3 years and a related increase in staff employed of around 15% (Texas Controls has a staff of 32 people).

Looking beyond the business challenge described above, Texas Controls has a range of services (including equipment and seal design, procedure definition linked to rental of tightening tools) where the use of the new cloud-based HPC tools have the potential to similarly enhance Texas Controls’ competitive advantage for project acquisition with both EPC (Engineering, procurement and construction) and Petrochemical companies.

Their work in addressing the challenges of the Texas Controls study has generated know-how and expertise for both of the other participants, AIMEN and CESGA, which they will use to enhance their consulting, service and training portfolios. AIMEN has demonstrated its ability to solve challenging industrial problems using large-scale numerical simulation based on open-source software and will offer new services to a number of target industries (including petrochemical, nuclear, heavy industries and shipbuilding). This will contribute to the expected 5% growth in annual income of AIMEN’s Calculation & Simulation unit over the next 2 years. The provision of support to industry, and SMEs in particular, in technology take-up is a strategic part of CESGA’s mission. The development of industrial HPC gateways and graphical user interfaces for industrial workflows will allow CESGA to increase the number of SMEs that it can support in the integration of HPC within its business processes. Indeed, CESGA expects to work with 15 such SMEs in 2015.

Participating Organisations

- Domain Expert: AIMEN
- End-user: Texas Controls
- HPC Centre and HPC expert: CESGA:

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HPC-Cloud-based design of high-voltage cables

The Company

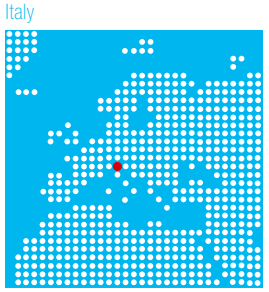
Prysmian Group is world leader in the development and supply of energy and telecom cables and associated systems. In the energy sector, Prysmian Group develops underground and submarine power transmission cables and systems, special cables for applications in many different industrial sectors and medium and low-voltage cables for the construction and infrastructure industry. In this case study, Prysmian is an end-user with a need to model the physical behaviour of high-voltage power-transmission cables.

Prysmian has a clear business requirement to scale-up its current simulations of energy cables and systems to a larger refinement and size. This exceeds the computing power available in-house. Furthermore, Prysmian would like to undertake more ambitious simulations, requiring new competence and tools. The demonstration of a successful, cost-effective cloud-based HPC simulation would represent a breakthrough for Prysmian.

The Challenge

Prysmian has used a standard third-party modelling package for several years as the main tool for its electromagnetic simulations using 2-D models running on a few high-end workstations. The challenge of this case study was to satisfy the need for new and finer simulations through the use of Cloud-based HPC 3-D simulations, together with an insight into how improved simulations could be exploited in a future business model. A further goal was to evaluate the potential of using open-source software in these simulations with a view to eliminating the need for expensive software licences.

Prysmian Group
Italy



The Solution

Both the third-party and open-source simulation packages have been ported to a Cloud-based HPC system. The resultant simulations have enabled Prysmian to improve the calculation of losses inside an energy cable, especially those induced by the magnetic field due to the load current. Prysmian is also able to model better the transfer of heat from the cable to the surrounding environment. This has improved Prysmian's design capability significantly. In particular, the 2-D simulations running on workstations have been replaced by much more realistic 3-D simulations running on the HPC system.

The need for Cloud-based HPC simulation is of the outmost importance in this case study. Cloud-based HPC modelling has enabled better, more detailed simulations to be made in a shorter time. Indeed running such simulations would not be feasible on a network of workstations.

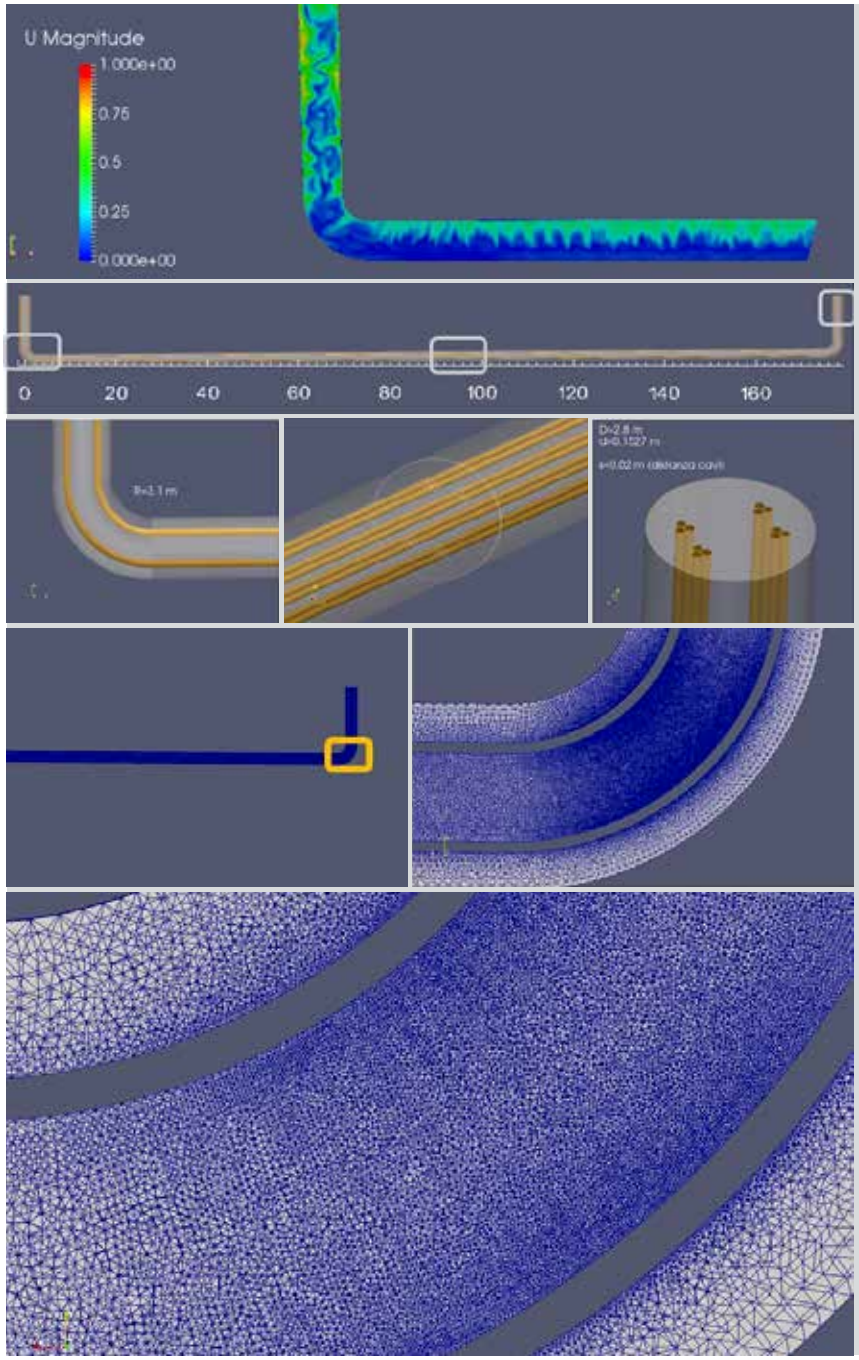
The Benefits

The business benefits from the use of a Cloud-based HPC system arise from several sources. The move from the previous 2-D model to an advanced 3-D model enables much better cables to be designed. This allows Prysmian to retain the competitive edge needed to remain market leader with a time to market independent of the increase in complexity of the design process. Previously Prysmian did not have the capability to run such advanced simulations.

Prysmian estimates that the use of a Cloud-based HPC system instead of investing in an in-house system can provide savings of around 30% per annum in costs for cycles alone. This is based on the costs of the cycles needed to run the simulations in the HPC-Cloud compared with the costs of a suitable HPC computer system which would cost €150K, amortised over 3 years with additional annual operational costs of €40K. Further savings were also identified through the use of expertise on-demand at the computer centre rather than through the employment of a member of staff with the necessary expertise in simulation.

Participating Organisations

- End-user: Prysmian
- HPC Expert and HPC Service Provider: CINECA



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HPC-Cloud-based urban planning

The Company

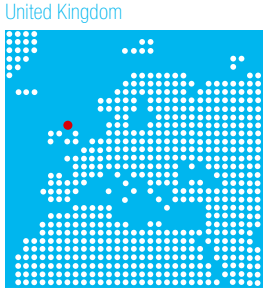
Founded in 1994, IES is an SME, based in Scotland and with offices around the globe. IES develops the world's leading integrated building-performance modelling software system. It has unparalleled experience in the application of advanced design tools to enhance building performance and create more sustainable buildings. IES provides leading-edge support for the design, construction and operation of some of the largest and most challenging buildings in the world. The IES, Virtual Environment (VE) is a suite of building performance-modelling tools based around a single integrated data model. The purpose of the VE is to provide the high-quality information required to design, build and operate better performing, more sustainable communities. It can be applied from the earliest stages of the design or through operational stages. The VE is used today by many of the world's leading architectural and engineering practices. In this case study, IES will take the role of end-user, application expert and ISV.

Based on its VE, IES has developed a planning tool for cities, which will enable relevant stakeholders to assess, for example, the energy efficiency of a city, quality of living etc. The tool can be used at any stage of a city's life, and can be used in cities only beginning the journey towards a 'Smart' City or those that are well on their way towards sustainable advancement and integration with 'Smart' Technologies. This interactive decision support tool can be used by all those involved in the design of buildings and cities.. This tool relies heavily on the availability of HPC cloud-based simulation because of the very large amounts of data associated with multiple buildings and their interaction within the urban context.

The Challenge

The challenge of this case study is to demonstrate the use of such a tool, which requires the performance of an HPC system because of the scale of the simulations being addressed. Previously this tool had been used for small-scale simulations running on a workstation. In this case study, the workstation will be used to visualise the outcomes of the simulations running on a Cloud-based HPC system. A major objective will be to enable VE desktop installations and web-based interfaces to access the calculation resources hosted on an HPC-cloud infrastructure.

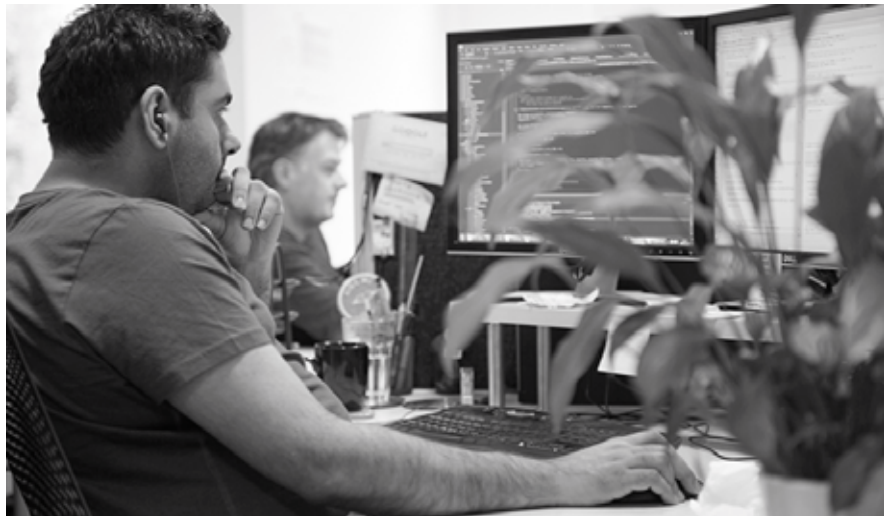
IES
United Kingdom



The Solution

IES has developed a tool, based on its VE, which addresses large simulations effectively and quickly through the use of Cloud-based HPC, but still uses a familiar workstation for the display of data.

This case study has proved to be very significant for IES. Traditionally, IES has worked primarily with simulating individual buildings. Running simulations from personal workstations or company servers were often long and tedious with the consultant having to wait for relevant results to be available. This case study has shown that it is possible to decrease significantly the run-time of simulations whilst substantially increasing the number of buildings in a simulation.



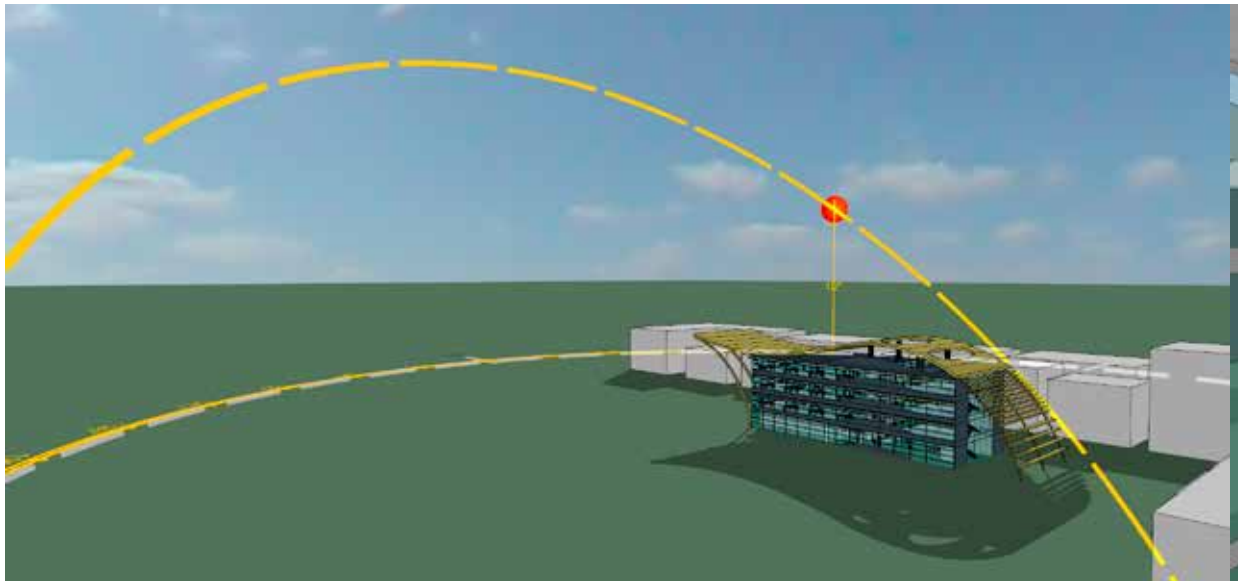
The Benefits

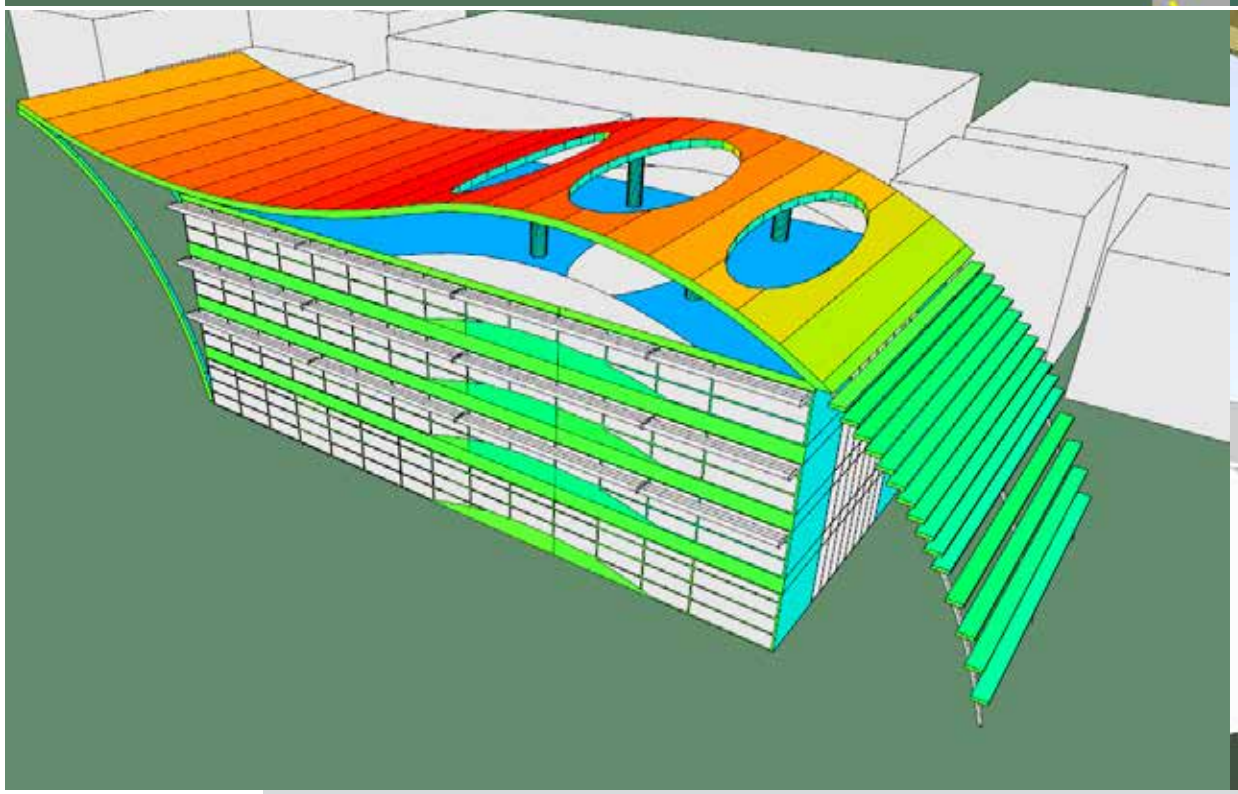
In this case study, model simulations ranging from the small to the very large were tested. Typical speedups (comparing the workstation to the HPC system) were between 5 and 10 times. The major benefit is that simulations taking unrealistically long compute times of days or weeks on the workstation could run in a few hours or days using the Cloud-based HPC system with clear commercial benefits. Indeed, based on the successful experiment, IES is now offering an HPC-based service to its customers. This service embodies a pay-as-you-go approach which is underpinned by HPC-systems available from EPCC, the HPC centre of the University of Edinburgh.

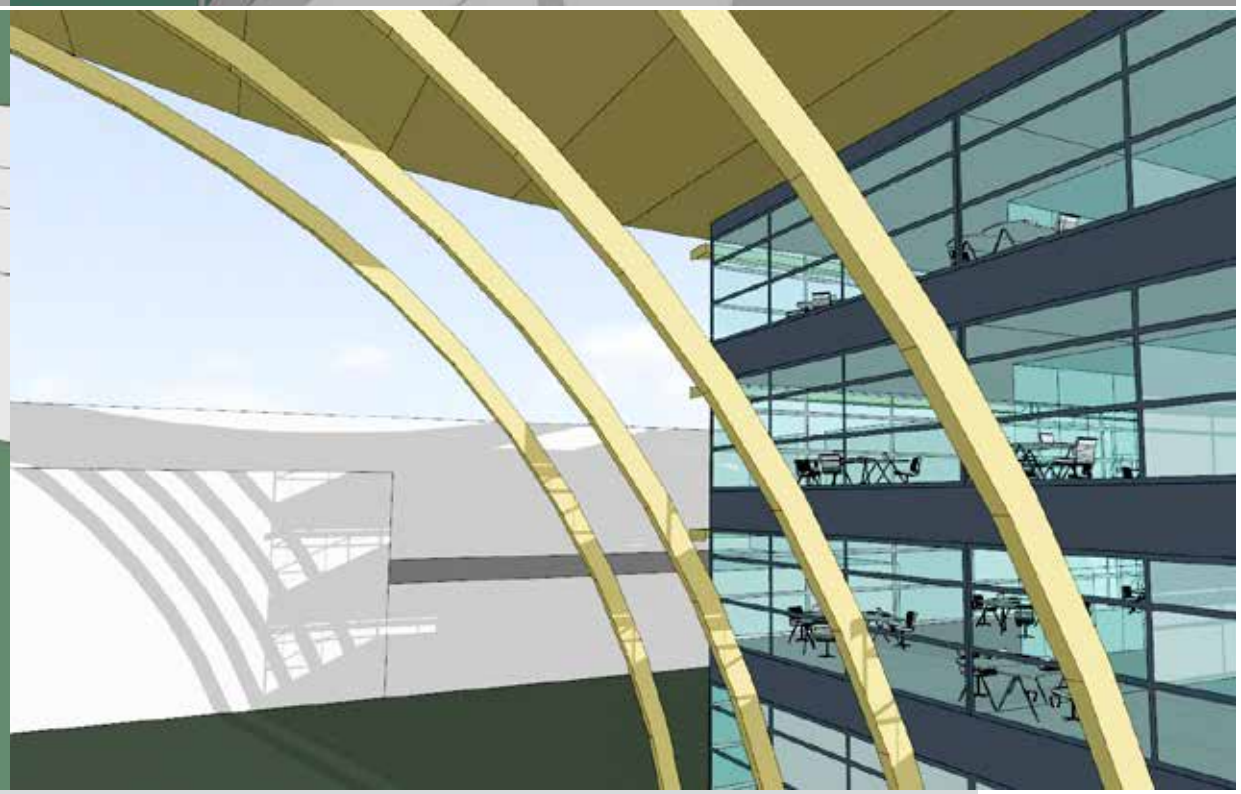
A 64-core in-house system costing £33k would have an annual running cost of around £22k (support, maintenance, electricity, housing, etc.). Amortised over three years, this gives a total cost per core hour of £0.10, compared with a cost of £0.05 for Cloud-based HPC cycles. Of course the in-house system would never be used continuously and so would be even less competitively priced than this calculation indicates.

Participating Organisations

- End-user, Application Expert and ISV: IES
- HPC Provider and HPC Expert: EPCC







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HPC-Cloud-based optimisation of aircraft wiring

The Company

KEW, an SME founded in 2008, specialises in the optimisation of engineering-intensive projects in the manufacturing industry. In many companies with multidisciplinary development processes, unnecessary time, money and energy are wasted on activities that can easily be structured and automated. In particular KEW is active in the aerospace sector and has developed an application to optimise the routing of wiring within an aeroplane. This is an important issue in the design of aircraft which traditionally has been addressed by trial and error. Although this problem can be tackled using computer models, applications to do this are very computationally intensive. SMEs generally do not have the available resources to buy and maintain, in house, the large computer systems needed to perform the necessary optimisations. Neither do they have the required expertise to use such systems.

The Challenge

The challenge addressed by this case study was to adapt a wiring optimisation application from KEW to run on a Cloud-based HPC system, so that wiring layouts could be optimised in a feasible length of time and at an acceptable cost. Such a solution would involve computationally intensive simulations that could be run on a pay-per use basis, which would be much cheaper than owning and maintaining a large system and would offer sufficient resources to satisfy peak demands.

The Solution

The solution has involved porting the KEW optimization software to run on an HPC system and developing the necessary "glue" software to bring all the necessary software components together taking account of any software licensing issues. The successful implementation of this solution has enabled typical optimisations to be run on an HPC system much more quickly and effectively. It should be noted that this case study was the first time that KEW had used HPC in its wiring optimization.

KE-Works
Netherlands

The Benefits

The business benefits for electrical wiring companies are a reduction of about 90% in the lead-time for a single (non-recurring) electrical design of an Electrical Wiring and Interconnection System and a reduction of computational costs of about 8 to10 times by using Cloud-based HPC instead of in-house resources. A typical simulation has compute costs of around €1,400 It should be borne in mind that a single, optimised, wiring design may be used in hundreds of aircraft and so the impact of a single simulation may be very significant. It should also be noted that there is a significant trend in the aerospace industry for the greater use of wiring in modern aircraft.

By using more advanced simulations, KEW expects to improve both the quality of its designs and an expected reduction in costs of 2.5% per design. This case study showed that an advanced wiring optimisation application would run 20 times faster on an HPC system compared to the current sub-optimal simulation running on a workstation. Comparing the current sub-optimal process with the automated, optimised process running on a Cloud-based HPC system shows a 2.5% reduction in cost and weight of the wiring system. This is a recurring benefit for hundreds of aircraft that are produced over several decades. In the aerospace industry, a 2.5% saving in costs may increase profit margins by 50%. Furthermore, saving one kg in weight of the wiring in an aircraft may enable a 20 kg reduction in overall aircraft weight with consequent reductions in fuel consumption over the 30 to 50 years of aircraft life. These results are of significant economic relevance.

The Business Case

The cost of computation on a Cloud-based HPC system is about €660 for a single design run, In contrast, the annual cost of an in-house HPC system is about €61K. Because of the limited number of design runs per year, having an in-house HPC facility is much more expensive than using cloud HPC. Furthermore, a Cloud-based HPC system is much more flexible in terms of the number of processors which can be applied to a particular optimisation, if more computational power is required. This demonstrates the feasibility and cost-effectiveness of using Cloud-based HPC for engineering simulations. It also demonstrates that SMEs are able to compete with larger organisations in the use of HPC, because the cost barrier of advanced simulation has been eliminated.

Organisations Involved

- End-user: KEW
- Domain Expert: NOESIS
- HPC Expert: SCAI
- HPC Centre: GOMPUTE

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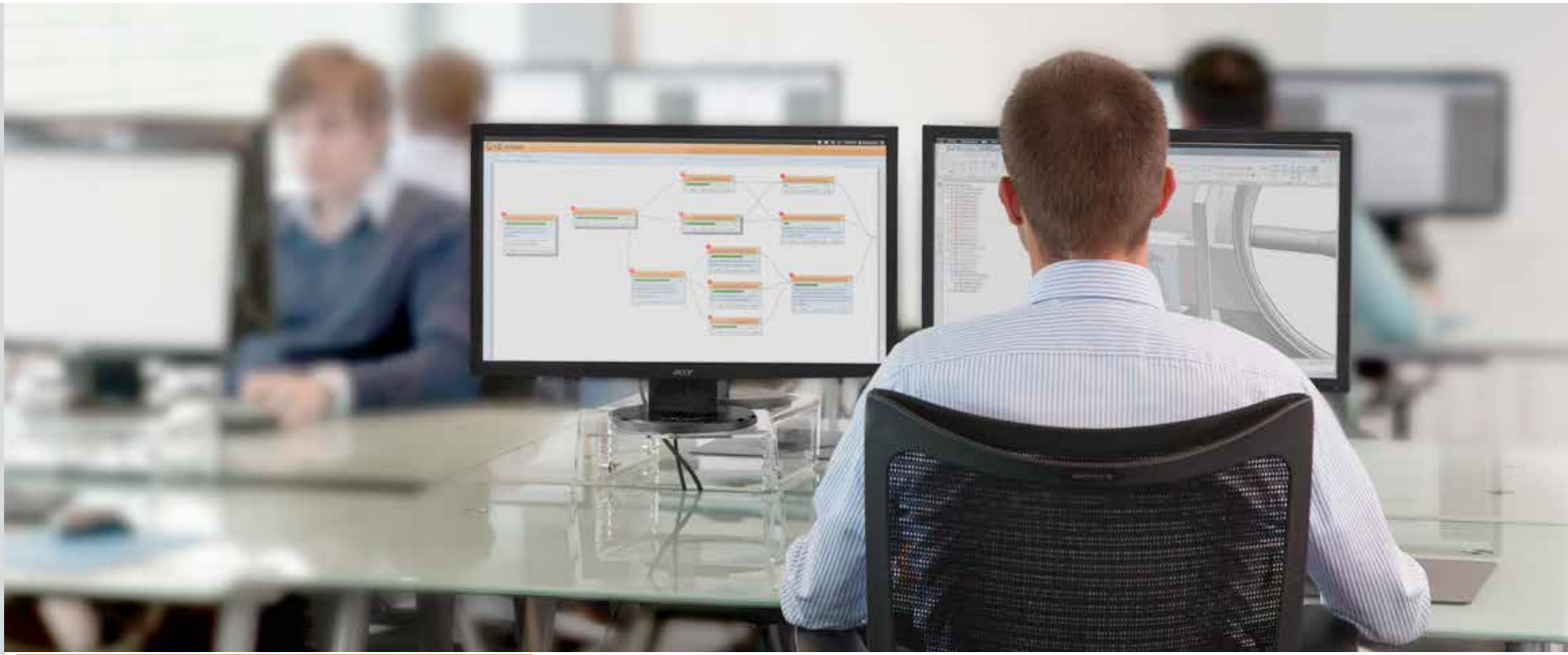

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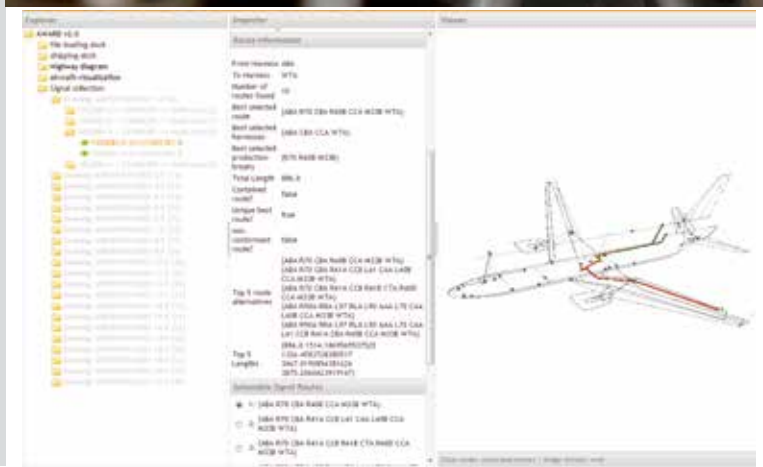
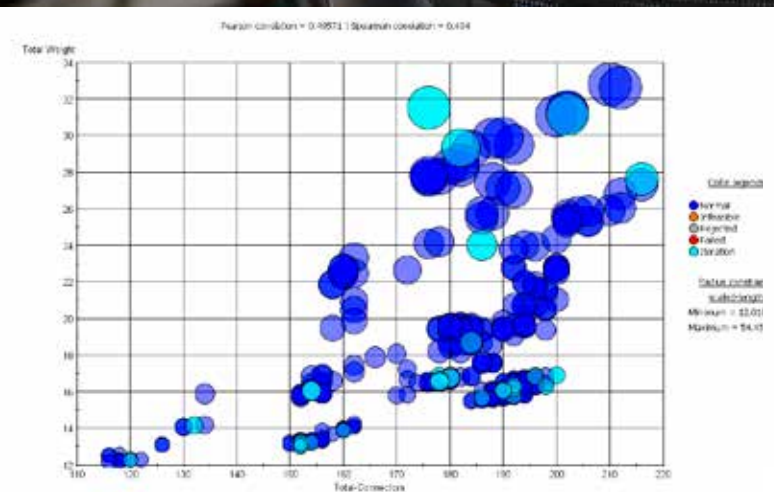
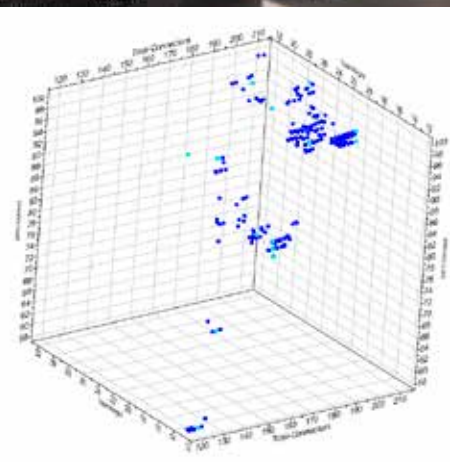






HPC-Cloud-based prediction of air quality

The Company

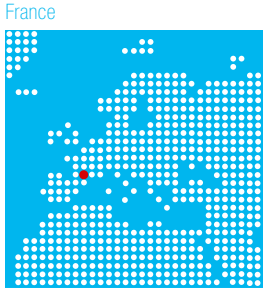
Numtech is a French SME specialised in air-quality and meteorological simulations, for which it has developed and uses effective and innovative digital tools. Numtech currently has 19 employees and is the market leader in France for modelling the weather and atmospheric dispersion. Its customers are mainly large companies such as TOTAL, EDF, Suez Environment, Rhodia-Solvay and Michelin, local and regional authorities and research institutes such as CEA, INERIS, InVS and DGA. Numtech makes substantial use of the ADMS code from CERC in its day-to-day business.

European regulations on the protection of air-quality require more and more the testing and evaluation of adaptation and reduction scenarios. From the traditional evaluation of 2 to 3 scenarios, consulting companies and regional air-quality agencies are now facing the need to evaluate tens of scenarios. This requires a large increase in their capacity for computing beyond what they can easily manage with in-house resources.

The Challenge

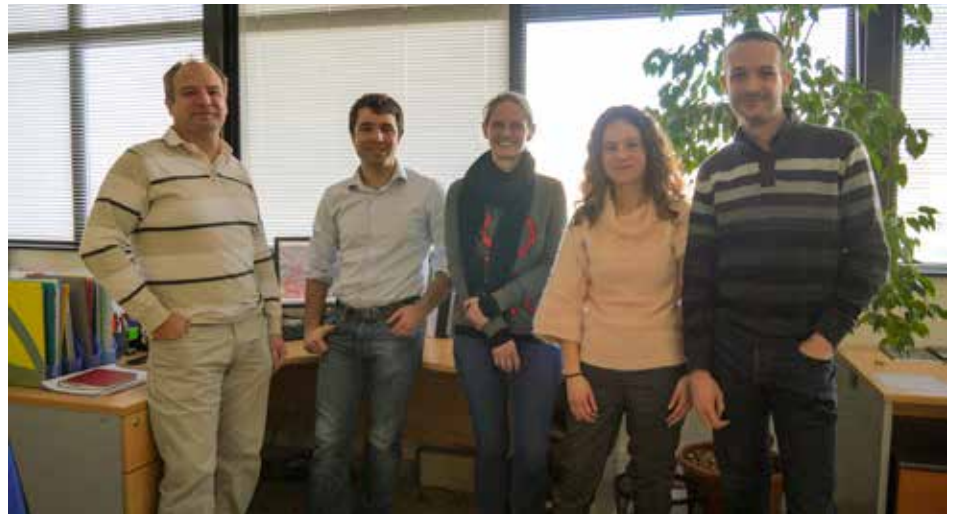
The challenge of this case study was to demonstrate the use of Cloud-based-HPC services to investigate air-quality at the scale of cities. This case study used the ADMS-Urban software from CERC running on the Extreme Factory HPC offering from BULL. The possibility of running urban air-quality simulations using Cloud-based HPC would help to increase the numbers of scenarios which could be feasibly simulated in a given time. This is required to quantify statistical uncertainties associated with the simulations. Using an HPC system would also reduce the computational time needed for such simulations. The outcome of using such a system includes shorter times for simulations with resultant competitive advantage and the cost reduction of using pay-per use resources rather than owning and maintaining an expensive in-house system which may only be used on a part-time basis.

Numtech
France



The Solution

ADMS-Urban has been adapted to run on a Cloud-based HPC system. The results of the simulations were then made available via a familiar workstation environment. In doing this, an evaluation of the viability of this service on commercial HPC clouds has been carried out and possible business models for such a service have been proposed.



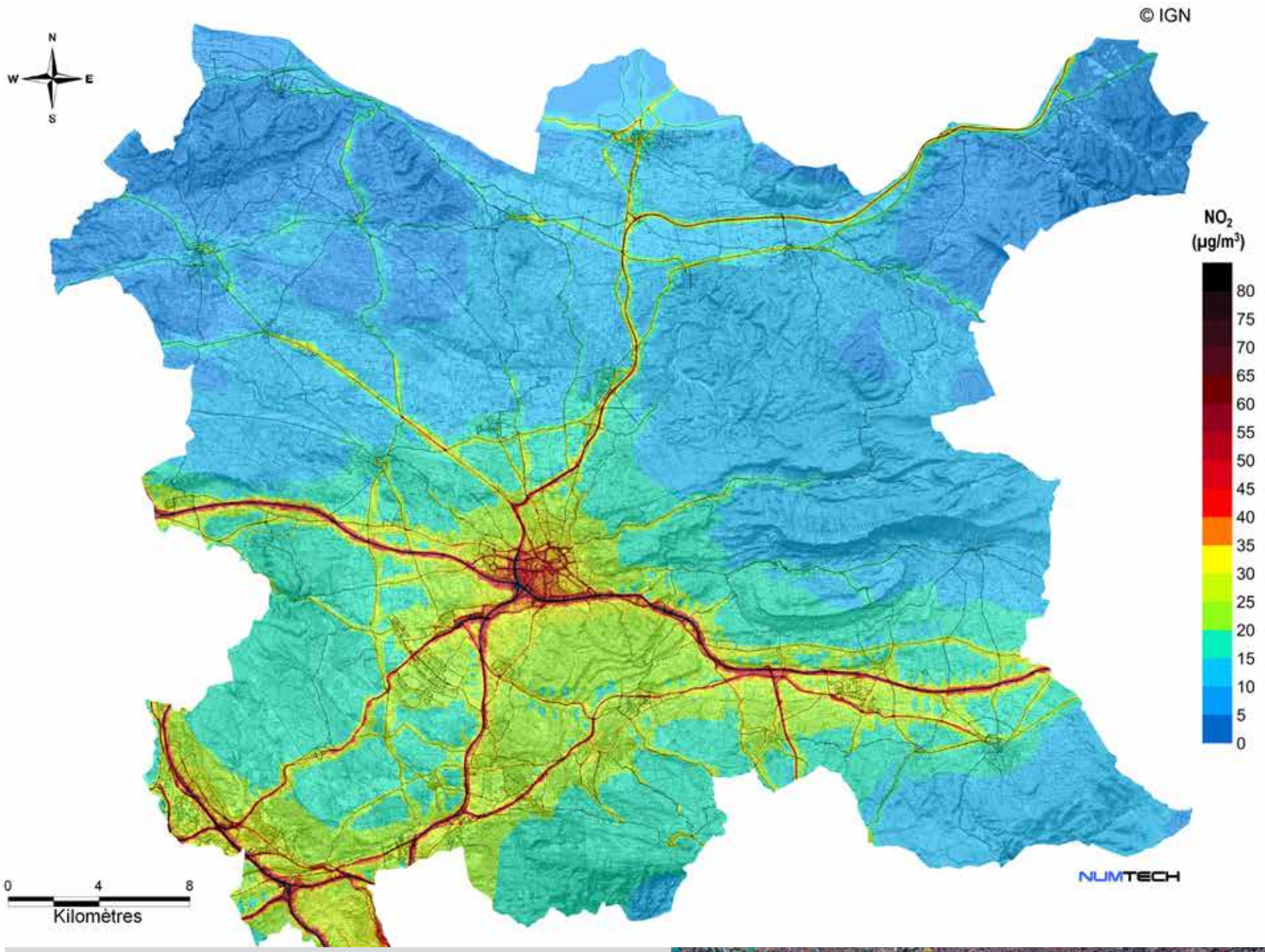
The Benefits

CERC can now offer the ADMS-Urban software as a cloud service, on a pay-for-use basis rather than requiring a customer to purchase an annual licence and install and run the software locally on workstations. This allows for an attractive pricing option for customers needing an infrequent use of the model.

To offer a simulation service, CERC needs to source computer cycles. Either it needs to own and maintain a sufficiently powerful HPC system or it needs to buy cycles on demand from an HPC centre. In the former case, a powerful enough in-house server would need to be purchased. This case study has shown that if the average percentage of use of an internal server falls below 40%, a pay-on-demand cloud service becomes economically viable compared with the costs to acquire and maintain that server. Clearly this depends on the mode of use, but the possibility to buy cycles on demand offers considerable flexibility to SMEs looking to set up a service.

Participating Organisations

- End-user: Numtech
- Software and Domain Expert: CERC
- HPC Provider and HPC Expert: Bull



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HPC-Cloud-based reduction of vehicle emissions

The Company

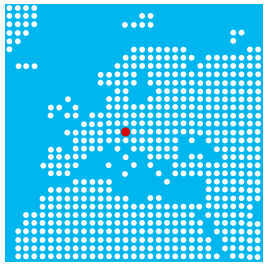
AVL is the world's largest independent company in the development of powertrain systems for internal combustion engines and associated instrumentation and test systems. From diesel engines to electric drives, from alternative fuels to control software, from transmissions to batteries, AVL has been working in partnership with companies all over the world for more than 60 years. AVL tackles the development of highly creative, mature and application-specific solutions for its customers in order to meet their market challenges.

The need for CO2 reduction, the increasing complexity of new powertrain systems, and a requirement to achieve the highest possible level of process efficiency are some of the key challenges facing the automotive industry now and for the foreseeable future. AVL provides its customers, many of which are SMEs, with a set of comprehensive simulation tools in a flexible and open environment enabling multi-disciplinary solutions as an integral part of the powertrain development process. AVL's powerful simulation platforms, based on its engineering expertise, focus on application-oriented solutions. Fully validated state-of-the-art physical models embedded in application specific simulations enable virtual prototyping at the component and system level for the most effective combination of simulation, design and testing.

The Challenge

The majority of projects in the area of vehicle optimization involve studies with large-scale variations in parameter and components on a limited palette of base vehicle models. These studies require high levels of CPU cycles on-demand. Not only SMEs, but even larger companies, struggle to provide sufficient computational resources necessary to accomplish optimization tasks in an acceptable time-frame. This case study addresses the use of on-demand, Cloud-based HPC resources to tackle the important requirement for the reduction of CO2 emissions in the design of vehicles.

AVL
Austria



The Solution

The outcome of this case study has been to demonstrate the viability of on-demand computing resources in the design of powertrains with specific emphasis on the reduction of CO2 emissions. This solution involves the running of AVLs simulation codes on a Cloud-based HPC system where computer resources are made available on-demand.

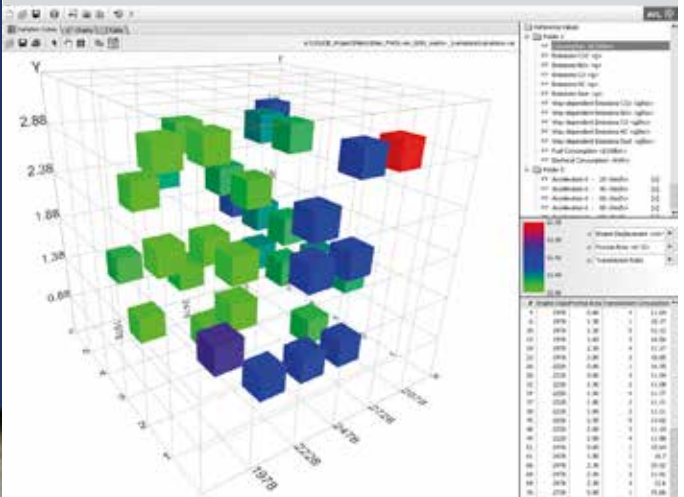
The Benefits

The most clear cost benefit of using HPC-cloud resources is the possibility to lease a powerful computing cluster for single projects instead of acquiring and maintaining computational resources which would be underutilized for most of the time, and probably even not sufficient when really needed. Using a Cloud-based solution, taking into account all additional cloud overheads, short-term projects running millions of simulations on 400 cloud CPU cores for a period of a couple of weeks, several times a year, would run with costs reduced by up to 90% when compared to the total cost of ownership of a dedicated in-house system. This is the cost range where it becomes attractive for SMEs to participate in projects which require high CPU power for only a short time.

Participating Organisations

- End-user and Code Owner: AVL
- HPC Centre and HPC Expert: University of Stuttgart

The outcome of this case study has been to demonstrate the viability of on-demand computing resources in the design of powerchains with specific emphasis on the reduction of CO2 emissions.



HPC-Cloud-based simulation of hazardous chemicals

The Company

Founded in 1897 in Switzerland, Lonza is one of the world's leading and most trusted suppliers to the Pharma&Biotech and Specialty Ingredients markets. Lonza's products and services range from active pharmaceutical ingredients and stem-cell therapies to drinking water sanitizers, from industrial preservatives to microbial control solutions that combat dangerous viruses, bacteria and other pathogens, from the manufacture of vitamin B compounds and organic personal care ingredients to agricultural services and products. In particular, Lonza utilizes distillation columns, whose operation requires a detailed knowledge of the thermodynamic properties of the target compounds.

Nowadays, powerful predictive methods, using computer-based simulations, exist that calculate the thermophysical properties of compounds. These can form the basis for the design and optimization of chemical engineering processes. Nevertheless, the chemical industry typically measures the required data experimentally. However, if they are needed for hazardous substances (explosive, toxic or mutagenic), the associated costs of physical testing may be prohibitive. In such cases, computer-based simulations are a very attractive alternative. To carry out such simulations, a large number of model runs are necessary requiring a very powerful computer. Previously, Lonza had determined the physical properties of compounds experimentally. The objective of this case study was to evaluate the use of HPC-based simulation in the determination of such physical properties.

The Challenge

The challenge of this case study was to take an existing third-party code for the determination of the physical properties of compounds, port it to an HPC-system and to demonstrate the accuracy and cost-effectiveness of such an approach. An accurate calculation of thermodynamic properties at a given state point currently requires around 20 hours on a computer with 16 processing cores. In order to acquire enough data to determine the full set of physical properties, around 200 state points need to be evaluated. This means that even with exclusive access to small compute cluster, the calculation would take up to 4000 hours (close to six months). Access to an HPC system through a Cloud-based approach would therefore be very attractive because it would enable simulations to be made in a reasonable length of time.

The expertise and experience of Lonza, an HPC-Centre and the code owner were combined to tackle this challenge.

Lonza
Switzerland

The Solution

A detailed molecular-simulation code has been implemented on an HPC system driven by a simple, web-based user interface. Multiple simulations of state points can be initiated through this interface enabling the complete thermodynamic properties of a compound to be determined in a reasonable length of time. For example, whilst the calculation of a complete set of physical properties would take ~6 months on a 16-core cluster, the calculation time can be reduced to below 20 hours on an HPC system.

The Benefits

Lonza is a company which manufactures various chemical intermediates requiring detailed knowledge of the thermodynamic properties of target compunds, starting materials and side products. The use of simulation can bring massive savings to Lonza's production process. There are clearly benefits to the design process in being able to determine the complete thermodynamic properties of a compound in a much shorter time. It is also clear that the cost of cycles is much less than that of owning and maintaining a large HPC system in-house

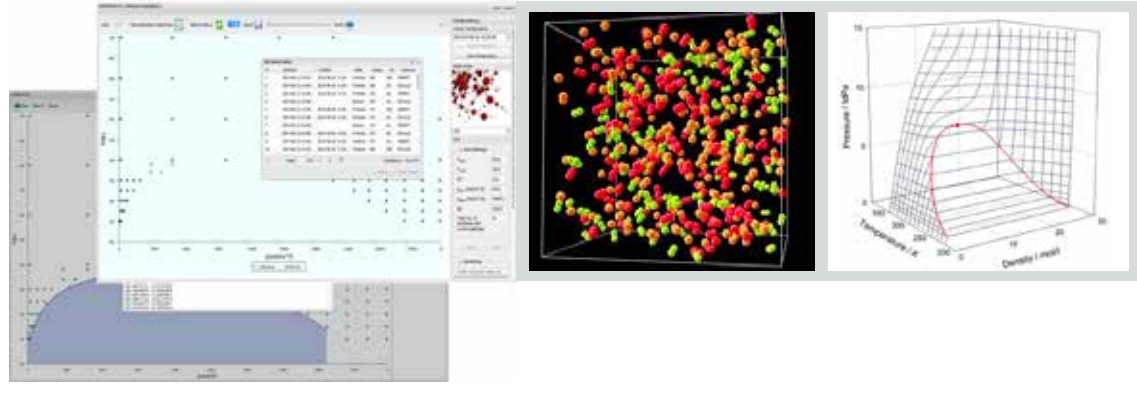
Experimentally determined pure component densities cost around 2,700 € per substance for a very limited temperature and pressure range, when bought from an external supplier. Compared to that, 60 molecular simulations carried out in the entire fluid region up to arbitrary high pressures will cost around €1,600 yielding not just the density but every static thermodynamic property simultaneously.

For mixtures of compounds, the difference in costs is more extreme. 60 experimentally measured gas solubility data points of a binary mixture can cost up to €50,000, while the cost for the molecular simulation usually increases by a factor of two compared to a pure component to €3,200. It should be noted that the prices for the experimental data gathered by physical measurements only apply to moderate conditions and non-hazardous substances. Such measurements at high temperatures or pressures can be much more expensive or even impossible to conduct.

For the design of a distillation column costing €1.5 million, the following cost calculation can be made: A given system requiring €100,000 to obtain all required physical properties through experimental measurements (corresponding to 100 staff days at €1,000), would be expected to be developed by calculating the same physical properties by rigorous modelling, which would cost only approximately €13,600. This value was estimated according to a physical case study (computer cycles €6,400, 4 staff days at €550 and 5 staff days at €1,000). The overall saving in the design process would add up to approximately €86,400. Clearly HPC-based simulation has considerable benefits for Lonza. It should be noted that Lonza usually designs more than 5 distillation processes per year.

Organisations Involved

- End-user: Lonza
- Domain Expert: University of Paderborn
- HPC Centre and HPC Expert: University of Stuttgart



HPC-Cloud-based design of copper-alloy moulds

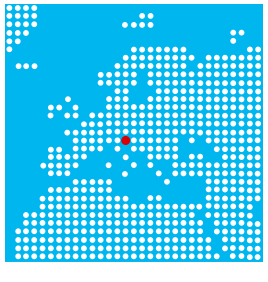
The Company

Founded in 1959, IMR is an SME which designs and manufactures foundry equipment for brass alloys and bronze. The company also offers its customers dedicated consulting services for the design of moulds and other manufacturing processes. In 80% of cases, IMR's equipment is used for the production of taps and valves and 20% for other high-performance artefacts. The moulds mounted on the installation are filled by injecting the liquid metal at temperatures of about 1,000°C. The inside of the moulds for casting comprises preformed cores in sand.
The success of the entire process depends on the quality of the piece obtained. Therefore, it is essential to design the moulds and the casting channels so as to obtain a laminar flow of the liquid metal and a constant cooling gradient throughout the final piece in order to avoid cracks and defects. Currently, the design of moulds and filling channels depends on the experience of mould makers in collaboration with experts from the foundry. Generally, the exchange of experience produces good results, but often it is necessary to modify the mould several times and repeat tests before committing to production.
There are several commercial packages for the simulation of casting processes. However, apart from very recent industrial results on some specific copper alloys, simulation has not been widely used in this sector.

The Challenge

In the past, IMR has tried to conduct simulations with commercial software, but never with HPC. However, it wanted to investigate how these could improve the time to market and productivity. There were no success stories reported for such simulations in this sector. Furthermore the costs of dedicated casting software and the necessary hardware and the training required for its use are excessive for a SME like IMR whose normal activities do not require such an investment. The challenge of this case study was therefore to demonstrate the benefits of HPC-based simulation to IMR.

IMR
Italy



The Solution

A computer model to simulate the flow of copper alloys was developed based on an open-source software package. This model produces a reliable simulation of the filling of a mould by the molten copper alloy at low pressure. It keeps track of both the filling velocity and the thermal exchange between the mould and liquid metal. The simulation results have been validated by comparison with physical tests. Running the simulation on a desktop system took an unacceptably long time of over a day, which is not consistent with an efficient design process. Using a Cloud-based HPC system, the time for a simulation could be reduced to 3 hours, which is an acceptable time frame. Before this case study IMR had only used limited simulations. This case study was their first experience of advanced simulation using an HPC Cloud.

The Benefits

The use of HPC-based simulation reduces the number of changes to the mould prototype during its design. The simulation using HPC reduces by 20% the time for development of the mould and saves 20% of the cost of testing, before mass production can begin.
The average cost for the design and testing of a set of moulds for a new product based on the traditional, empirical method, is currently about €41,000. The use of a Cloud-based HPC simulation, including all costs, such as set-up times and computing costs, saves about € 8,000 per set and 3 weeks of testing and modifications. IMR has about 8 sets of moulds per year to develop, so this represents a total annual saving of €64,000, not taking into account the benefits of a shorter time to market. Furthermore these simulations create the opportunity for IMR to offer its customers a new, HPC-based design service.

Participating Organisations

- End-user: IMR
- HPC Provider and HPC Expert: Arctur

The challenge of this case study was therefore to demonstrate the benefits of simulation, in order to support the business decisions of the SME.

A computer model to simulate the flow of copper alloys was developed based on an open-source software package. This model produces a reliable simulation, in a simple geometry, of the filling of a mould by the molten copper alloy at low pressure that keeps track of both the filling velocity and the thermal exchange between the mould and liquid metal.

HPC-Cloud-based simulation of sports-car aerodynamics

The Company

Koenigsegg is an SME based in Sweden. It was established in 1994 and is a leading designer and manufacturer of high-performance sports cars. In order to develop its product line, Koenigsegg needs to understand how air flows over its cars. There are two ways of doing this: the first is a wind tunnel test of a physical body and the second is to simulate the flow of air in a computer using Computational Fluid Dynamics (CFD). Although both methods have pros and cons, the standard practice for companies in the automobile industry is to use both alternately. Computational simulations are often used throughout the whole design phase, whereas wind tunnel tests are used only at certain phases of the design, since they are considered to be much more expensive from the cost and time point of view.

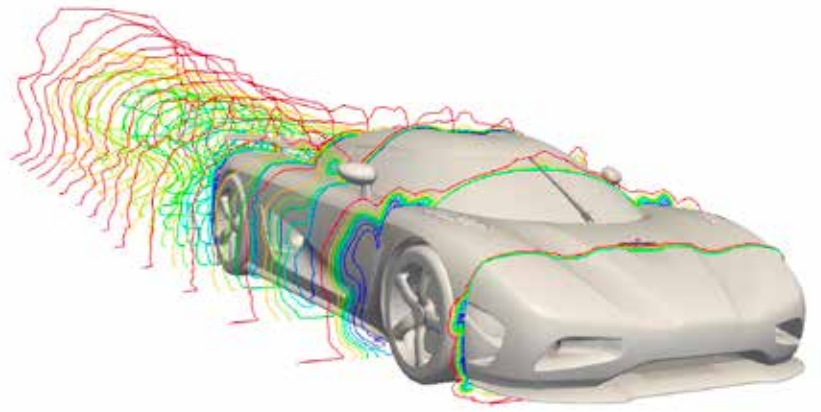
In the development of high-performance cars, intensive CFD simulations are carried out in order to reduce the cost of wind tunnel testing. Models used to replicate real-life cars with high accuracy, consisting of every geometric detail such as rotating wheels and integrated components (including heat exchangers, fans and condensers) can be very large and complex. In simulating such large models, the use of HPC can make a significant difference. Past experience has shown that the full aerodynamic design of a hypercar can be almost entirely conducted using CFD with minimal road and wind tunnel testing. However, in a production environment tight deadlines must be met, placing an emphasis on the use of significant HPC resources.

This case study was the first time that Koenigsegg had used HPC in the design of a hypercar, the One:1.

The Challenge

The challenge facing Koenigsegg was to perform simulations of the flow over its hypercars which were sufficiently detailed to model real physical effects accurately. Such simulations require suitable simulation software and expensive computer resources, which are normally beyond the means of an SME. However, the use of Cloud-based HPC offers the possibility of running such simulations on a pay-per-use basis, which is financially viable for an SME. The challenge was therefore to demonstrate the feasibility of using cloud-based HPC resources, the porting of a suitable simulation code to such resources and the cost-effective outcomes of the simulations.

Koenigsegg
Sweden



The Solution

The use of ICON simulation software on a Cloud-based-HPC system has enabled Koenigsegg to reduce or even, in some circumstances, avoid wind tunnel testing. Accessing powerful computing resources remotely also reduces hardware expenses and maintenance costs. Before the start of this case study, Koenigsegg had only limited computer resources available in-house and little or no experience in HPC-based CFD. In this case study, 100% of the aerodynamic development of the Koenigsegg One:1 has been conducted using HPC-based CFD simulations. In less than eight months, hundreds of simulations to test various configurations have been carried out. The results were an impressive 250% increase in down-force with only a 15% increase in drag at 250km/h and with a 50% higher down-force at 440km/h, the vehicle's maximum speed.

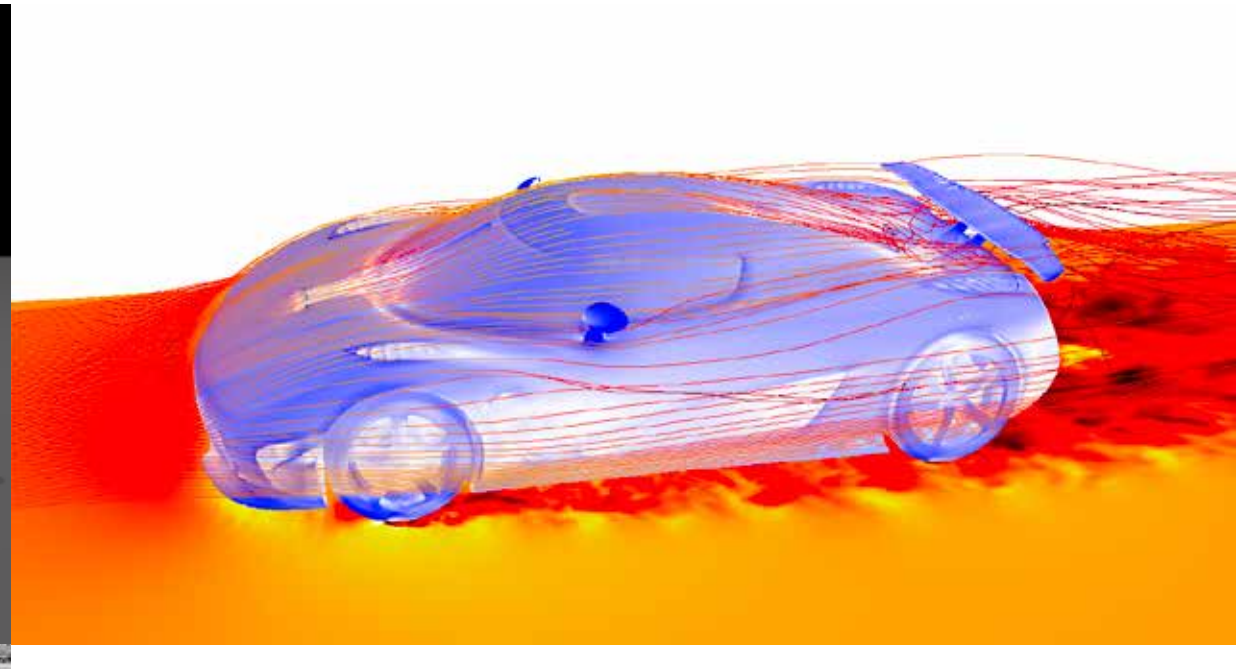
The Benefits

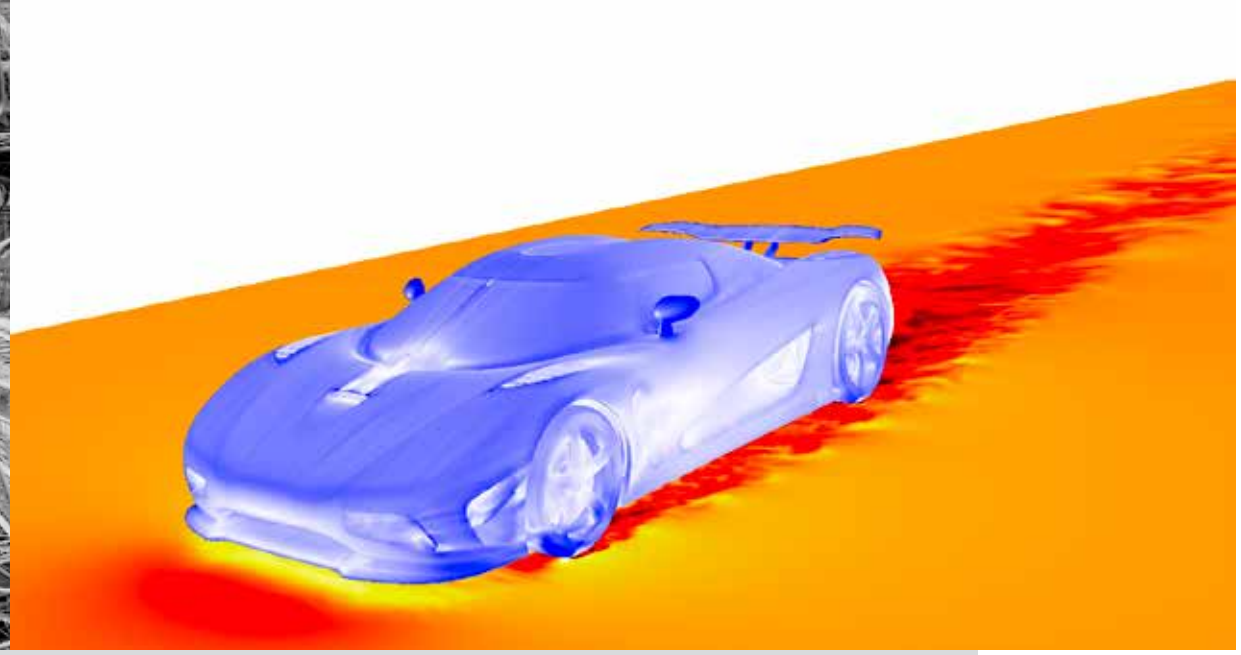
Tests have shown that the use of HPC-based simulation supported by external software and expertise led to a return on investment in less than three months for the production of a new car configuration. Significant costs can be saved and transferred to other critical parts of the development and production process.

The benefits obtainable by the use of the Fortissimo HPC-Cloud can be quantified as a 5% saving in operational costs, a 30% saving in design costs, a reduction of 50% in wind tunnel and physical testing, a 60% saving in prototyping costs, and a 30% shortening of the time to market. Furthermore, savings in development were about €90K per year on the design process, corresponding to a 1.5% reduction in overall development costs. These calculations take account of a computing cost on the Cloud-based HPC system of around €100K.

Companies Involved

- End User: Koenigsegg
- ISV: ICON
- HPC Expert: NTUA
- HPC Provider: CINECA





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Such simulations require suitable simulation codes and expensive computer resources, which are normally beyond the means of an SME.

HPC-Cloud-based design of centrifugal pumps

The Company

Founded in 1984, EnginSoft is a consulting SME operating in the field of computer-aided engineering, virtual prototyping and advanced simulation, including computational mechanics and fluid dynamics, numerical crash testing, and environmental engineering. EnginSoft has around 160 employees, 6 sites in Italy and 5 branch offices in Europe. In this case study, Enginsoft addressed the design of centrifugal pumps using advanced HPC-based simulation.

Centrifugal pumps are widely used in many industrial applications, from oil&gas to water treatment, automotive and home appliances. Such devices may be required to operate over a wide flow range and the prediction of operating characteristic curves is essential for a designer. Numerical simulation has become an important and common tool for pump designers. Many tasks can be solved much faster and cheaper numerically than by means of experiments and, most important, the complex internal flows in water pump impellers can be predicted well.

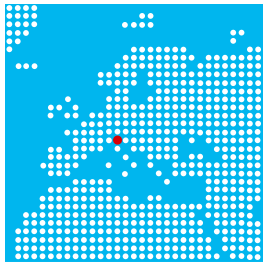
The Challenge

The numerical simulation of centrifugal pumps is not easy due to a number of challenges: complex geometries, unsteady flows, turbulence, secondary flows, flow separation, boundary layers and so on. These aspects require a high-fidelity CFD model, very fine computational grids and the analysis of transient flows. This approach is quite prohibitive for a typical SME which has neither the technical expertise nor the computing resources to carry out such a simulation. The challenge is to demonstrate an attractive solution in terms of cost, effectiveness and relevance for those SMEs which do not have the resources to perform the necessary simulations on their own.

The Solution

A simulation model has been implemented for a centrifugal pump using a commercially available software package. This model has been developed to run on a Cloud-based HPC system. Through a series of experimental runs the benefits of simulation using Cloud-based HPC system have been demonstrated.

EnginSoft
Italy

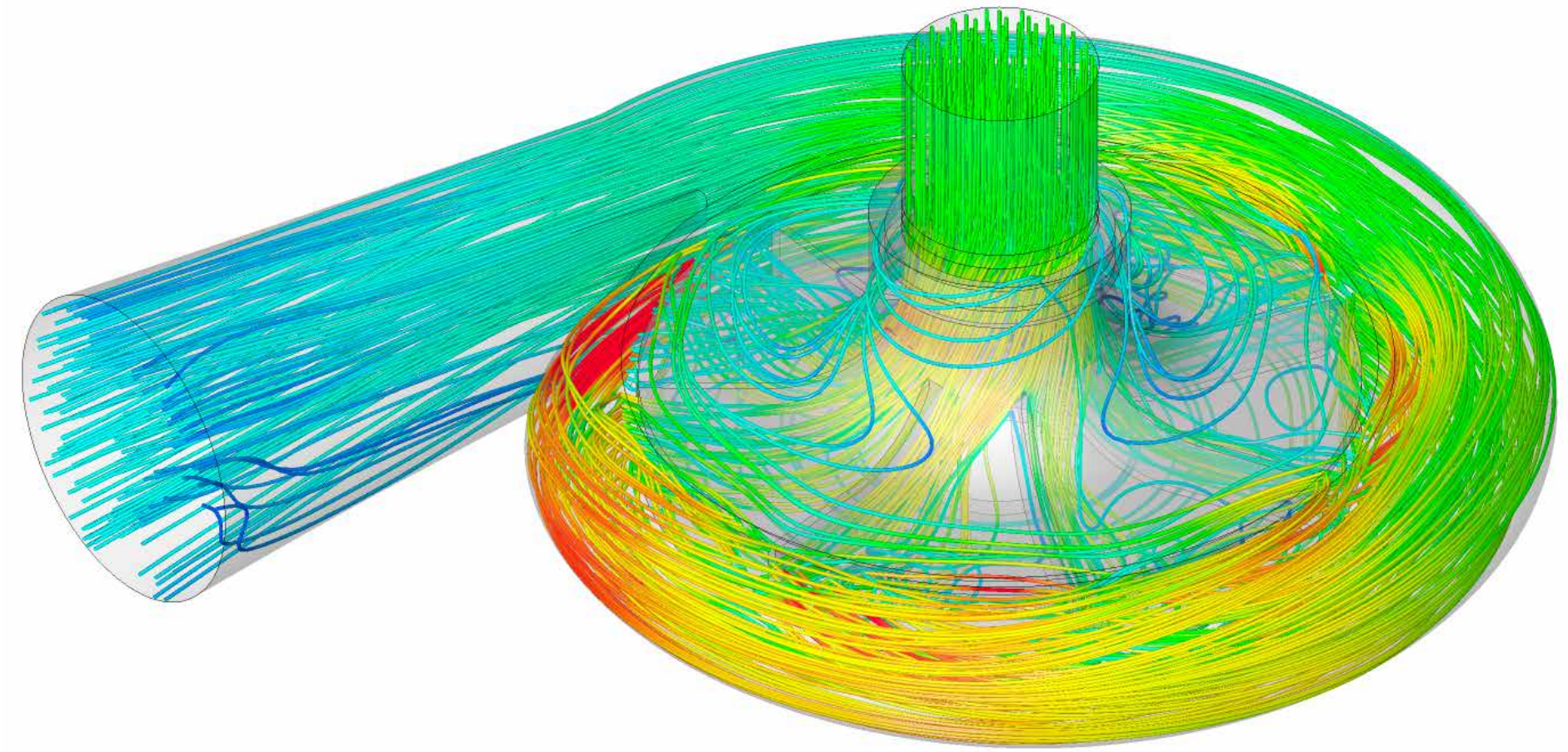


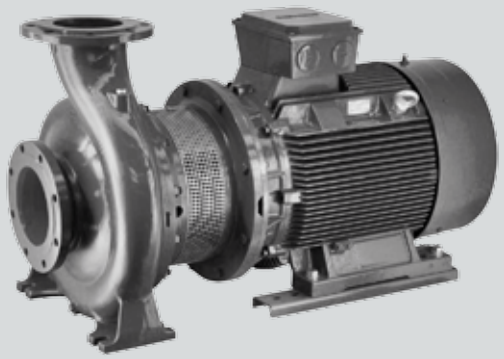
The Benefits

The test runs have shown that the use of HPC-based simulation using a Cloud and external expertise results in a return on investment in less than six months. That is the design and optimisation of a single pump can be completed in 6 months rather than in the usual 2 to 3 years. This improved design process using simulations can give Enginsoft a significant commercial advantage. Due to this improvement in the design process, Enginsoft expects to increase its market share by at least 1% with a resultant profit of €100,000 per year.

Participating Organisations

- End-user: Enginsoft
- HPC Centre and HPC Expert: CINECA





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HPC-Cloud-based simulation of drifting snow

The Company

Founded in 2005, Binkz is an SME whose business is consultancy, specialising in single and multiphase flows. Binkz provides state-of-the-art consultancy services using computational fluid dynamics (CFD) for applications such as wind engineering, process technology and aircraft icing.

Every year, roof collapses due to accumulated and drifting snow are responsible for losses of hundreds of millions of Euros as well as bodily injuries and loss of life. This is a problem for all countries in Northern Europe and more generally in the Northern hemisphere. The maximum snow load that may be accumulated on a building rooftop is an essential parameter in assessing the safety and stability of a building. It is, however, hard to predict the maximum snow load when designing a new building. This leads to a costly over-design of the structure, which could be avoided if the snow load could be predicted with sufficient accuracy.
Binkz has developed the CFD program snowFoam. This program allows an accurate assessment of snow loads on buildings. When compared to existing alternatives, snowFoam is more accurate, more reliable and more versatile, but it requires the computational resources that only an HPC system can provide.

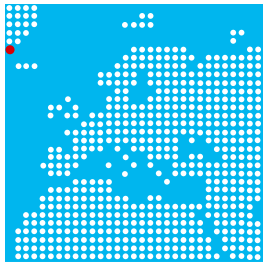
The Challenge

The overall challenge was to study the commercial feasibility of a CFD consultation service to civil engineering firms for assessing snow loads on buildings employing snowFoam on the Fortissimo HPC-cloud infrastructure. For the viability of such a consultancy service, it is essential that both the simulation time and the cost of the computation are acceptable within the framework of a typical CFD consultation project.

The Solution

The work in this case study has shown that the simulation of drifting snow using snowFoam is feasible using a Cloud-based HPC system. An analysis can be completed within a few weeks, which fits well with the timescales for the design of buildings. In the solution developed in this case study, the user has access to computing resources, storage and visualization facilities from a desktop environment via a secured webpage in a browser. The required computational resources needed and their costs are appropriate considering those for the overall design of a building.

Binkz
Canada

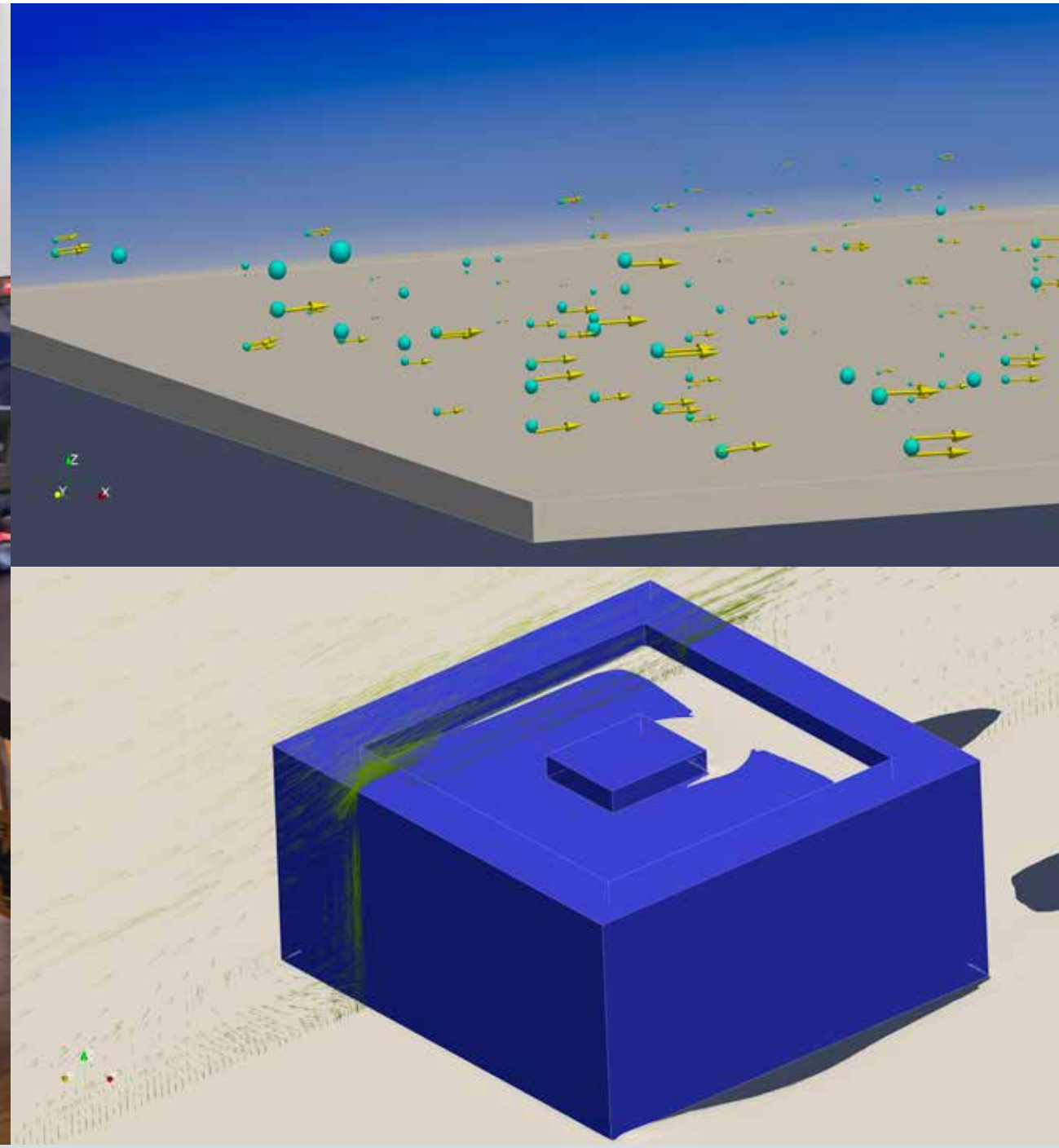


The Benefits

The simulation of drifting snow requires significant compute resources, which can only be provided by a large HPC system. A typical simulation of drifting snow takes 50,000 CPU hours. This equates to 150 CPUs for 14 days. Furthermore, at a cost of €0.2 per CPU hour, this represents a cost of €10,000.
A small consultancy at Binkz would not be able to afford the capital cost of a system containing 150 CPUs, neither could it use a smaller system in-house because the computation time would be much longer than the target two weeks. Even if Binkz were to buy a suitable system, then it would only be used for a fraction of the time and its overall costs would be much greater than the use of a Cloud-based system. Consequently, there is a clear benefit for Binkz in the use of a Cloud-based HPC system.

Participating Organisations

- End-user and Code Developer: Binkz
- HPC Expert: Vortech
- HPC Provider: SURFsara



Every year, roof collapses due to accumulated and drifting snow are responsible for losses in the order of hundreds of millions of Euros as well as bodily injuries and loss of life.

Binkz has developed the CFD program snowFoam. This program allows an accurate assessment of snow loads on buildings. When compared to existing alternatives, snowFoam is more accurate, more reliable and more versatile, but it requires the computational resources that only an HPC system can provide.

HPC-Cloud-based molecular modelling

The Company

The Albemarle Corporation is a globally leading developer, manufacturer, and distributor of highly engineered speciality chemicals for a wide range of sectors, including petroleum refining, automotive, transportation, pharmaceuticals and food safety. It serves customers in approximately 100 countries. Molecular modelling is a proven powerful tool, providing key information for the design of new chemicals and materials. The software for modelling large-scale molecular systems has applications in sectors such as electronics, organic chemistry, food, paints, dyes, adhesives and alloys and ceramics for the aerospace industry. Albemarle already uses HPC in the development of its products. However, it wants to improve its capability in this area through the use of CPU-GPU hybrid HPC platforms which offer significant benefits in terms of price-performance and power-performance, but to take advantage of this, the simulation codes used need some reprogramming.

The Challenge

The challenge is to port an existing simulation code so that it will run on a hybrid HPC platform. To demonstrate the successful porting and the benefits of using a hybrid HPC system a test case was chosen from the petroleum refining sector which involved the use of catalysts in the removal of sulphur from vehicle fuels.

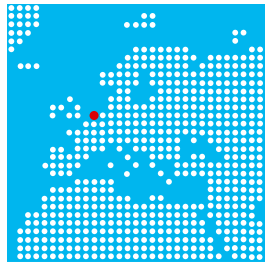
The Solution

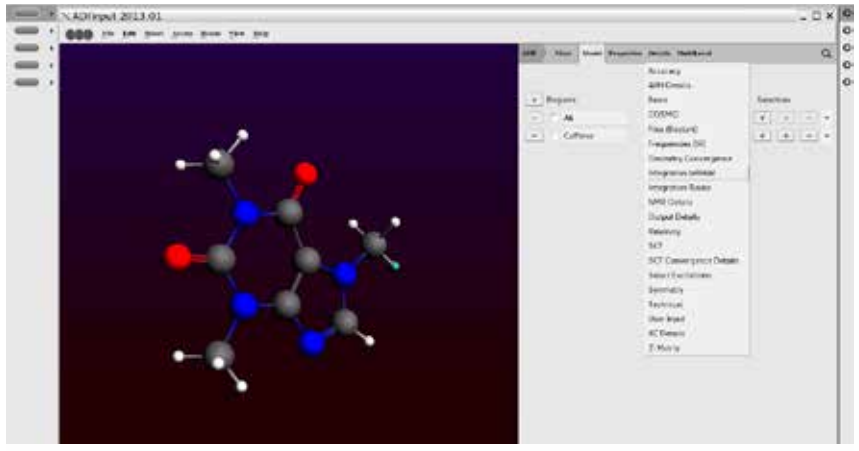
The solution involved not only the porting of the simulation code for the target computer system, but also the development of a simple user interface to prepare the models and their submission to the HPC system.

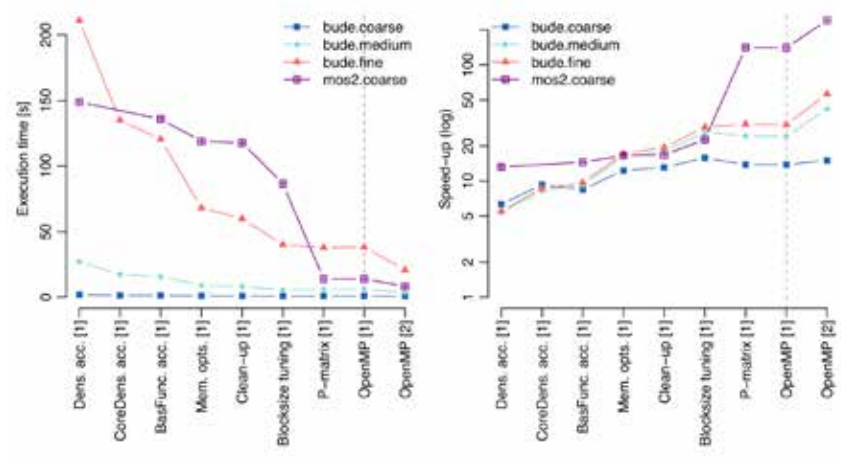
The Benefits

The case study demonstrated a successful port of a molecular modelling package to a hybrid HPC system with resultant cost benefits. The case study also demonstrated that the annual costs for the use of a Cloud-based HPC system on a pay-per-use basis was approximately half that of owning and maintaining a sufficiently powerful in-house system, representing a yearly saving of €38,000. As a result of this case study, Albemarle has allocated a significant budget for Cloud-based HPC computing for its next business year.

Albemarle Corporation
Netherlands





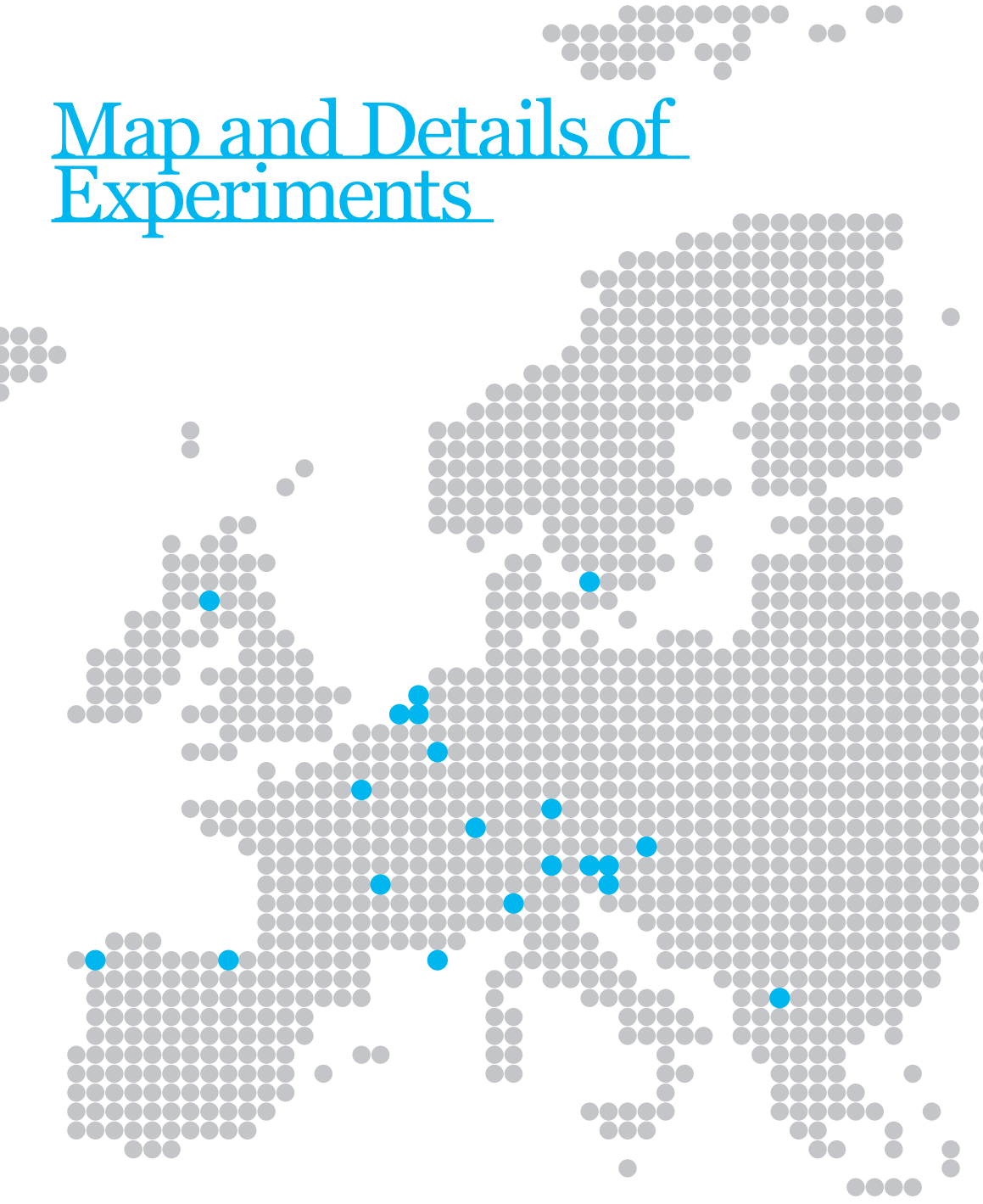


Molecular modelling is a proven powerful tool, providing key information for the design of new chemicals and materials.

Participating Organisations

- End-user: Albemarle
- ISV: Scientific Computing and Modelling
- HPC Expert and Service Provider: SURFsara

Map and Details of Experiments



Project Name:	Fortissimo – Factories of the Future Resources, Technology, Infrastructure and Services for Simulation and Modelling
Start date:	July 1st 2013
End date:	December 31th 2016
Total Budget:	21.7 M€
EU Contribution:	16 M€
Contract Number:	609029 under the 7th Framework Programme
No of Partners:	123 in total (14 Core Partners and 109 Partners in Experiments)
Core Partners:	University of Edinburgh, Scapos, Bull SAS, GENCI, INRIA, University of Stuttgart, Cineca, Surf SARA, XLAB, Arctur, CESGA, Gompute, Sicos and Intel
No of Experiments:	53 in total of which 20 have been started with the project and have already finished. As the result of the first open call 22 new experiments have joined the Fortissimo project October 1st 2014 and expected to finish early 2016. The second open call added another 11 new experiments which started July 1st 2015 and expected to finish end of 2016.

More information on Fortissimo is available at
www.fortissimo-project.eu

European Commission
http://i4ms.eu

Seventh Framework Programme
http://cordis.europa.eu/fp7

European Commission
http://ec.europa.eu