FORTISSIMO

D10.13, D10.14 and D10.15

First, Second and Third Tranches of Success Stories

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Executive Summary

Fortissimo has conducted 53 business relevant experiments to demonstrate the commercial benefits of Cloud-based-HPC simulation. Of these 53 experiments, 44 have each resulted in a Success Story focusing on the business benefits of such advanced simulation. The target audience for such Success Stories is SMEs, primarily those, involved in manufacturing.:

Most importantly, the emphasis on business benefits, means that these Success Stories comprise a significant body of material for use in the promotion of Fortissimo and its objectives to the target audience. This material is being used in the production of promotional brochures, the project's and other websites, the promotion of the Fortissimo Marketplace and as supporting material for the open calls for proposals in the follow-on project, Fortissimo-2.

Benefits demonstrated by the experiments include:

- Reduction in computational costs of up to a factor of 10 through the use of Cloud-based HPC;
- Savings of over €600K per year for a medium-sized steel foundry through improved industrial processes;
- Savings of around 50% in the use of cartographic data;
- An annual growth in revenue of around 8% as a result of HPC-based, electromagnetic-simulation;
- Reduction in design times from a week to two days;
- The capability to simulate important phenomena which are not amenable to physical experiments in the design of steel foundry control systems;
- Annual savings of €400K for an SME producing specialist optical dyes.

With the development of further Success Stories in the follow-on project, Fortissimo-2, these initial Success Stories are now part of a growing base of knowledge supporting the wider use of Advanced, Cloud-based-HPC simulation to the benefit of European industry.

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1 Introduction

The purpose of this document is to present an overview of the outcomes of the Fortissimo experiments. This document does not present detailed technical developments and achievements. They are presented elsewhere in the Final Experiment Reports for the individual experiments. What this document does present is a high-level business-orientated view of the markets in which the technical developments and outcomes of the experiment are relevant. This is done on a per experiment basis under the headings “The Company (ies)”; “The Challenge”; “The Solution”; and “The Benefits”. In the “Benefits” section, particular emphasis has been placed on the presentation of benefits such as increased turnover, savings in costs and staff time, faster times to market, creation of employment, increased competitiveness and greater accessibility of advanced Cloud-based simulation to SMEs through the use of pay-per-use billing structures, involving both licence and computer cycle costs.

This document presents success stories from three sets of Fortissimo experiments comprising Fortissimo Deliverables D10.13, D10.14 and D10.15. With the agreement of the Commission, these three sets of success stories have been combined into a single document, which is this document. The first set of experiments were embedded in the original Fortissimo project; the second and third sets of experiments were the result of two open calls for proposals. There were 20 experiments in the first set, 22 in the second set and 11 in the third set. The 20 experiments in the first set resulted in 15 success stories; the 22 experiments in the second set resulted in 18 success stories; and the third set of 11 experiments resulted in 11 success stories. It should be noted that the Success Stories from the first tranche of experiments have been accepted in the deliverable D10.13. These Success Stories are included again in this deliverable so that all Success Stories are brought together in the same document. Altogether there are 44 success stories from Fortissimo. This represents a significant body of material promoting the use of Cloud-based HPC in a variety of sectors. This material is being used in the production of promotional brochures, the project’s and other websites, the promotion of the Fortissimo Marketplace and as supporting material for the open calls for proposals in the follow-on project, Fortissimo-2.

This document comprises four sections plus an Executive Summary. The four sections are: This introduction; the Success Stories in a standard format; the achievement the success stories represent for the project and for wider EU initiatives; and some concluding remarks.

2 The Success stories

2.1 Cloud-based simulation of the aerodynamics of light aircraft

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.

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 Benefits

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.

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

2.2 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

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

2.3 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.

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 a total of about €150,000 over the next 5 years. More importantly its product offering (production machines for high-pressure vessels) will give each of its customers an advantage in production costs of around a total €1.5 million per machine over the next 5 years 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 a total of around €2 million over 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

2.4 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.

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:

2.5 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.

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

2.6 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.

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 HPCExpert: EPCC

2.7 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.

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 experts: SCAI
HPC Centre: GOMPUTE

2.8 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.

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.

Using Cloud-based HPC services, as evaluated in FORTISSIMO, NUMTECH can realise total cost savings in production of €125k over the next 5 years. This allows NUMTECH to offer more competitive services. It is estimated that NUMTECH's turnover will increase by a total of €750k over the next 5 years, thanks to new customers. Finally, the new capacity to launch multiple scenarios at reasonable cost using SaaS constitutes a new business model that will further increase NUMTECH's turnover by €150k up to 2020.

Cloud-based HPC allows CERC to bid more competitively for larger projects because of greater capability and lower costs. It is predicted that CERC's turnover will increase by a total of €225k over 5 years through the use of Cloud-based-HPC simulation.

Participating Organisations

End-user: Numtech
CERC: Software and domain expertise providers
BULL: HPC providers and HPC experts

2.9 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 CO_2 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 CO_2 emissions in the design of vehicles.

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 CO_2 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: HLRS

2.10 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.

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 compounds, 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

2.11 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.

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

2.12 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.

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 experts: NTUA
HPC provider: CINECA

2.13 Cloud-based simulation of the performance 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.

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

2.14 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.

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

2.15 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.

Participating Organisations

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

2.16 High Performance Management of Cartographic Data

The Companies

Sisener Ingenieros, a Spanish SME, is an engineering company whose main market is in energy projects, especially in the field of renewables. Projects undertaken by Sisener need accurate topographical information not only to determine the earthworks to be performed, which depends on intrinsic information, such as levels, slopes and volumes, but also for the overall design of the installation. The work involved in obtaining topographic information

from surveys and converting it into a usable format is both time-consuming and expensive. Ingeniería y Control Electrónico (Ingecon), a Spanish SME, develops and sells software for managing cartographic data. The use of accurate maps is essential in the optimum design of substructures comprising earthworks (where the selection of appropriate materials is important), drainage (including prefabricated components, such as piping) and equipment to satisfy the relevant requirements of international standards. Globally, several tens of thousands of maps need to be analysed each year in the wind farm area alone. The objective of this experiment is to demonstrate how Cloud-based HPC can be used to convert and manage cartographic data across a range of formats and resolutions in order to improve the design process of wind farms and to reduce overall costs.

The Challenge

Most civil engineering projects need accurate cartographic data during the tender, design and implementation phases. Such data is a significant component in the overall costs and duration of a project. In certain parts of the world this data may even not be available. All civil engineering projects require a resolution of 1 metre or even finer. This demanding resolution can be achieved through the application of Kriging interpolation to a map with coarser resolution. The original map could be an existing one or one generated at a lower cost and in shorter time whose resolution could then be increased by means of such interpolation. However, Kriging interpolation is very numerically intensive. Its use in the design of typical installations requires HPC. The challenge facing this experiment is to port Ingecon's Kriging interpolation software to run on an HPC system and to make it available on a pay-per-use SaaS platform to civil engineering companies, particularly SMEs. For the software vendor this would be a scalable way to offer a new service to customers. Civil engineering companies would save time and money because data acquisition times could be reduced and expensive data gathering could be replaced by cheaper and quicker numerical interpolation.

The Solution

Ingecon already uses Kriging interpolation for coarse maps with a typical resolution of 80 m. The software to do this runs on a powerful PC. To obtain the required resolution of 1 m, the computational load becomes 80x80 times greater. HPC is needed because a PC is no longer able to tackle such problems. Ingecon has ported its interpolation software to run on an HPC system via a PC-based GUI which supports both data input and output. The use of HPC has reduced the processing times for wind farms to a few minutes and for other projects requiring greater resolution to a few hours. Furthermore, it has moved such calculations away from the desktop by putting them on an HPC system. This enables engineers to work on other tasks while the interpolation is taking place.

The Benefits

Ingecon sees this as a major opportunity to provide a new service not only in the design of wind farms, but also in other application areas where cartographic data is used. For a company like Sisener, the costs of a yearly software licence and a powerful enough computer to perform the necessary computations are prohibitive. However, a pay-per-use service where computing costs and software licensing are available, would be a very attractive proposition for all parties.

The major benefit for Sisener is a reduction in the cost of map data. Through the use of interpolation, as opposed to buying raw data, the cost of a typical design can be reduced from €4k to €2k taking staff effort and computing costs into account. A company like Sisener will be involved in around 25 such projects per year, so annual savings amount to €50k.

Ingecon already has two further companies testing this solution and expects to engage 10 companies by the end of 2016. Based on data from Eurostat, there are over 350,000 potential customers across the EU for the proposed service from Ingecon of which 40,000 are based in Spain. Ingecon estimates a yearly income from this service at €200 per customer with 200 customers by 2018 and a 1% share of the European market (3,500 customers and a revenue of €700,000) by 2020.

Companies Involved

End-user: Sisener Ingenieros S.L.

HPC Expert: Ingeniería y Control Electrónico S.A.

HPC: Provider: CESGA

2.17 Advanced Simulation of Electromagnetic Effects

The Company

SEEMI is a French SME, which develops solutions for product packaging and transport. The devices it builds are often found in environments with significant electromagnetic fields, which can lead to serious malfunctions in equipment. The customers for products designed by SEEMI are major national and international groups.

The Challenge

Electrical devices play a major role in all types of automated and embedded systems. Cables, both shielded and non-shielded, have become a major issue in terms of safety, weight, performance, power consumption, cost and reliability. It is essential to verify during the design stage that cables are not susceptible to external electromagnetic effects. Today, the decision to shield a cable is complex. Simulation has become mandatory in making such decisions.

Recently Algo'Tech Informatique has developed an electromagnetic simulator which runs on PCs to simulate small and medium-sized configurations for its customers. Unfortunately, for large complex installations, computing on a PC becomes too time-consuming to meet user requirements. There is an additional risk of program crashes with the subsequent need to restart the calculation from the beginning. The calculations must be run thousands of times to simulate a reasonable range of frequencies, between 50 Hz and 6 GHz, for example to cover common sources of interference including WiFi

Algo'Tech's customers have a clear need to simulate large-scale electromagnetic problems. Such a simulator needs to be affordable and accessible simply and directly from a designer's computer. This would allow SMEs, such as SEEMI, to reduce the weight, design time and costs of electrical networks used in the packaging and other sectors.

The Solution

The use of Cloud-based High Performance Computing (HPC) has dramatically reduced the computation time for complex electromagnetic simulations from hours to seconds. It has become essential for simulating the complex electromagnetic behaviour of equipment in its operational mode.

The solution developed by Algo'Tech provides seamless access to HPC from a PC. In this way users can run simulations from their PC without regard to where they will run and then view the results directly on their screens. This seamless access to HPC is essential to meet the needs of users. It has required the development of Algo'Tech's code to run on an HPC

system. The end result is a service which enables SMEs and larger companies to perform the simulations necessary to demonstrate the electromagnetic integrity of their designs. Algo'Tech is now able to offer a pay-per-use electromagnetic-design service to its customers which enables them to carry out large-scale simulations as needed.

The Benefits

The cost-benefits of simulating the electromagnetic behaviour of devices depends on where they are deployed. For example, an electromagnetic issue in manufacturing equipment has cost implications, but may present no danger to life. In contrast, unwanted electromagnetic effects in a vehicle may constitute a significant danger. In the former case, the value of a simulation can be estimated at 1% of the cost of the risk. In the latter case, the value of a simulation can be much greater because the cost of the risk is much higher. Generally, the feeling across industry is that such simulations are cost-effective in most practical cases.

The market price, as determined by Algo'Tech's customers, for a small-scale simulation of the electromagnetic behaviour of a device is around €240. This cost can be broken down as follows: €200 for Algo'Tech to cover licence fees; and €40 to the computer centre for the cost of cycles. For a larger simulation the market price is €1,750: €1,500 in licence fees; and €250 for the cost of cycles.

For the end users, the cost of electromagnetic issues, detected during the installation phase on customer premises, would be between tens of K€ to hundreds of K€. This compares favourably with the corresponding costs and benefits of simulation. The use of a pay-per-use software licence and compute cycles enables small companies to compete with larger companies in electromagnetic design.

As a result of the new service it can offer, Algo'Tech expects to see an increase of 10% in licence revenue and for HPC-based simulations to constitute 20% of its overall business. Overall, it expects an annual growth in its revenue of around 8% as a result of its new HPC-based, electromagnetic-simulation.

Companies Involved

End-user: Seemi

HPC Expert: INRIA

ISV: Algo'Tech

HPC: Provider: BULL

2.18 Advanced Simulation of Metal Casting

The Company

Fundiciones de Roda is a Spanish SME specialising in the casting of grey and ductile cast iron. Like many other SMEs in this sector, Fundiciones de Roda finds the advanced simulation of its casting process prohibitively expensive because of the costs of software licences and of computer hardware.

Quantech is an ISV which develops and markets the software package, Click2Cast, which simulates the casting of a range of metals including aluminium, steel, brass and copper. The artefacts, whose casting is simulated, include automobile and aerospace components, hydraulic valves, turbine disks, impellers and flanges.

The Challenge

To save time and money, foundries need advanced simulation to detect metal casting defects as soon as possible, that is at design time before any expensive prototypes need to be developed. However, many SMEs in the casting industry are reluctant to use advanced simulation software because of the high costs of software licences and of access to the necessary high-performance hardware to run the software. The challenge addressed in this experiment is to develop a service based on Quantech's Click2Cast package which offers SMEs such as Fundiciones de Roda an affordable pay-per-use service where its casting processes can be simulated accurately and quickly and without the need for detailed specialist knowledge of the simulation process. Accurate simulation implies that defects in the casting process can be detected at design time and before expensive prototyping. This is an essential requirement of the Click2Cast software and one which needs to be implemented in an effective service.

The Solution

Click2Cast has been ported to a High Performance Computer system available via a Cloud infrastructure. Access to this application has been made available as a pay-per-use service which enables even naïve users access to advanced simulation via a simple click-based interface. Click2Cast tackles 90% of all casting techniques including High Pressure Die Casting, Gravity Casting, Low pressure Die Casting and Tilt Pouring.

The use of Click2Cast simulation service supported by an HPC-Cloud enables a foundry to determine the most efficient casting technique quickly and optimise its configuration. In this way, the weight of casting systems can be reduced as much as possible. This reduction in weight is a significant factor in the productivity of foundries. In particular, the use of a service that simulates the completed metal casting processes can significantly save time and money in the development of new types of moulds. A pay-per-use service such as that now offered is a very attractive option for SMEs in this sector. Through the use of an HPC Cloud-based service, design times can be significantly reduced by up to 60%, that is from a week to a couple of days.

The Benefits

Through the use of the Click2Cast service Fundiciones de Rode can reduce its annual design costs by €3,200. Furthermore, because of an increase in productivity, it expects to increase its annual revenue by €20,000.

Quantech now offers the only casting design and simulation pay-per-use service in the market. Over the next 5 years, the growth in its business is estimated to be 40%, with a total of approximately 500 new customers by the third year. The additional profit for Quantech per customer, taking into account the cost of compute cycles, is estimated to be €1,000 per annum representing a significant increase in business.

Companies Involved

End-user: Fundaciones de Rode

HPC Expert: CIMNE

ISV: Quantech

HPC: Provider: CESGA

2.19 Simulation of airflow in concentric chimneys

The Company

DINAK is a Spanish SME expert in designing, manufacturing and installing domestic and industrial chimneys and ventilation systems. DINAK needs to improve its capabilities to be competitive in a global market. The reduction of CO_2 emissions and the more efficient use of energy require the design of optimised chimneys. The optimisation of chimneys involves many variables and physical testing is not feasible on the grounds of cost and time. DINAK needs a simple and powerful tool to analyse and test the design of exhaust chimneys. This tool should help them to improve the design of concentric chimneys and gain understanding of the physical phenomena involved in exhaust processes. To reduce design times to reasonable levels, High Performance Computing (HPC) has become an essential component in the development of such a design tool.

The Challenge

The reduction of emissions requires the design of optimised chimneys. Simulation plays an important role in the design of new chimneys. In a building with stoves it is necessary to install a ventilation system to assure an effective and regulation-compliant exhaust system and a proper air renovation ratio. The concentric chimney designed in this experiment is a countercurrent design, where flows have different directions: The inner tube leads hot combustion gases to the exterior and the external cylinder directs fresh air from the exterior providing oxygen to the stove. If the chimney is not properly designed, not enough oxygen will reach the stove and combustion will be inefficient. There are many variables involved in the optimization of the design of a chimney and physical testing is not feasible on the grounds of cost and time. Consequently, it is necessary to use advanced numerical tools. The problem is complex because there are many variables and the simulation must be sufficiently accurate and detailed. High performance computing (HPC) is needed for a fast time-to-solution, supported by a user-friendly interface to make the simulations easily accessible. The implementation of such a solution is the task of this experiment.

The Solution

Before this experiment DINAK did not have access to HPC-based simulation and had no experience in its use. It needed approximately a month of work for the design and testing of a new chimney. Every new product required the work of 3 specialised engineers and 2 craftsmen to assess the different options, to design prototypes and manufacture them and to test complete chimneys to verify the initial design concept. Now it has a reliable HPC-based simulation, based around the open-source Open Foam package, DINAK can shorten the whole design process down to one week. Moreover, the user-interface provides the ability to explore the design space in a systematic way which can improve the quality of the resulting designs. This experiment has demonstrated that the design of concentric chimneys using HPC-based simulation resources is feasible and accurate. The results from this solution have been successfully validated against commercial software and experimental data.

The Benefits

HPC simulation enables DINAK to accelerate and optimise the design of concentric chimneys. Faster design will allow DINAK to enter new markets and to increase its competitiveness. Experience shows that the first company with a new design of chimney increases its market by 5% to 10%. Currently, DINAK develops around 3 to 4 new products per year and this advantage would increase its turnover by approximately €100K. Before this experiment, DINAK required approximately a month for the design and testing of a new chimney. The costs comprised 3 specialist engineers for 1 month (€9,300), 1 craftsman for 1

month (€2,100) and prototype costs of €2,000, totalling €13,400. Using HPC simulation taking 1 week, these costs reduce to 1 week of an engineer's time (€900) and computing costs of €240 totalling €1,140. This gives DINAK a saving of over €12,250 per design which is €49,000 per year. The optimised design through the use of HPC, enables DINAK products to pass CE Mark tests with a zero failure rate with a consequent cost reduction. Previously there were 1 to 2 failures per year resulting in additional operating costs of around €6,000.

Based on experience gained in this experiment, UDC is planning to offer, via the Fortissimo marketplace, a consultancy service to develop web interfaces for cloud-based applications. AIMEN will be able to offer consultancy services in the Marketplace based on OpenSource modelling. CESGA will increase its sales of computer cycles by around 10,000 CPU hours per year. It will also improve its visualisation services and be able to use the outcome of this experiment as a reference to promote its services.

Companies Involved

End-user: DINAK

HPC Expert: UDC

Application Expert: AIMEN

HPC: Provider: CESGA

2.20 High-Performance Gear Analyzer

The Company

VE&D is an SME which has been working in the field of automotive engineering for over 50 years, providing design services to its industrial partners. In particular, it has been involved in designing gearboxes for large companies such as Piaggio. The gearbox market in Europe had revenues of ~ €3 billion in 2010. The market is forecast to reach ~ €3.7 billion in 2017. Italy has a large number of gear manufacturers, many of them are SMEs, operating in the areas of gear production, gear design and gearbox manufacture. Generally, these SMEs lack the skills and resources to develop complex simulation models. They also lack the resources to buy expensive software licences to perform large-scale computations and to hire highly skilled people having experience in stress analysis and gears. The objective of this experiment was to develop an HPC-Cloud-based High Performance Gear Analyzer (HPGA) using advanced software and high-performance computing resources which would allow SMEs such as VE&D to benefit from the most advanced methods for gear analysis and design.

The Challenge

A typical SME gear designer, is generally an expert in gears and traditional design tools, based on standards, simple tables, databases implemented in spread-sheets and specialist commercial and CAD software. Such designers generally have only a basic knowledge of software for structural analysis and only limited awareness of specialized applications. The challenge of this experiment was to provide a new technology for supporting the design of reliable and efficient gears, using cloud-based advanced simulation, without the need for significant investments in computational resources, expensive software licences and time consuming and expensive training. The goal is to develop HPGA as an advanced analysis methodology which will provide new innovation opportunities and services for European gear manufacturers.

The Solution

The development of HPGA draws on more than ten years of research in the field of mechanical transmissions. The research group of UNIMORE, the ISV partner in this experiment, developed several computational tools for gear analysis and optimization. During this development, it became clear that HPC Cloud technologies would be needed to make HPGA available for design engineers with an appropriate time to solution. The HPGA software appears as a simple interface, where the end-user finds all standard gear datasheets. In addition, some popup menus are devoted to specific operations such as the creation of gear geometry and checking for data coherence, the performance of analyses and optimizations and the presentation of results in a standard way acceptable to potential end-users. Behind such a simple interface, innovative and advanced analysis is implemented using Cloud-based HPC and state-of-the-art software.

The Benefits

The current yearly costs for VE&D to simulate gears in-house are approximately €160K: €10K for software licences; €88K for staff costs, computer hardware costs of between €20K to €40K and other costs (administration, personnel and security) of €32K. The yearly costs for VE&D to simulate gears using HPGA via Cloud-based HPC are approximately €143K: €10K for the use of HPGA (licence and computing costs included); €25K for computer hardware, €79K for staff costs and other costs of €28K. VE&D will see an annual saving of €17K as a result of using HPGA via cloud-based HPC. Given that there are a significant number of SMEs, which design gears, this represents a substantial saving across this sector.

A further benefit is that HPGA enables tooth contact analysis, which is more refined than that currently performed by VE&D. The market is going to increasingly require this kind of analysis. Having this capability is expected to increase VE&D's market share.

For the ISV UNIMORE the benefits of HPGA will be twofold. Firstly, there will be a direct increase of contracts related to the design of mechanical transmissions, starting from the actual turnover of about €20K per annum in 2017 rising to €100k per annum after 5 years. Secondly, the reputation of UNIMORE will rise leading to a subsequent increase in collaborative research projects. CINECA expects to see a rise in revenue from cycle sales through the use of HPGA. UNIMORE, VE&D and CINECA will make the HPGA tool, developed in this experiment, available via the Fortissimo marketplace.

Companies Involved

End-user: VE&D

HPC Expert and HPC provider: CINECA

Application Expert and ISV: UNIMORE

2.21 Simulation of laser-based welding in the automobile and machine tool sectors

The Company

Lasersystemtechnik Bollinger & Ohr (LBO) is an SME founded in 1999, specialising in laser-welding technology. LBO offers a range of laser-welding services including the repair of dies and moulds, sheet-metal joining, surface coating and deep penetration welding and cutting.

Many of the components of automobiles and machine tools are welded components which suffer thermally induced stress in the manufacturing process, resulting in flaws. The impact of these flaws on the durability of components needs to be assessed. Traditionally, welds have

been assessed by physical inspection which involves the cutting, polishing and sanding of samples to obtain micro-sections. Such trials are costly and time consuming. Furthermore, the work piece under assessment is destroyed by this process. Simulation of the welding process, taking only a few hours on an HPC system, would dramatically reduce the time to assess and optimise a particular weld, thus avoiding expensive prototypes. However, to do this requires a suitable methodology for performing such simulations. The aim of this experiment was to determine and implement such a methodology.

The Challenge

The major advantages of simulations are the savings due to the avoidance of physical prototypes and the faster development cycle. Using simulations, initial results can be available within few hours rather than after days or weeks with prototypes. Models can be modified in order to find optimized welding parameters, such as feed rate, welding penetration depth and laser power. This can contribute dramatically to reducing costs and time. However, there are few, if any, simulation tools to model welding processes. This is because such processes are highly complex and difficult to observe. Accurate simulations require significant computing power due to the non-linear behaviour of materials and the highly transient conditions. These imply high levels of discretisation, resulting in very large models. SMEs simply cannot afford the necessary computer hardware to perform these simulations. In Fortissimo, SMEs have access to high-performance computing which can overcome this barrier by enabling the implementation of a suitable simulation tool. The challenge of this experiment was therefore to determine and implement such a tool.

The Solution

Lauer & Weiss (L&W), an expert in the development of software solutions for the automobile and machine tool industry, has developed a simulation of laser-welding processes based on the commercially available ABAQUS package. The accuracy of this methodology has been positively assessed through the physical inspection of welding samples in cooperation with LBO. This confirms that simulated welds accurately model real-world cases and that expensive physical prototypes can be eliminated.

The need to model temperature-dependent material properties and to resolve accurately the very fine scales of welds results in a large model requiring significant compute resources. Such resources are easily available, using Cloud-based HPC resources from HLRS, as are the necessary licences to use the ABAQUS package. LBO, L&W and HLRS are together making the simulation tool available as a service in the Fortissimo Marketplace, enabling customers both large and small to carry out simulations on a pay-per-use basis.

The Benefits

The cost of a physical prototype at LBO is ~€3.3K comprising materials (~€2K), staff costs (~€500) and microsections (~€800). Testing using a physical prototype takes ~1 week. However, using a physical prototype takes 3 or 4 trials costing in total ~€13K including ~€1.5K staff costs and a development time of ~3 weeks, which is quite long for urgent tasks.

In comparison, a computer-based analysis costs L&W €6K, comprising staff costs for 1 week of €4K for modelling, preparation of the computation, user subroutines and evaluation and one week of computing time (€2K for in-house cycle costs and licence fees). Results are available within two weeks. Once a running FEM model has been created, modifications to certain parameters are made very quickly, thus a second simulation loop is less expensive. The in-house cycle and licence fees remains at €2K, but the staff cost reduces to ~€500. Assuming that three simulations runs are necessary to find suitable welding parameters, the costs for the evaluation of a weld at L&W using HPC-based simulation are about €11K,

which is almost the same as the physical weld trials at LBO with roughly the same development time. However, a complex calculation of a welding process would block all licences at L&W for seven days. This means that no other projects could be processed during this time, which is not acceptable.

The use of an HPC cloud at HLRS reduces the computing time to 24 hours. In this case, HLRS provides only the hardware environment and L&W brings its own licences. For L&W, the costs for the solver software per year are currently €80K for 24 ABAQUS licences. This is sufficient for using 40 cores in parallel for one calculation job. Increasing the costs for ABAQUS licenses by only 10%, L&W is able to run one FEM analysis with 80 cores at the HLRS. This reduces the computing time to less than 24 hours.

The staff costs for the first simulation remain at €4K and a further €500 for each simulation loop. However, the cycle and licence costs are reduced significantly to about €500. Assuming as before that three simulations loops are necessary, the costs for an HPC-based evaluation supported by HLRS can be reduced to about €5.5K, which is less than half the costs for physical weld trials at LBO.

In recent years, LBO has conducted four to five expensive welding trials per year. Using Cloud-based-HPC simulations, L&W can generate a significant cost reduction of ~40k EUR per year for these trials. For each new client like LBO, L&W sees a further benefit of €20K to €30K. In Germany alone there are several tens of such companies which gives L&W a significant potential for new business.

Companies Involved

End user: Lasersystemtechnik Bollinger & Ohr

HPC and Application expert: Lauer & Weiss

Independent Software Vendor: Lauer & Weiss

HPC Provider, Expert and Host Centre: HLRS

2.22 Cloud-based simulation of target drug compounds

The Company

Transinsight is a German SME which develops software products in the area of bioinformatics where it analyses high-throughput data. This case study addresses the identification of existing drugs to treat illnesses other than those for which they are currently prescribed. This has the potential to make a significant impact in drug discovery where the costs of developing new treatments are becoming prohibitive. The assessment of target compounds requires the use of Cloud-based HPC because the search space is so large and complex. A new Cloud-based-HPC service will be offered by Transinsight to support drug discovery both by SMEs and by larger organisations

The Challenge

The journey for a drug from invention to market is a long one. It has been estimated that the time required to develop a new drug de novo ranges between 10 and 17 years; that is, if it ever makes it. The chance for a new drug to actually make it to market is only 1:5,000. These slim chances are accompanied by the high cost for developing a new drug, which may reach an average of US$ 403 million. These rising costs threaten to make the development of new drugs increasingly unaffordable for both companies and patients.

Repositioning existing drugs for new diseases could deliver the productivity increases that the industry needs. A prerequisite for drug repurposing is drug promiscuity, a drug's ability to

bind to several targets. Research indicates that there is a correlation between promiscuity and structural similarity as well as binding site similarity of protein targets. The use of this correlation has a huge potential to infer currently unknown drug-target relationships. However, such an approach requires significant computational resources. The use of Cloud-based computing can speed up drug development and reduce its costs by uncovering off-targets and thus causes of adverse drug reactions early in the development pipeline.

The Solution

The use of an HPC-Cloud infrastructure combined with algorithmic improvements enabled substantially better computational performance. This was achieved through the parallelisation of the algorithms used combined with the more efficient use of memory. This resulted in a significant reduction in the time and cost of the evaluation of a single compound. The Cloud-based approach enabled significant computational resources to be deployed without the need to purchase and maintain expensive hardware.

The Benefits

Transinsight estimates that there are hundreds of potential users of its proposed service. Each user represents a potential profit of €2,000 per annum comprising around 4,000 queries regarding protein matching. For Transinsight this represents a potential increase in profits of around 3% per annum.

Companies Involved

End-user: Transinsight

Domain Expert: Technical University of Dresden

HPC Expert: Harokopio University

HPC Provider: UEDIN

2.23 HPC-Cloud-based analysis for optical control in manufacturing processes

The Company

EPC is a Spanish SME specialising in the manufacture of camshafts. These are critical components in high power engines where dimensional tolerances are very small. For this reason, EPC is always working to improve its quality-control process, integrating the latest innovations in hardware and software. The integration and exploitation of 3D optical scanning systems for dimensional quality control in manufacture results in significant benefits in terms of time and dimensional information generated compared to traditional tactile technologies.

However, the use of such systems has to overcome issues associated with the processing, analysis and storage of the huge amount of data acquired. For example, a typical file size is around 300 Megabytes, representing 15 million points. This means that a single company generates several Terabytes of information in short periods of time to be processed by a metrology service provider such as Unimetrik. At the same time, metrology software developers such as Datapixel have to work on the optimisation of their processing algorithms to enable quicker access to the information contained in the data collected. The use of Cloud-based HPC has the potential to provide a detailed and quick analysis of manufacturing processes enabling significant improvements in the control of quality in production processes.

The Challenge

The challenge of this case study is to develop a data-processing service which enables manufacturing companies, particularly SMEs, to control manufacturing processes to a very high level of accuracy using optical scanning techniques. This requires intelligent, fast and intensive analysis of manufacturing quality using 3D digital information of the parts to be manufactured. The combination of scanning, measurement and analysis has the potential to enable the early identification of any deviation in the manufacturing process from the required design parameters and of the necessary corrective measures to be taken.

The Solution

Through the use of Cloud-based-HPC resources, the participants in this case study have been able to exploit advanced optical systems and exploit the information in the data gathered. New methods of analysis such as large-scale geometry extraction and temporal analysis of the dimensional quality of large batches are now possible. Moreover, traditional tasks such as reverse engineering are now optimised enabling the much faster generation of control data for the production line. This allows the generation of additional information concerning the manufacturing quality at both the part and system levels. Geometry extraction and reverse engineering enable the computation of information concerning the quality of final parts, detailing the size and shape of components and comparisons against the nominal expected value. When dealing with large batches, the output data are related to the evolution of the manufacturing quality of the production line enabling the detection and prediction of when a defect will occur due either to a lack of machining performance or to damage to machining tools.

The Benefits

The use of the HPC-cloud-based service enables a reduction in the time needed to extract dimensional information from 5 minutes to 1 minute. Due to this time reduction:

- Unimetrik will increase its service business by 30% and its portfolio of international customers by 20%. This is expected to lead to an increased turnover of €400K over the next five years due to the commercialisation of these advanced services and the creation of two new positions within the company.
- Datapixel, expects an increase of 25% in new licences, representing an additional turnover of €750K over the next five years, due to the commercialisation of the optimized data-processing software developed in this case study.
- The end-user, EPC, expects to improve the quality of its manufacturing process reducing the production of defective parts down to 0%. This would result in a cost reduction of €1.5M over the next five years.

Furthermore, the HPC provider, CESGA, will be able to offer its services to new users working in the manufacturing domain. In particular, it will exploit HPC applications in the virtual metrology field.

Companies Involved

End-user: EPC

Domain Expert: Unimetrik

ISV: Datapixel

HPC Provider: CESGA

2.24 Cloud-based processing of seismic data

The Companies

Seismic Image Processing (SIP) and Sharp Reflections are a premier suppliers of geological and geophysical services, with a strong reputation for integrated processing, depth imaging, and rock physics. SIP and Sharp Reflections offer a wealth of experience and proprietary technologies which provide clients with unique and innovative solutions. SIP and Sharp Reflections are innovative SMEs employing together18 geophysicists who work on processing and imaging, reservoir characterization and rock physics. SIP is the end user of the Pre-StackPRO software tool.

Sharp Reflections is an innovative software company bringing fast, full-survey pre-stack computing to the interpreter's desktop. The application Pre-StackPRO harnesses the power of many-core CPUs to deliver visual, real-time affordable processing via the Cloud. Sharp Reflections defines a leading edge in seismic data analysis.

The Challenge

As the Oil&Gas industry has to deal with more and more complex geological targets, high-resolution processing of seismic data and interpretation of results has become strategically important for most companies in this sector. The Pre-StackPRO software addresses this need for high resolution by taking advantage of innovative and powerful computation and visualization capacities. Pre-StackPRO enables users to work interactively on very large pre-stack data sets. It offers seismic interpreters the possibility to execute complex processing to improve data quality and extract information about sub-surface geology. This software is in production use by SME oil and service companies. These SMEs do not buy HPC clusters for financial reasons, but run the software on up to a few nodes, and therefore do not benefit from the software's full scaling capabilities, one of the main advantages of Pre-StackPRO. The aim of this experiment is to allow small seismic processing companies and small oil and gas exploration companies to analyse their data by using cloud-based HPC systems without the need to buy and maintain a compute cluster themselves.

The Solution

Significant changes to the underlying software architecture of Pre-StackPRO, including fully decoupling Pre-StackPRO from a specific hardware infrastructure, have been made. This way the end-user can freely choose the datacentre and hardware that fits best to their use-case. End-users can now fully exploit the full potential of Pre-StackPRO through the utilization of a cloud-based HPC infrastructure. With the implementation of Pre-StackPRO in the HPC cloud it is now available from any remote location through remote desktop connections, which enables new business models and opportunities for collaboration on seismic datasets. The ISV, Sharp Reflections, has created a new pay-per-use business model and licensing scheme for cloud-based HPC computation, thus gaining access to new markets. The significant cost savings of this new approach can lead to an increased market share and reduced costs.

The Benefits

A common configuration for in-house seismic processing by SMEs using Pre-StackPRO comprises a perpetual software licence costing €87k plus 20% annual maintenance. The software runs on a 2-node in-house system costing €40K. Annual hardware maintenance costs are €4K. Amortising over 4 years gives an annual cost of ~€55K regardless of the number of hours of processing on the system. These costs are an obstacle to SMEs to use the advanced capabilities of Pre-StackPRO. Furthermore, the limitations of such a system are clear. When

the processing requirements are high, they cannot be met by the in-house system. When the processing requirements are low, expensive hardware and software are not being used.

Based on the outcomes of this experiment, Bull is offering a compute node with Pre-StackPRO installed and licensed as a Cloud-based service. Such nodes can be purchased on a pay-per-use basis ranging from 1 week to 3 years. Clearly the advantage of such an offering is that variable workloads can be easily and cost effectively accommodated. Savings, over the in-house solution, of between €20K to €30K for each SME can be expected. There are around 250 such SMEs in the EU so these savings across the industry are significant. Furthermore, the flexible pay-per-use approach enables much larger data-sets to be processed by scaling up the hardware as needed. It is expected that the provision of such a service will increase Sharp Reflection's total revenues significantly. In a conservative business model SaaS will realise about 1 M€, equivalent to 10% of total revenues in 2017, gradually increasing to 4 M€ and 23% of total revenues in 2022.

Companies Involved

End-user: SIP and Sharp Reflections

ISV: Sharp Reflections

HPC Expert: Fraunhofer ITWM

HPC Provider: BULL

2.25 Cloud-based simulation of pipeline components for the oil & gas industry.

The Companies

The Dynaflow Research Group (DRG) is an SME that has provided engineering consultancy services to globally leading oil & gas companies since 1983. This work often requires multidisciplinary simulations encompassing static and dynamic analysis of both fluids and mechanical components. To satisfy this advanced modelling requirements, DRG relies on the open-source based CFD software solution HELYX® developed by the ISV ENGYS®. In the past, such simulations were mainly performed on DRG's local systems with a small-scale parallel capability. The objective of this experiment was to enable DRG to run CFD simulations of oil & gas pipeline components using HELYX® on remote supercomputing facilities via a familiar desktop environment. This represents a significant enhancement for DRG's simulation capabilities in this area of application. The feasibility of the proposed solution was demonstrated by means of two simulations of oil & gas pipeline components.

The Challenge

For many SMEs in the engineering and manufacturing sectors, in-house computing hardware is usually insufficient for solving large problems. This is the case for the CFD simulations required by DRG for oil & gas applications. Furthermore, the initial investment required to acquire in-house HPC resources is often prohibitive, in particular for businesses with occasional CFD usage. On-demand cloud-based HPC solutions, combined with software based on open-source technologies, can offer a more cost-effective alternative. The main challenge faced by DRG and its partner ENGYS was to create a new methodology to perform oil & gas CFD simulations using on-demand cloud-based HPC solutions in a similar fashion as computations perform using in-house hardware resources.

The Solution

ENGYS developed and tested a novel client-server framework for their CFD software HELYX® with the help of NAG and DRG. The new client-server framework allows end-users to perform CFD simulations on remote HPC hardware directly from a desktop Graphical User Interface. The new technology facilitates access to and effective use of remote HPC resources from a local desktop, such as those employed by DRG. The introduction of the client-server module in HELYX® also opens the possibility of providing this product on a short-term licence as an on-demand service, which could be promoted and delivered via the Fortissimo Marketplace and other similar platforms.

The Benefits

A simple calculation based on the work in this experiment showed that the costs to DRG of buying and maintaining a computer cluster in-house for performing these CFD simulations can be as much as 5 times higher than the costs associated with the equivalent cloud-based HPC solution. In addition, there is a clear benefit of faster turn-round times for the simulations, as well as the opportunity to perform much larger computations using a cloud-based HPC platform. The simulations can be as much as 10 times faster with potential savings of €2,000 per simulation/per day, based on standard industry consultancy rates for relevant consultancy projects.

The new client-server approach in HELYX® is also expected to increase sale opportunities for ENGYS by as much as 20%, thanks to the introduction of short-terms licences for on-demand usage of the software in the cloud. Furthermore, the possibility of providing these resources via the Fortissimo Marketplace should lead to increased revenue by exposure to a wider market.

EPCC will see an increase in its commercial activities through extended use of its commercial supercomputer platforms. NAG will create case studies based on this experiment to showcase its capability in software engineering and high-performance computing. Such marketing materials will be distributed to potential customers to attract new HPC consulting business. Current estimates are that this would result in an additional revenue for NAG in excess of €150K over the next three years.

Companies Involved

End-user: Dynaflow Research Group

HPC Expert: NAG

Domain Expert: ENGYS

HPC: Provider: EPCC

2.26 Cloud-based environmental modelling

The Company

eAmbiente is an SME operating in the area of environmental consulting. It provides its services to architects and designers involved in the design of large factories and industrial plants, characterized by significant environmental impacts. eAmbiente's mission is to reduce these impacts to acceptable levels. Since 2002, eAmbiente has used computer simulation to model emissions and water flow to predict the risk to soil and groundwater. During this period, environmental modelling has become an important tool during the planning phase of buildings, factories and public infrastructures. Although the required simulations are well understood, their performance and ease of use are limited. In particular, models may take prohibitively long run-times on conventional computing resources. This Case Study aims to

overcome the limitations of existing environmental modelling tools such as processing time, cost and lack of user friendliness. eAmbiente will deploy and test a new Cloud-based-HPC service as a pay-per-use one-stop shop targeting the environmental modelling domain for both public and private organisations.

The Challenge

The challenge of this Case Study is to overcome the current limitations of environmental modelling tools. The main aim is to set up and test an innovative service for SMEs, public sector (i.e. environmental agencies) and private stakeholders (i.e. consultancy companies, research centres and engineering facilities) through a single access-point/platform. The clear goal is to offer a service through the Fortissimo Marketplace structured in two ways: a Cloud-based 'on-line' service that will launch and aggregate the results of different models in parallel; and an 'off-line' service where augmented and virtual-reality facilities will be used to evaluate and interact with the results of the simulations. This challenge targets environmental issues such as noise, atmospheric fallout and soil pollution

The Solution

This challenge of this Case Study has been addressed through the development of a customized platform to integrate environmental software including a single easy-to-use GUI available to potential end-users. This GUI gives access to cloud-based HPC resources providing a one-stop-shop for the end-user. The use of this solution enables an 80% reduction in both simulation time and time to result with consequent cost benefits. Furthermore, the use of open-source software for the simulations has resulted in a significant reduction in the costs of using the platform.

The Benefits

The total cost of running a single traditional Environmental Impact Assessment (EIA) on a powerful in-house system is ~€30.5K, including staff effort, computing resources and software licences. The same assessment, using open-source software, Cloud-based HPC resources and reduced staff effort is ~€6.5K resulting in a saving of ~€24K per EIA. eAmbiente will share 1/3 of this saving with customers with a consequent saving to eAmbiente of ~€16K per EIA. eAmbiente expects to carry out an additional 4 EIAs yearly over each of the next five years resulting in an overall cost saving of ~€64K per year. Similar gains apply to other consultancies active in this area.

Furthermore, eAmbiente expects to increase its revenue with around €374 K of additional business over the next five years, corresponding to about €75K per year. eAmbiente has a revenue of about €270K per year for the EIA sector. The experiment can generate an increase of +28% in that yearly revenue. As a result of the experiment, two new employees over the next five years is expected. Finally, an increase in competitiveness at the European level is anticipated since the workflow is easily customizable to European environmental legislation.

T2i will develop a brand new EIA-related service starting from scratch. There is no such (digital) service in T2i's portfolio and compared to the overall 'environment lab services' such as product tests, energy performance evaluations and CE labelling. T2i estimates a 5% increase in commercial revenues in the next two years corresponding to an expected increase in sales of €5K to €10K euros per annum.

Finally, this experiment offers a success story for CINECA, in the application field of environmental services. It is estimated that this will bring at least one new customer per year, with an approximate 5% increase in revenues from commercial services. This is in addition to an increase in cycle sales resulting from the use of CINECA resources in EIAs undertaken by eAmbiente.

Companies Involved

End-user: eAmbiente

HPC Expert: Progesi

Domain Expert: T2i

HPC: Provider: CINECA

2.27 HPC-Cloud-based Additive Manufacture

The Company

HSL is a hi-tech centre for the development of new products. With hundreds of products handled over the years, the company has developed experience with materials, traditional and innovative manufacturing technologies, prototyping, dies and moulding. HSL is an SME and a market leader in both Additive Manufacturing and the rapid production of prototypes. In recent years Additive Manufacturing has emerged as a viable mainstream production technology. Overcoming technical and bureaucratic obstacles has allowed 3D printing to grow as a cost-effective option for small and medium scale production together with the ability to produce complex shapes not achievable by standard manufacturing processes. This flexibility in design enables the optimisation of components, a reduction in manufacturing time by almost a third and a halving of production costs by reducing the waste of materials and energy.

The Challenge

Despite the clear advantages of Additive Manufacture, current design tools have been developed for traditional manufacturing procedures and are not flexible enough. This limits the potential of 3D printing. CAE tools are able to suggest new shapes and accurately predict the behaviour of components making them a natural choice in the design chain. However, and especially when dealing with complex Computational Fluid Dynamic (CFD) simulations, shape optimization can be a prohibitively expensive task for SMEs. The objective of this case study is the development of an optimisation service. The goal is to demonstrate the validity of such a service by optimising a prospective industrial artefact, a Lamborghini 12-cylinder airbox.

The Solution

Numerical grid parameterisation using a mesh morpher avoids the time consuming task of mesh generation (that can take up to 70% of the total analysis cost). Access to CFD simulation through the Fortissimo HPC Cloud allows a further speed-up in calculation times reducing the time to market and to return on investment. Using a collaborative, interactive, cloud interface helps analysts and clients to work together and to be integrated in the value chain, increasing customer satisfaction and building better products more effectively.

The development cost of a new air-box, estimated as 250k€ using a standard approach, can be reduced to 75k€ using the HPC cloud service. Based on a forecast that, over the next two years, HSL will undertake three new air-box optimisations each year and that, compared with traditional CAD methods, there is a cost saving of 175k€ per optimisation, the annual saving is equivalent to 525k€.

The Benefits

HSL expects that the new service will see the development of a business department with two to three staff, potentially growing to five to six staff after three to four years. For UTV it is estimated that thanks to the new know-how acquired the relevant department will increase its

industrial research services. The economic benefit is estimated to be between 40 to 70k€ per year in a five-year plan. Finally, this case study comprises a success story for CINECA, in the application field of high fidelity CFD, that is estimated to bring in at least two new SME customers per year, with an approximate 5% increase in revenue for commercial services.

Having access to the RBF Morph morphing tool combined with CFD analysis powered by HPC opens a wide range of business opportunities. In parallel with existing rapid prototyping services, HSL can now propose to its clients alternative component designs corresponding to appropriate performance indicators. For HSL, offering a shape optimisation service in parallel with its existing core business of rapid prototyping activities, represents an opportunity to establish customer activity over a range of key R&D areas. HSL is ready to offer the developed tool to a range of existing clients in the automotive industry, anticipating for the next two years, a total revenue growth of 16% per year in that sector.

Companies Involved

End-user: HSL

Domain Expert: University of Rome Tor Vergata (UTV)

ISV: RBF Morph

HPC: Provider: CINECA

2.28 Advanced Simulation for Metal Forming

The Company

MATRICI is a Spanish midcap company founded in 1964, specialising in the production and design of complex metal panels in the automobile and aerospace industries. In these sectors, it is involved from the initial phases of design through to installation and test. The sheet metal forming industry is important in the development of the world's economy. The use of HPC-based simulation can have a significant financial impact on the manufacturers of such panels. However, despite recent significant advances in computing hardware and software, high-end computer simulation and engineering design tools are often unaffordable for small companies because of the large capital investment in computing power required. This experiment demonstrates the benefits of advanced Cloud-based HPC tools in design and how these can be delivered as a pay-per-use service, affordable by small companies.

The Challenge

This experiment tested the feasibility of using a Cloud-based HPC simulation environment for the forming of sheet metal parts. The challenge was to develop a software solution that allows industry to simulate metal forming with higher efficiency and ease of use than possible using today's state-of-the-art commercial codes. The main customers of the new service will be SMEs, usually acting as part providers to OEMs and factories in the metal-forming industrial sector. End-users are also expected from large design departments of big companies, mainly automobile manufacturers. The goal is the full, simple, efficient and affordable integration of available powerful high-performance computing infrastructures with advanced simulation software

Stampack, a simulation code available from QUANTECH, models the forming of sheet metal panels. Its simulations enable engineers to concentrate on engineering problems and their solution. The major challenge of this experiment was to develop a high-performance version of Stampack able to run effectively in a Cloud of HPC resources, made available on a pay-per-use basis.

The Solution

A Cloud-based version of Stampack (StamHPC) has been adapted, developed and validated. Its performance and usability have been evaluated in an industrial setting. A graphical interface has been developed offering easy and intuitive use in the metal forming industry. This allows any end-user, even without HPC expertise, to launch a calculation and get results with an appropriate response time. Furthermore an appropriate licensing server has been developed which supports the availability of StamHPC on a pay-per-use basis.

The Benefits

MATRICI estimates that it will realise a minimum additional revenue of €200K per year through the use of a Cloud-based StamHPC in its design processes. QUANTECH and CESGA expect to involve around 300 new metal forming SMEs in using StamHPC over the next 5 years, leading to a potential return on investment of 60 M€ in that period.

A typical simulation to support the design of a metal forming process takes around 120 iterations each of which needs 20 computing hours on a standard workstation (8 cores and 32 GB of memory). Such a simulation represents10 weeks of work involving a workstation and an engineer. Using the StamHPC solution within an HPC-Cloud it is possible to run, at the same time, several options of the feasibility design concepts. This reduces the time to design a prototype. The reduction of time to solution is about 50%, which means an overall reduction of engineering costs of 50%. Considering that in a year a company like MATRICI performs 200 Feasibility design studies in order to make offers to customers, the reduction of design costs, plus the accuracy of the new StamHPC software would represent savings around 1.5 M€/year (2.5% of current company turnover for MATRICI).

CESGA estimates that it will see, due to the sale of computer cycles as a result of the Cloud-based StamHPC, an additional annual revenue of €45K in 2017 growing to €365K in 2021. SCAI will use the success of this experiment as a reference to support the sales of its software products, particularly those relevant to HPC-based Clouds.

Companies Involved

End user: MATRICI - Spain

Technology expert: SCAI - Germany

Independent Software Vendor: QUANTECH - Spain

HPC Provider, Expert and Host Centre: CESGA - Spain

2.29 Optimised cutting and bending of steel reinforcement bars using Cloud-based HPC

The Company

Schnell Software, a Spanish SME, designs specialized CAD-CAM software for companies which cut and bend steel. In particular, it develops software applications which optimise the cutting of iron bars for reinforced concrete. SCHNELL already had optimisation software which ran on a PC. For medium-sized orders with lower levels of optimisation, SCHNELL could get results on a PC in around 10 minutes. However, execution on a PC could take several hours if the level of optimization were increased. Big orders, which needed high levels of optimisation, could take more than 3 hours, which is impractical in a production environment.

The optimisation of cutting and bending of iron bars is based on complex algorithms which are numerically intensive. Good optimisations would enable SCHNELL's customers to plan

their schedules to obtain the best possible combination of its orders, to minimise wastage in the cutting and bending process and to save time in the analysis of production orders and raw material requirements.

The Challenge

The challenge facing SCHNELL was to modify its software to run on a Cloud-based HPC system rather than on a local PC. The objective was to reduce the compute time from hours down to minutes for even large-scale optimisations. A further goal was to develop a graphical user interface to steer the optimisations. The modified software would serve as a database portal to optimize functions in the Cloud and clients would be able to carry out a real simulation of a cutting process with minimal cost and effort.

For small companies, the acquisition of an in-house optimization system that guarantees a reliable cut of high quality requires an initial economic investment in hardware and software. Not all small and even large companies, are willing to do this because they are not sure of the benefits. Through the implementation of a cloud-based optimisation service on a pay-per-use basis this barrier can be overcome because companies are able to test and evaluate the service without the need for a large capital investment.

The Solution

The optimization software has been adapted to run in a distributed Cloud-based HPC infrastructure. Through the use of a graphical user interface it is easy to setup and optimise bar cutting and bending optimisations. This hides all the complexity of the Cloud. Launching optimisations is as simple as sending some input files, with appropriate parameters and receiving the results after a manageable processing time.

The Benefits

A large foundry produces 2,000 tonnes of steel bars per month. Through the use of Cloud-based high-level optimisation, it can reduce waste steel by 2% (480 tonnes per annum) Given that the average price of steel is €500 per tonne, this represents a saving of €240K per annum. This compares with a saving of only €60K per annum using only low-level optimisations on a PC. Additionally, by using high-level optimisations there is an associated reduction in personnel costs of €30K per annum.

A simple analysis of the costs of performing the high-level optimisation in-house on a sufficiently powerful system results in a yearly expenditure of €80K. The corresponding computing costs of performing the same optimisation in the Cloud are only €7.5K per annum.

Over the next 5 years SCHNELL estimates a total income of ~€480K from the provision of its Cloud-based optimisation service to steel foundries, including Cloud-computing and SCHNELL licence costs, resulting in a total profit of ~€440K. In addition to this, CESGA will increase its sales of computer cycles by around 175,000 CPU hours per year. It will also use the outcome of this experiment as a reference to promote its Cloud Services.

Companies Involved

End user: SCHNELL

HPC and Application expert: UNIZAR-BIFI

Independent Software Vendor: SCHNELL

HPC Provider, Expert and Host Centre: CESGA

2.30 Advanced Simulation of Hydro-power Turbines

The Company

Zeco is an Italian SME from the renewable energy sector. It specialises in the production of different types of water turbine. Nowadays, the renewable energy sector is one of the most competitive and promising markets, as efficiency and pollution constraints are becoming increasingly strict. SMEs like Zeco must develop and innovate their products to remain competitive. High-fidelity simulation using Computational Fluid Dynamics (CFD) has become an essential tool for turbine designers because it results in better designs for less effort and lower cost. However, for Zeco and, in general for SMEs, the main obstacle to the full exploitation of CFD tools is the necessary computing power, which can be considerable and which requires the use of HPC. A further obstacle is the lack of skills in both CFD and in HPC which need to be provided by external experts. The objective of this experiment is to demonstrate how all the necessary resources can be assembled to give ZECO a one-stop-shop for the simulation of turbines leading to business benefits across the whole value chain.

The Challenge

Current practice in the design of hydro-power plants is to determine empirically the most suitable design in a series of time-consuming experiments. However, SMEs in this sector have to face private and public tenders to sell their turbines in both national and global markets, where the competition is very strong and the development time is very short. The challenge facing Zeco is to improve its design processes by the use of HPC-based high-fidelity simulations of flow in its turbines through the use of CFD-based tools.

The Solution

In order to reduce development times significantly and hence to increase the competitiveness of SMEs, a CFD-based HPC application has been developed which enables the customization of a small hydro power plant in a very fast and reliable way, when compared to current practices. The use of this application can contribute significantly to savings in time and money in the development of new water-turbine systems, customized to meet user demand. It enables Zeco to understand the performance and characteristics of its products. High-fidelity simulations and the availability of HPC, significantly reduce the development costs of prototypes. Hence the time to market using HPC-based simulation is drastically lower than current in-house practice.

The Benefits

The use of HPC-based CFD calculations has reduced the design time of a turbine from 1 year to 3 months. Given that manufacturing the turbine takes 8 months, this means a reduction in time to market from 20 to 11 months. Without the use of HPC-based simulation, the overall development process could take up to two years which is no longer a competitive time frame.

The benefit for Zeco of HPC-based simulation is a highly efficient and customizable turbine. Using such turbines, a medium-sized hydropower plant costing 1.5M€ a can generate for Zeco's customers a reduction in operational costs per installation of 350 k€ over two years. Furthermore, the optimization through HPC leads to an increase of efficiency of the plant of around 1%, with a 50% reduction in the total number of days required for maintenance. This means an increase of the revenue related to energy production of up to 40 k€ per year per installation.

HPC-based simulation has been used to address the customisation of water turbines and the avoidance of problems arising in hydro-power plants. In this test case, the investment in software is around 40 k€, while the cost of computing cycles is 75 k€. The recovery of this

investment can occur if a single power plant is sold. Zeco's commercial history has shown a potential for 2 of these complete power plants to be sold per year. Due to these improvements, Zeco expects to increase its market share by at least 5% with an additional profit of 50 k€ per year representing a positive return on investment for every single plant sold.

As a result of the increased market for advanced simulation using HPC, EnginSoft expects a growth of 10% in business related to the turbo-machinery market sector, which means an additional profit of around 50 k€ per year.

Based on the compute needs of Zeco to design two plants, CINECA has a revenue potential of 100 k€ per year, that is roughly 5% of its HPC commercial services revenues. Since the kind of workflow developed for Zeco is easily translatable in other engineering sectors, the target market for CINECA is much larger than the small hydropower turbines niche, that is already an interesting market by itself. The target for CINECA is to acquire two customers of this type per year in the following three years. This means an estimated increased revenue of 900 k€ over the next three years, with a profit of around 100 k€.

Companies Involved

End-user: Zeco

HPC Expert: EnginSoft

ISV: ANSYS

HPC: Provider: CINECA

2.31 HPC-based prediction of the optical properties of dyes

The Company

Scriba Nanotechnologie is an SME active in the fields of smart packaging, health and machine vision. In particular, Scriba is involved in the development of time temperature integrators (TTIs) which are devices for recording the thermal history of goods. Placed close to perishable products, they can be used to monitor the thermal history of packaging and storage conditions. Such devices address an important aspect of cold chain logistics in a world where production is global. Cold chain logistics are also addressed by regulators because the quality of products and goods is greatly affected by the thermal history across the distribution chain.

This Fortissimo experiment addresses the prediction of the optical properties of dyes. It uses molecular dynamics to simulate dyes used in the manufacture of innovative TTIs. Simulations reduce the time to customise these devices, thus lowering the overall cost of traceability systems. Molecular dynamics-based simulations are known to be well suited to HPC systems, since existing algorithms have been optimized to obtain a very high performance. The objective of this experiment is to develop an effective Cloud-based-HPC system for the modelling of potential dyes for the manufacture of TTIs.

The Challenge

The challenge faced by this experiment is to use HPC to simulate candidate dyes, based on molecular dynamics, to be used in the fabrication of innovative TTIs. Customization of temperature and time of integration is fundamental to optimize the data provided by the smart sensor and its integration into the production line, without slowing down the rates of production and distribution. This requires a multidisciplinary approach using molecular dynamics-based simulations of dyes in the fabrication of innovative TTIs. The aim is to reduce the time required for customisation of TTIs, lowering the overall cost of traceability

systems proposed to manufacturers. The goal is to develop a new tool for cold chain logistics which enhances both packaging technology and the availability of relevant logistical data.

The Solution

The experiment has addressed the determination of the physical properties of dyes suitable for use in the productions of TTIs. A computational pipeline for the simulation of optical properties of dyes in different environments has been set up. A cloud-based web portal has been developed, to manage the simulation of the optical properties of dyes. This portal has been specifically designed for a user with no expertise in simulation. The complexity of the simulation is hidden from the user, who needs only select the material of interest and the experimental conditions to be simulated. Default options are presented to help the user proceed through the steps in the simulation and, most importantly, to optimise the balance between computational cost and the reliability of the simulation.

The Benefits

Through the use of the advanced simulation package Scriba expects to see a saving of €90K per simulation in the first year of use, with further savings of €70K in subsequent years. This can be broken down as savings in personnel costs of €45K, in infrastructure costs of €10K, in material costs, including computing costs, of €25Kand optical readout and further development of €15K in the first year. Scriba estimates that it will be involved in ~ 6 simulations per year resulting in an annual saving of ~€400K.

CINECA expects to see an increase in HPC cycle sales due to the use of the simulation package. It also plans to use the success of this experiment to target SMEs in the European market having the need for high-fidelity chemical and molecular dynamics simulations needs. The target is to acquire two customers of this type per year in each of the following three years. UNIMORE and UNIVAQ expect to see an increase in their consultancy business as a result of this successful experiment. Both partners will be further involved in the enhancement of the software, operating as external consultants. The value of the external consultancy to the two domain experts is estimated to be ~€10K per year each. The number of potential users to run simulations explicitly for the development of temperature sensors is about 5 and for the design of optical (bio)sensors about 100.

Scriba will make available the developed virtual tool in the Fortissimo marketplace, subject to appropriate terms and conditions.

Companies Involved

End-user: Scriba Nanotechnologie

HPC Expert and HPC provider: CINECA

Domain Experts: UNIVAQ and UNIMORE

2.32 Multi-physics simulation of high-temperature superconducting devices

The Company

Oxolutia is a technology-based Spanish SME specialising in thin-film oxide architectures deposited by industrial inkjet printers using special inks. The objective of this experiment is to investigate a new market for Oxolutia in the area of high-temperature superconductors (HTS) which can be used to construct generators, motors and superconducting magnets for applications such as power cables, energy storage and magnetic resonance imaging (MRI) devices. This is a growing market and one where there is a need for new design tools, tackling

mechanical, thermal and electromagnetic behaviour. The hard non-linearity, hysteretic behaviour and time dependence of HTSs require a robust, fast and powerful computing environment for obtaining solutions consistent with a productive design cycle. To reduce design times to reasonable levels, High Performance Computing (HPC) has become an essential component in the development of such a design tool.

The Challenge

Starting from the electromagnetic software package, FEMPAR from the ISV CIMNE, the challenge was to develop and implement the capabilities of the code to calculate magnetic, electric and current density fields, mechanical and thermal properties including temperature, stress and strain fields. An important part of this challenge was to compare the calculations from the enhanced FEMPAR with those from commercially tested solvers in order to verify the results obtained.

The Solution

In order to enable feasible computation times and to increase the competitiveness of an SME by enabling a new business area, a multiphysics-based HPC application has been developed which enables the behaviour of HTS devices to be simulated. The use of this application can contribute significantly to savings in time and money in the development of such devices adapted to meet customer demands. It enables Oxolutia to understand the performance and characteristics of its products. High-fidelity simulations and the availability of HPC, significantly reduce the development costs of prototypes and have opened up a new market for the SME.

The Benefits

CESGA and CIMNE plan to offer a service enabling SMEs to simulate the electromagnetic and physical behaviour of HTS devices. This service will be offered on a pay-per-use basis including licence fees and the costs of computing cycles.

Through the use of this service Oxolutia expects to see a new business turnover over the next year of €25k, based on the sales of HTS devices, of which production costs, licence fees and computer cycles would comprise €12k, that is a net profit of €13k. Over the next 3 years, Oxolutia expects to see a new business turnover of €500k of which production costs, licence fees and computer cycles would comprise €150k, that is a net profit of €350k.

Similarly, ISV CIMNE anticipates a net profit of €54k from related new business over the next 3 years due to the provision with CESGA of the pay-per-use simulation service. Over this period CESGA expects to increase its provision of CPU cycles to CIMNE by 32k core hours.

ICMAB, the HPC application expert, expects a profit over this period of €45k based on increasing of consultancy and research contracts using the pay-per-use service.

Companies Involved

End-user: Oxolutia

HPC Expert: ICMAB-CSIC

ISV: CIMNE

HPC: Provider: CESGA

2.33 HPC-Cloud-based monitoring of crowds

The Company

DFRC is a leading centre for knowledge, research, and development of geospatial data fusion and analysis. Its expertise lies in crowd monitoring and smart cities, safety and security. DFRC delivers powerful end-to-end solutions using data about the location and the movement of people, using a suite of tools, software platforms and applications relevant to location-based technology, smart cities and maritime surveillance.

DFRC operates a service called LBASense, which anonymously measures crowd behaviour on a city-wide scale. This information is highly valuable for services such as transportation planning, the promotion of tourism and public safety applications. LBASense, which is currently operated in Bern, Zug, Skelefteå, Barcelona, Prague and Singapore, requires an extensive "fingerprinting" of the cellular network radio signals in order to calculate the location of mobile phones.

This "fingerprinting" uses the Amazon EC2 cloud infrastructure to extrapolate number of measurement points onto a map of cellular coverage. The most expensive part of the current system is not the extrapolation itself, but rather the process of taking measurements at specific points. In practice, some points are nearly useless in terms of determining the "fingerprint" of a city, while others provide significant information. Furthermore, this mapping requires a lot of time and the deployment of special measurement equipment. DFRC is looking to use Cloud-based-HPC simulations to speed up this expensive mapping process by determining the best points at which to take measurements.

The Challenge

The challenge of this experiment was to improve the process of "fingerprinting" a city by offering a near real-time (in terms of hours) simulation to determine the best locations at which to take measurements. Doing this was expected to reduce the time to map a city from weeks to days and hence the associated costs by at least 50%. To achieve this objective, DFRC aimed to take advantage of advanced simulation services and tools running on a cloud infrastructure. The clear goal was to use high-performance simulations to speed up the deployment of LBASense. Clearly, the realisation of this goal would enhance DFRC's competitive position in the market. To respond to this challenge, the mapping algorithm, which determines the best locations for measurement points, would need to be ported to a Cloud-based HPC system.

The Solution

Existing simulation tools have been ported to enable them to run on an HPC system with many processors. Detailed tests have been made to verify the correctness, accuracy and stability of the ported algorithm and to determine the speed up of the implementation. The outcome of the experiment has been a high-performance combined simulation tool that reduces the deployment time of LBASense. This allows DFRC to finish a single iteration of the simulation within hours as opposed to days using a more conventional approach.

The Benefits

The ability to access a cost-effective one stop-shop HPC service enables DFRC to reduce significantly the deployment costs of LBASense. This saving is approximately two weeks each for two engineers per deployment, which is approximately €25K. The results show that DFRC is able to speed up the whole process of mapping a city (i.e. 1000 base stations – 10x10 km) by a factor that is very close to the number of processing units available. That is, with 32 processing units it is possible to speed up the computation process by a factor of

almost 32. This allows DFRC to offer a cheaper, faster and more focused service and hence to be more competitive with respect to cellular operators. DFRC expects to gain new market share, especially by being able to reduce time to market. Based on the overall costs of installing LBASense in a city and the speed with which it can be done, DFRC expects to see a growth in its business from 20 installations in 2017 to 200 in 2021 with an overall cost saving of ~€8M.

HLRS benefits from the experiment through an increased knowledge about commercially relevant scenarios leading to improved offerings for a wider range of customers, which will increase its competitiveness.

Companies Involved

End-user: DFRC AG

HPC Provider: HLRS

2.34 Cloud-based design of motorcycle helmets

The Companies

The NolanGroup is a Mid-Cap Italian company manufacturing motorcycle helmets. It has approximately 350 employees with annual sales of €42M. It owns the commercial helmet brands Nolan, X-Lite and Grex. It is one of the leading manufacturers of motorcycle helmets worldwide. Nolan produces helmets for professional, leisure and racing activities, participating in the main international motorcycle competitions. Production facilities are located in Italy. Nolan serves a worldwide market with 80% of its sales in Europe (35% Germany, 20% Italy, 15% France). Nolan wants to enhance its helmet design capabilities to reduce costs and time to market through the use of advanced HPC-based simulation.

Moxoff is an Italian SME using mathematical modelling to solve complex industrial problems. Moxoff's projects cover a wide range of applications, including multiphysics modelling, numerical simulations, statistics and big data analytics. Moxoff has had a partnership with Nolan since 2010. A dedicated multiphysics platform, CASCo, has been developed by Moxoff to support the simulation of the characteristics of Nolan's motorcycle helmets. The objective of this experiment is to develop CASCo further to use Cloud-based HPC and to enable Nolan engineers to perform advanced multiphysics simulations in a simple way and with a shorter turnround time.

The Challenge

Traditionally, Nolan helmet design has been based on physical experiments using prototypes. They have only recently introduced the simulation-based approach using CASCo to simulate external aerodynamics, thermal effects, acoustics, and impacts. This enables Nolan engineers to perform simulations easily even if they are not expert in the underlying physics. In performing such simulations, the choice of the computational platform is critical as computing times can be minutes, hours, days or weeks depending on the computing platform used. Clearly, this can have a significant impact on the design cycle and the right choice of platform can reduce compute times by two or more orders of magnitude. The aim of this experiment is to enable advanced and fine detail simulations with feasible runtimes through the use of HPC via the CASCo platform. A further aim is to enable these simulations to be performed without a deep knowledge of the underlying physics and mathematics to enable the focus to be on design. Realising such aims would give Nolan a powerful tool and a significant advantage over its competitors. Because these challenges are commonly experienced by Moxoff's customers, the aim for Moxoff is to stimulate its business by configuring a flexible HPC-simulation-based service to be re-used in other projects.

The Solution

The CASCo Multiphysics platform has been ported to an HPC system. This enables detailed models to be simulated in a simple way by those not expert in the underlying physics. This has involved the enhancement and customisation of GUIs, workflows and file formats, and the development of the interface with an HPC scheduler system. Specific attention has been given to improve the performance of the routines managing the simulation data as the size of the computer models has increased significantly.

Similarly, post-processing has been optimised to support the easy display and greater usability of results given the significant increase of output data. Originally, all post-processing was performed on a desktop client, involving huge data transfers onto a platform with limited resources. The new HPC approach has shifted all the post-processing to the HPC server to take advantage of its hardware performance, while downloading only the processed data to the local client. These enhancements have achieved the aim of enabling those not expert in multiphysics to perform detailed simulations and to make their results easily accessible and in a much shorter timescale.

The Benefits

In this experiment a powerful simulation platform has been developed by Moxoff which can be easily configured to provide Simulation-as-a-Service using massive HPC computing resources, even in totally different industries. Nolan can either use its own IT resources or, for time sensitive simulations, use a pay-per-use service hosted in the CINECA HPC facilities.

Moxoff estimates that its exploitation of the SaaS and the platform will increase its turnover by 10% and will significantly contribute to its planned growth for the coming 3 years. Furthermore, through the wider development of this platform, Moxoff will reduce its software development costs by €50K per year.

Nolan estimates that, for each new helmet developed, the use of HPC simulations will save money in physical prototype testing and final product tuning. This new approach will provide a net saving of €52K per helmet once the cost of compute cycles and software licences are deducted. Furthermore, advanced simulations will lead to a 3-month reduction in the current 15-month development cycle which can have important implications for Nolan's market impact.

Finally, this experiment comprises a success story for CINECA, in the application field of integrated multiphysics workflows, that is estimated to bring at least two new SME customers per year, creating an approximate 5% increase in commercial revenues.

Companies Involved

End-user: NolanGroup

Technology and Domain Expert: Moxoff

HPC Expert and Provider: CINECA

2.35 Simulation of High-Performance Composite Materials in the Automobile Industry.

The Company

The industrial use of carbon-fibre-reinforced plastic (CFRP) is being driven by the increasing use of composites to reduce weight in the automotive industry, where cost and performance are major factors. Legislation around the world is increasing the requirement for lightweight vehicles. With world-wide tooling budgets running well into hundreds of millions of Euros,

the simulation of processes and the prediction of manufacturing times are central to delivering high-quality products at an affordable price.

Formtech Composites specialises in the design, engineering and manufacture of lightweight composites structures and components, using carbon, glass, aramid and other high-performance fibres. It collaborates with leading automotive, motorsport, military and aerospace partners to take forward composite research, engineering, prototyping and serialised manufacture. As a concrete example, Formtech produces inner bonnets for automotive vehicles. To maintain or improve its competitive position, Formtech has a clear need to use advanced simulation in its design process.

The Challenge

This experiment aimed to develop an integrated virtual process chain to simulate the manufacture of high-performance composite structures. The objective of this CAE chain was to combine all essential simulation steps to enable integrated product development. Such a chain would firstly consider manufacturing effects from previous steps in the simulation and, secondly, allow an iterative structural optimisation over multiple simulation steps.

To make high-performance CFRP economically viable for large-scale production, it is essential to reduce overall development and production costs. The big advantage of a continuous virtual CAE chain would be the acceleration of the development loops, with each single loop covering the simulation of manufacturing processes (draping, moulding and curing), the automated transfer of process simulation results, and the structural simulations of the product itself.

The objective of this experiment was to develop a CAE chain which could tackle the reduction of overall development and production costs through the development of the required CAE chain and the implementation of the associated development loops.

The Solution

KIT in cooperation with Fraunhofer SCAI has developed a prototype simulation platform, which allows the planning of the manufacturing processes and the prediction of final structural performance. This enables the required holistic product optimisation. In this experiment an integrated workflow to optimise the design of CFRP components has been developed, which uses the prototype from KIT and Fraunhofer SCAI. It is accessible through a web-based interface and runs on a Cloud-based-HPC system at Gompute. Even though this approach requires significant compute resources for the design of components, such as an inner bonnet, the Gompute system can easily satisfy the necessary compute requirements.

The Benefits

The platform developed increases the quality of designs. It adds functionality while reducing the work load on the engineer's side. It shortens simulation times from days to hours whilst offering more detailed simulations. Such simulations lead to less material usage and the need for fewer mechanical tests. Formtech has already exploited the HPC capacity of Gompute to meet a project deadline where a 50% reduction in compute time was imperative. Clearly advanced simulation enables Formtech to maintain a competitive edge over other companies world-wide. As a result of using advanced simulation, Formtech anticipates an increase in revenue per annum of ~€100K.

KIT estimates that, due to time saving through using HPC systems, it will increase its annual revenues by around €30K. Additionally, annual personnel costs will be reduced by €10K.

Fraunhofer SCAI expects a strongly growing demand for customised and integrated CAE development. Fraunhofer SCAI estimates that, during the next 2 to 3 years, it can increase its regular annual licence revenues for such developments by ~€60K

The outcome of this experiment has given valuable feedback to Gompute. The success of this CAE chain implementation has already brought new business with annual turnovers of over €2K for the sale of compute cycles.

KIT and Fraunhofer SCAI plan to offer a CFRP simulation service via the Fortissimo Marketplace starting in Q3 2017.

Companies Involved

End-user: FORMTECH COMPOSITES

Software Provider: FRAUNHOFER SCAI

Domain Expert: KIT-FAST

HPC: Provider: GOMPUTE

2.36 Cerebral blood-flow simulations

The Companies

The non-invasive accurate and quick measurement of the intracranial pressure (ICP) is of paramount importance for the diagnosis and treatment of neurological diseases, brain injuries and other neuro-pathologies. The world's first accurate, non-invasive ICP absolute value measurement device, based on two-depth ultrasound Doppler technology, has been developed by a Lithuanian SME, Vittamed. Despite the technological achievements and success of measuring ICP non-invasively, Vittamed faces technological challenges in seeking to increase accuracy and precision of its measurement device, its user-friendliness and its cost effectiveness both to reinforce the company's leadership and to open access to new markets. Mathematical modelling and simulation are key to improvements in Vittamed's technology because of the impossibility of obtaining this information in other ways, such as experiments with humans.

The Simula Research Laboratory was founded in Norway in 2001. Its main objective is to create knowledge about fundamental scientific challenges of genuine value for society. Simula has developed leading-edge blood flow models. The use of these models in the simulation of ICP requires the use of HPC. The implementation of these models on a Cloud-base-HPC system is the objective of this experiment.

The Challenge

The challenge facing the partners in this experiment was to create mathematical models and develop the necessary software tools to enable simulations of cerebral blood flow in the ophthalmic artery to be performed. The computational requirements of such simulations made it necessary to adapt the software tools to run on an HPC system. The goal was to demonstrate the feasibility and benefits of such simulations to Vittamed and how the necessary computations could be performed via a pay-per-use Cloud-based-HPC solution.

The Solution

An internal Carotid/Opthalmic Artery model has been developed, based on MRI imaging, and used to simulate blood flow. This model has been tested and optimised to run on a multi-processor HPC system. It will be used by Vittamed in the future development of its non-invasive ICP measurement technology by simulating blood flow in arteries with specified

parameters under different external conditions in order to gain understanding of blood-flow pulsations. Simula has written and tested the necessary software tools needed to implement the required simulations. These tools enable the efficient implementation of the model on an HPC-system. Simulations of the blood-flow model can be performed easily by non-experts by specifying the model parameters through a simple text file.

The Benefits

Through cloud based-HPC simulations Vittamed can realise a reduction in time to market, due to shorter simulation times. It can also design more accurate products. In particular, Vittamed is targeting a new ophthalmological market niche for glaucoma diagnostics, where more precise and accurate ICP measurements are needed. Glaucoma blindness is irreversible, but it may become preventable, if aided by advancements in screening and early detection. Improved measurements of intraocular and intracranial pressure would enable the development of innovative diagnostic and screening technologies and treatment methods. Vittamed can gain a significant commercial benefit resulting from the global expansion of the market for ICP diagnostic devices in ophthalmology. The global market for ophthalmic diagnostic equipment is estimated to reach $947M in 2017. The new market niche for SME in ophthalmology will create a commercial opportunity with an estimated potential of more than €100M per year.

Simula Research Laboratory will exploit the results of this experiment by developing research projects with industrial, clinical, and scientific communities across Europe and beyond. The open-source solver developed is an attractive alternative to commercial solvers because there are no associated licence fees.

The results of the experiment will support the HPC cloud provider, CINECA, in offering its services to the biomedical market, enabling SMEs to benefit from HPC-based simulation.

Companies Involved

End User: Vittamed

HPC and Application Expert: Simula

Application Expert: Simula

Provider and Host Centre: CINECA

2.37 Cloud-based simulation of complex fluids

The Companies

Ioniqa, a Dutch SME, specialises in the development of Magnetic Smart Materials and Processes. Magnetic Smart materials are used in a range of applications including car brakes and shock absorbers in civil engineering, industrial machinery, washing machines and prosthetic limbs.

Ioniqa has developed a Magnetic Smart Process to recycle all kinds of coloured PET polyester waste into ‘virgin quality’ raw materials, competing with oil-base PET in both quality and costs. With this game changing technology Ioniqa has found a profitable solution for almost a quarter of all plastic waste in the world.

The modelling of Magnetic Smart Materials and Processes is very demanding involving the simulation of the microstructure of complex fluids and its effect on transport and rheology. Electric Ant Lab, a Dutch SME, has developed a software package called SuSi which performs such simulations. This package is available as RheoCube, an SaaS, which addresses the need for high-fidelity predictive simulations in prototyping smart materials and complex

fluids. RheoCube allows product developers to use novel simulation methods and HPC resources just as they would use a physical rheometer. RheoCube as an SaaS makes high-fidelity simulations of complex fluids available to SMEs in an affordable way giving them a valuable tool for innovation. Market research has shown that there is a €2B market for rheology directly accessible to RheoCube.

RheoCube and SuSi are built on top of the HPC infrastructure of SURFsara, the Dutch National HPC Expertise Centre.

The Challenge

Electric Ant Lab (EAL) has developed software, SuSi and RheoCube, for the detailed simulation of complex fluids that provides a solution to many practical applications. However, the high-fidelity simulation of a Magnetic Smart Material or Process, as needed by Ioniqa, requires a resolution of smaller than 1µm in space and 0.1µs in time. Such a simulation, representing a material sample of $1mm^3$ and a physical time span of 1 second, would take around 10 years on a single CPU-core. State-of-the-art HPC resources with dedicated compute nodes, high-end GPGPU accelerators, and fast interconnect are prerequisites to bring the total runtime for such a simulation down to an acceptable timescale of 1 or 2 days. The challenge facing this experiment was to make such high-resolution simulations available to material scientists not familiar with the technicalities of advanced simulation and for such simulations to be available within a practical timeframe of a few days through the use of Cloud-based HPC.

The Solution

A user interface has been developed within the RheoCube environment, which emulates a "wet-lab" familiar to material scientists. This includes a workflow which enables the user to design and run an experiment on the Cloud-based-HPC backend system. For each step of the workflow, objects such as particles, fluids and materials can be defined. Post-processing libraries and visualisation, and analysis frameworks support the interpretation of results by the user.

An interface between RheoCube and HPC systems has been developed. This interface manages all aspects of the computationally intensive simulations including job submission and queueing, and data storage. Modifications to SuSi to handle magnetorheological fluids have been made and validated against data from physical experiments. SuSi has also been extended to include experimental conditions which cannot be realised in a wet-lab, but which are nevertheless relevant for real-world applications.

The Benefits

EAL estimates a total net profit of ~€400K over the next five years based on income from consulting and the provision of RheoCube as an SaaS, leading to an ongoing yearly profit of ~€550K from 2022 onwards.

SURFsara has a projected revenue stream through its collaboration with Electric Ant Lab of ~€13K in 2017 with a doubling of revenue each year for the following 4 years.

Both, RheoCube and EAL's consultancy on HPC simulations of the flow of complex fluids will be offered through the Fortissimo Marketplace.

Companies Involved

End-user: Ioniqa Technologies

ISV: Electric Ant Lab

2.38 HPC-Cloud-based seakeeping design

The Companies

Seakeeping is the study of a ship or a marine structure subjected to the action of waves. The objective of this experiment is to develop an HPC-Cloud service for seakeeping assessment for the end-users WAVEC and VICUSDT. WAVEC is a private non-profit association active in applied research and consulting. HPC-Cloud-based simulation of marine structures has the potential to expand WAVEC's activities as a consulting company specialized in services for the offshore renewable industry and other related industries (aquaculture, oil and gas, shipbuilding). VICUSDT operates in the shipbuilding and shipping industries. It provides hydrodynamic engineering services including hydrodynamic optimization for the complete ship. VICUSDT also provides hydrodynamic analysis capabilities to the offshore and marine energy sector, carrying out advanced simulations of structures for the oil and gas industry. COMPASSIS is an SME ISV which provides simulation software for a variety of different engineering fields including multiphysics simulations and structural and seakeeping analysis. In this experiment COMPASSIS will enable and evaluate simulations that require intense computational and data storage resources. CIMNE, a research organisation, will also provide some of the software components required for this simulation.

The Challenge

The challenge addressed in this experiment was to demonstrate the use of advanced simulation in seakeeping design. Such simulations require large amounts of computing power to realise viable calculation times. This requires the use of computing resources from an HPC provider. The objective of this experiment was to adapt seakeeping software to run on remote HPC resources, to demonstrate the benefits of advanced simulation using Cloud-based HPC, to study the resultant performance of the simulations and to demonstrate their potential economic impact. A further aim was to develop a service for seakeeping studies available within the Fortissimo Marketplace. Realising such aims would give WAVEC and VICUSDT a powerful design tool and a significant competitive advantage.

The Solution

The relevant software packages have been ported to the HPC-Cloud-based system and integrated into an overall simulation package. An effective interface between the end-user and the HPC resources has been implemented which integrates the various software components and the HPC system. This enables the simulations to be run from a familiar desktop system whilst using the full capabilities of the HPC system. The simulations running on the HPC system have been benchmarked using a model of an off-shore floating wind platform and a model of a stern trawler. These demonstrated a significant speed-up by a factor of 45 through the use of an HPC system. This makes previously infeasible simulations now feasible and paves the way for new services to be offered by the end-users WAVEC and VICUSDT.

The Benefits

The use of Cloud-based-HPC simulations enables cases to be analysed more quickly. It also allows previously infeasible cases to be analysed.

Over the next four years, from 2017 to 2020, WAVEC expects an increase in its total profit of ~€550K, based on a revenue of €1.8M, due to an increase in its consultancy activities. Over the same four-year period, VICUSDT expects an increase in its total profit of €480K, based on a revenue of €1.4M, due to an increase in its consultancy activities. Over the same four

year period, COMPASSIS expects an increase in profit of €2M based on an increase in its licence sales of €4.5M.

A service for seakeeping assessments based on the results of this experiment is planned to be available in the Fortissimo Marketplace offering a pay-per-use model. Furthermore, CESGA proposes to offer a service in the Marketplace bases on the benchmarking of key applications and their performance and scalability.

Companies Involved

End-user: WAVEC and VICUSDT

ISV: COMPASSIS

Domain Expert: CIMNE

HPC: Provider: CESGA

2.39 HPC-Cloud-based standard strength assessment of commercial ships

The Companies

The standard strength assessment of merchant ships such as tankers and container ships is an important and statutory requirement. The objective of this experiment was to develop and validate an easy-to-use solution for standard strength assessment calculations using HPC-Cloud-based resources. This solution has been made available to the end-user ISONAVAL, an SME working in the areas of naval architecture and marine engineering services. ISONAVAL is specialized in structural and piping systems design, and the generation of analysis and production information for ships, yachts and naval artefacts. ISONAVAL has recognised expertise in the use of simulation. COMPASSIS is an SME ISV which markets simulation software, RamSeries, in different engineering fields including multiphysics simulations and structural analysis. In this experiment the expertise and software of COMPASSIS will be complemented by FNB-UPC, a University research centre developing innovative simulation tools and implementing them on HPC systems.

The Challenge

The challenge addressed in this experiment was to demonstrate the use of advanced simulation in standard strength assessments of merchant ships. Such simulations require large amounts of computing power to realise viable calculation times. This requires the use of computing resources from an HPC provider. The objective of this experiment was to adapt standard strength assessment software, RamSeries, to run on remote HPC resources, to demonstrate the benefits of advanced simulation using Cloud-based HPC, to study the resultant performance of the simulations and to demonstrate their potential economic impact. A further aim was to develop a service for standard strength assessment available within the Fortissimo Marketplace. Realising such aims would give ISONAVAL a powerful design tool and a significant competitive advantage.

The Solution

The relevant software packages, including RamSeries, have been ported to an HPC-Cloud-based system and integrated into an overall simulation package. An effective interface between the end-user and the HPC resources has been implemented which integrates the various software components and the HPC system. This enables the simulations to be run from a familiar desktop system whilst using the full capabilities of the HPC system. The simulations running on the HPC system have been benchmarked using a model of the full 3D

hull structure of a merchant ship. These demonstrated a significant speed-up by a factor of 42 through the use of an HPC system. This makes previously infeasible simulations now feasible and paves the way for new services to be offered by the ISV COMPASSIS.

The Benefits

A standard strength assessment study of a tanker requires more than a week on a desktop system. The use of RamSeries with HPC resources allows a complete analysis in less than 6 hours. This significantly reduced compute time fits much better to the design cycle of companies.

COMPASSIS will increase its market by introducing the use of the RamSeries software for the direct strength assessment of a complete ship structure. This assessment requires large computational and data storage resources. COMPASSIS estimates an additional annual revenue of €24K in 2017 growing to €120K in 2020, due to the sale of direct strength assessment of complete ship structures using RamSeries integrated with a Fortissimo HPC infrastructure.

ISONAVAL estimates an additional annual revenue of €15K in 2017 growing to €60K in 2020, also due to the sale of direct strength assessment of complete ship structures.

CESGA will offer new HPC added-value services for SMEs such as benchmarking to analyse performance of HPC applications, including multi-core scalability and its dependency on different parameters such as size of the problem and processor frequency. It expects a consequent increase in its HPC services and customers. New alliances with ISV and application experts have been formed during this experiment. Revenues based on 3 benchmarking studies and an annual fee for hosting the ISV software and for infrastructure maintenance will be around €35K over a 4-year period.

Companies Involved

End-user: ISONAVAL

ISV: COMPASSIS

Domain Expert: FNB-UPC

HPC: Provider: CESGA

2.40 Cloud-based shape optimisation in manufacturing

The Companies

Over the last two decades, numerical simulation has become a key enabler for innovation in manufacturing. The capability to simulate the features of a new product, without the need to build a physical prototype, has lowered both cost and time to market and enabled the design of better products.

Automobili Lamborghini, is an Italian manufacturer of luxury sports cars and SUVs. The company is owned by the Volkswagen Group through its subsidiary Audi. Founded in 2006, OPTIMAD is an Italian SME active in shape and topology optimisation in the engineering sector. The objective of this experiment was to demonstrate that by combining High-Performance Computing (HPC) and optimisation software, there is an opportunity to change current design practices and bring automatic shape optimisation (ASO) to a wider audience of manufacturing SMEs. The goal was to develop and implement an HPC-cloud-based platform that gave the inexperienced user the possibility to optimise automatically the shape of a particular mechanical system. The aim was to text this solution using practical test cases from the end-user Lamborghini.

The Challenge

There are several issues associated to the use of automatic shape optimization. It takes significant computational power, because many simulations need to be evaluated. Only specialised engineers with an in-depth knowledge of the product can set up a viable ASO procedure. Several different software packages need to be interfaced and integrated into a single platform. The challenge facing this experiment was therefore to develop a platform which combined Cloud-based HPC resources with in-house computing capabilities, to develop an intuitive user interface providing an integrated solution for non-expert users and to create a one-stop-shop for end-users who are only occasional users of ASO.

The Solution

The SOUTH platform, which provides an integrated environment, granting access to the necessary optimization software and to adequate computing resources, both in-house and Cloud-based HPC, has been developed. An easy-to-use graphical user interface has been designed with an optimal trade-off between easiness of use and flexibility. While there is a high degree of automation, the user retains the possibility of interacting with the optimisation process by stopping it and investigating partial solutions. This permits the user to exploit his own expertise and effectively steer the optimisation towards the optimal design. An inexperienced user in terms of optimization, but experienced in terms of numerical simulation, can easily and autonomously set up an optimization run

The SOUTH platform constitutes an innovative and cost-effective approach to making shape-optimisation software available to small and medium-sized enterprises, which do not employ this software on an everyday basis, which cannot afford to have permanent in-house expertise in optimisation and which cannot afford the necessary computing resources. Furthermore, the SOUTH platform allows Lamborghini to scale-out during productivity peaks to avoid bottlenecks due to limited in-house capacity. The possibility to deal with simulation peaks in this way enables much more cost-effective computing to be performed.

The Benefits

Lamborghini has its own HPC resources. However, having its environment duplicated on a supercomputing class HPC centre has the following benefits: a reduction in overall development time of 40%; the opportunity to use better simulation tools; and the capability of dealing with peaks in the demand for computer resources by using Cloud-based HPC. The use of SOUTH reduces the effort for a typical optimisation from 2.25 person months to 2.0 days and the elapsed simulation time from 3 months to less than 10 days. Although the number of cpu hours required rises from 120K to 160K, the overall reduction in cost is ~ €18K. Generally, considering the average design activity in the company, yearly cost savings are expected to range from €140K to €200K.

Until now, OPTIMAD has provided automatic shape optimization mainly as a consultancy service with typical cost to the end-user of ~ €20K to €40K per optimisation. Through the SOUTH platform, the same service may be delivered with typical costs of ~ €8K to €12K whilst keeping the same profit margins. This will permit OPTIMAD to offer a more competitive and attractive service to the market. It is estimated that in the first year through the use of SOUTH in its consultancy service, the increase in revenue for OPTIMAD will be ~ €75K with a net profit of ~ €22K. By deploying SOUTH as a scalable SaaS using Cloud-based HPC resources, OPTIMAD expects further revenues in the first year of operation to be €150K with a net profit of €37K

Both CINECA and the University of Strathclyde expect to benefit from the availability of SOUTH in their research activities and in the sale of computer cycles to support their commercial and teaching activities.

Companies Involved

End-user: Automobili Lamborghini

ISV: OPTIMAD

Application Expert: University of Strathclyde

HPC Provider: CINECA

2.41 HPC-Cloud-based microscopy

The Companies

Clinical laboratories and R&D departments produce and analyse huge amounts of microscopic image data. This is used in medical diagnosis, to accelerate drug discovery and for biomedical research. To support the analysis of this data, there is a significant SME-based industry for the manufacturing of microscopes and spectroscopes serving the biotech and material science. industries. In many cases the analysis of this data can be computationally intensive requiring the use of powerful computers.

UZH is a University laboratory making significant use of microscopic data. In this experiment UZH provided a test case in the area of fluorescent microscopy. MicroscopeIT is a Polish technology-based SME company, founded in 2012, which has introduced an internet service called VIRTUM. VIRTUM provides computations in a Software-as-a-Service (SaaS) model for use in microscopy. Before this experiment, VIRTUM comprised a client-server architecture using in-house computer resources. OpTecBB, founded in 2000, is the competence network for optical technologies and micro-system technology in the region of Berlin-Brandenburg. Currently, this association has approximately 100 employees. In this experiment, the expertise and software of MicroscopeIT has been complemented by the end-user requirements of UZH and OpTecBB and the HPC expertise of ARCTUR. This has enabled the development of a Cloud-based HPC implementation of VIRTUM available as a service. This has greatly enhanced VIRTUM's availability, capabilities and affordability, particularly to SMEs.

The Challenge

The challenge addressed in this experiment was to adapt VIRTUM to an HPC-Cloud-based infrastructure and to test if the enhanced VIRTUM could be applied beneficially in four test cases. The test cases comprised: the analysis of the images from remotely controlled fluorescence microscopy; the processing of the data from super-resolution microscopy; the management and visualization of spectroscopic data; and whole slide imaging and analysis in digital pathology and high-throughput screening. These test cases are numerically intensive each taking around a full day on a PC.

The Solution

The VIRTUM service has been adapted to work with an external Cloud-based HPC infrastructure. Modules have been developed to support the implementation of the test cases described above. Through the use of HPC, the time taken to process test cases has been reduced from one day to a few hours, a typical reduction of 5 times. A cross-platform, simple user-interface has also been developed. This supports the visualisation of data and its

management from almost any device. Furthermore, the VIRTUM service provides flexible licensing models allowing end-users to optimize their costs.

A spin off from the enhancement of VIRTUM has been a generic platform, which can be applied to many various computational tasks in such areas as medicine, biotechnology, material engineering and optical inspection.

The Benefits

VIRTUM-DP has the potential to remove obstacles and bottlenecks in current oncological diagnostics. Its main benefits are a significant improvement in clinical diagnosis due to an increased speed of diagnosis, an increased quality of diagnosis, an increased throughput of diagnoses and more accessible storage of samples. VIRTUM-DP can result in a reduction in staff costs by 50% through increased efficiency. Extrapolating this to the USA alone results in an overall saving per annum of $1.7 billion.

Furthermore, there is a significant cost saving in IT infrastructure through the use of Cloud-based processing. In most cases, computer resources available via the Cloud are more cost-effective. As a result of the development of VIRTUM-DP, ARCTUR will see an increase in its sales of cycles of approximately €20K per annum.

Companies Involved

End-users: OpTecBB, UZH, NIKON

ISV: MicroscopeIT

HPC: Provider and Expert: ARCTUR

Hardware vendor: Opta-tech

2.42 Cloud-based CFD for marine design

The Companies

Ship transport represents more than 80% of the transport of goods and people around the world. To address the growing demand on shipping, the maritime industry is facing new challenges such as a reduction in fuel consumption and improvements in safety. The design of a new ship is complex, dealing with constraints of stability, velocity, manoeuvrability and structural design. Historically, ship design has evolved slowly and is rather conservative. In the past experiments on scale models have been carried out, but they are costly and restricted to a few designs. The use of Computational Fluid Dynamics (CFD) provides an alternative way to evaluate a ship's properties. This kind of simulation, while being very promising, has been restricted to specialised companies because it requires a wide range of skills. It is then generally out of scope for shipyards and naval architects to maintain a dedicated team. Furthermore, CFD software licences are also expensive.

VPLP is a world-renowned international team of French-based naval architects and designers that has been working worldwide in sail and motor craft for 30 years. It designs some of the world's most innovative racing trimerans. Their designs presently hold many of the world speed sailing records. VPLP is more and more working with CFD.

HydrOcean, a subsidiary of Bureau Veritas, offers support for design in the maritime field. This includes risk assessment, the evaluation and optimisation of marine structures such as ships, drilling platforms, marine renewable energy devices and racing yachts. The availability of Cloud-based-HPC CFD simulations would enable it to extend its current services in a competitive market.

The goal of this experiment was to develop and implement an HPC-cloud-based platform based around classical maritime scenarios that are familiar to naval architects. Automatic procedures such as mesh generation, job submission, and post-processing, on cloud-based CPU resources have been developed. This would enable the inexperienced user to optimise the design of ships and other marine structures. The platform would be tested using practical test cases from the end-users VPLP and HydrOcean.

The Challenge

The challenge of this experiment was to make advanced CFD simulation available to end-users via a set of interfaces addressing different properties such as ship resistance and manoeuvrability. Complementary to this, there was a clear need to access a large system for a short period whilst mitigating issues related to software licences. The platform to be developed would automatically make appropriate technical choices regarding the numerical schemes and solvers to be deployed. Finally, an automatic re-meshing capability would be implemented.

The Solution

An HPC-cloud-based CFD platform based around classical maritime scenarios that are familiar to naval architects has been implemented. The features of this platform include the computation of basic hull resistance, hull resistance in oblique flow, open-water characteristics for an actuator disk, self-propulsion with an actuator disk and added resistance in regular waves. Automated pre-processing support includes advanced meshing and automated post-processing support includes 3D views of pressure and velocity fields and other features of interest. Finally, a portal to enable the secure submission of jobs to the HPC platform has been developed. The platform developed allows the calculation of the basic problems encountered in the marine market, in a simple manner and it makes CFD simulation accessible to the non-expert user. Such advanced simulations are a real alternative to the use of expensive tests and models.

The Benefits

Performance optimisation studies performed by HydrOcean on several kinds of ships show gains from 2 to 10% on fuel consumption by the evaluation of several hull forms in the design process.

Through the use of the Cloud-based-HPC CFD platform, NEXTFLOW expects an additional revenue of €215K in the first year, rising to more than €1M in the third year.

In the short term, new scenarios will be added to the marine CFD solution, to address the main hydrodynamic problems encountered by the market. In the long term, NEXTFLOW expects a significant part of its revenues from cloud solutions, with an estimated annual licence revenue of €500K to €900K each year.

In the short term, it is expected to conclude a business partnership with the partners of this experiment creating additional software revenues for Distene. In the longer term, Distene expects a significant growth to which this experiment has contributed, increasing annual licence revenue of €300K to €750K.

Companies Involved

End-users: HydrOcean and VPLP

ISV: Distène and NEXTFLOW Software

HPC Provider: BULL

2.43 HPC based Delft3D service for modelling flooding, morphology, and water quality

The Companies

Deltares is an independent non-profit institute for applied research in the field of water and subsurface with five areas of expertise: flood risk, environment, water and subsoil resources, delta infrastructure, and adaptive delta planning. Forecasting of flooding, morphology and water quality in coastal and estuarine areas, rivers, and lakes is of great importance for society. To tackle this, the modelling suite, Delft3D, has been developed by Deltares. It is used worldwide. Users range from consultants, engineers and contractors to regulators and government officials. Delft3D has been open source since 2011. It consists of modules for modelling hydrodynamics, waves, morphology, water quality, and ecology.

One of the several SMEs that use Delft3D is HKV Consultants. They provide consultancy services and conduct research in the fields of safety, drought and flood risk analyses for rivers, coasts, estuaries and urban water systems. Its clients include private businesses, governments, research institutes, and regional water authorities worldwide. For their consultancy services and research, at the moment, HKV runs Delft3D on local desktop machines and clusters.

SURFsara is the Dutch national high-performance computing and e-Science support centre. It offers a full range of services, expertise and support in the field of HPC, data services, visualisation, e-Science support, cloud services, and networking. SURFsara is an active partner in technology transfer between science and the business world.

The Challenge

To improve the quality of its work, create new opportunities and increase its competitiveness, HKV needed easy access to an environment with a pre-installed and validated version of Delft3D version that could scale to available hardware resources in a flexible way depending on the application, for example, risk analysis with large ensemble simulations or highly detailed modelling of structures. Delft3D as a Service (DaaS) is intended precisely for SMEs like HKV. The objective was to have a pilot version of DaaS running for remote use by HKV. With this pilot version, HKV would be able to perform production work with a certified Delft3D version on (HPC, Cloud) hardware. The development of such a pilot version was the challenge facing this experiment.

The Solution

The official Deltares version of Delft3D has been installed at the HPC systems of SURFsara. This version was certified with an extensive test bench. Such certification is crucial for SME end-users who need to work with the Delft3D software for their clients. A portal for DaaS has been developed. Access is via a command-line interface with more options and flexibility for experienced users and via a web-based interface for inexperienced users. Iterative refinement of the portal was based on beta testing by HKV. Delft3D has been optimized for large-scale HPC. This is needed for coupled modelling involving different Delft3D modules and for highly detailed modelling increasingly required by SMEs. For this, simulations with Delft3D models of the Elbe, Lake Marken, the North Sea and the Amsterdam-Rhine Canal have been used. The objective was to show with these cases the potential of DaaS available to SME end-users.

The Benefits

DaaS opens new possibilities for SMEs, such as HKV, because it offers quick, efficient, and flexible access to HPC hardware resources for modelling and simulation using Delft3D. This Fortissimo experiment served as a starting point for gradual transition for current Delft3D users and growth model for new Delft3D users worldwide. Deltares and HKV themselves are already involved in further projects using Delft3D running on remote HPC systems.

Deltares expects additional revenues of about €70K per annum due to an increase in the use of (certified) Delft3D and of about €500K per annum due to an increase in Delft3D-related advisory and research projects by Deltares itself. With DaaS, Deltares expects an increase of business opportunities in data and forecasting services based on Delft3D and projects related to large scale computing with Delft3D, for example for dike safety assessments.

Due to the new possibilities of DaaS for large ensemble modelling and highly detailed modelling, HKV expects additional revenues of about €100K and €30K per annum, respectively. With DaaS, HKV expects an increase of business opportunities in add-on services based on Delft3D. Furthermore, DaaS will reduce risks in projects with a lot of Delft3D modelling, with the opportunity to spend more project time on creating added value for the client.

As a result of the use of DaaS, the increased revenue from the provision of additional computer resources by SURFsara is expected to be around €120K per annum.

It is planned to make DaaS available as a service not only via HPC systems at SURFsara, but also more widely through the Fortissimo Marketplace.

Companies Involved

End-user: HKV

Domain expert and ISV: Deltares

HPC Expert and Provider: SURFsara

2.44 Cloud-based Simulation of Marine Communication Buoys

The Companies

Computational Fluid Dynamics (CFD) has demonstrated its ability to model detailed scenarios with great robustness. However, some very complex applications are still challenging. For such applications, High Performance Computing (HPC) is required to perform the required computations in a reasonable timeframe. Very often, SMEs, designing and manufacturing innovative products, need access to HPC-based CFD as part of their design process. However, the ownership of an HPC system is usually beyond the financial resources of an SME. Conversely, the availability of such a system on a pay-per-use basis is affordable for even small companies.

ALSEAMAR is a French SME, specialised in the design and manufacturing of radio communication systems for both surface ships and submarines. Alseamar wanted to develop a releasable, communication buoy for submarines. This experiment aimed to design such a device using HPC-based CFD.

K-Epsilon is a French SME which offers CFD consulting and the development of customised software. In particular, K-Epsilon develops and markets the software package K-FSI which formed the basis for the simulation model used in this experiment. In addition to this, the role of K-Epsilon in this experiment was to support the partners in the simulation of a releasable

communication buoy, using Cloud-based HPC, and to demonstrate the benefits of advanced CFD simulations.

The Challenge

The challenge was to simulate, during the launching phase, the behaviour of a radio communication buoy released from a submarine. Indeed, numerical simulation is the only way to predict the behaviour of such a buoy because tests involving submarines in a real environment are almost impossible.

This type of simulation involves fluid-structure interaction and overlaid meshes to obtain realistic results. The use of these technologies requires larges and fine meshes (several millions of cells). Computations are required to run for multiple days to converge. To compute such large and complex cases in a reasonable timeframe, simulation software must necessarily be run on an HPC system.

CFD is not an easy solution for SMEs such as Alseamar because generally they do not have the necessary resources and expertise in-house. Consequently, it has not been part of their design process. Many manufacturing SMEs currently do not have a satisfactory solution to the simulation of innovative designs. The goal of this experiment was to make HPC-based simulation available and affordable to Alseamar and other manufacturing SMEs.

The Solution

K-FSI and other supporting software has been ported to the BULL eXtreme factory HPC-as-a-Service to create an appropriate simulation model. An on-line solution monitor has been integrated with the eXtreme factory web interface. This monitor collects the information about computations running on eXtreme factory and sends them to a K-Epsilon web page accessible only by K-Epsilon staff.

Because naïve end-users such as Alseamar do not possess the skills to perform simulations of such complex cases, K-Epsilon makes use of the pay-per-use HPC cloud on their behalf. Specific workflows have been developed on the HPC system to reduce engineering time and to feed into the Alseamar design cycle.

The Benefits

In this experiment, Alseamar has developed a releasable communication buoy for submarines. The commercialisation of this new product has now started. The resultant revenue is estimated to be €500K in 2017 and €1M in 2018. Alseamar estimates that 3 jobs will result and its turnover will increase by 20%. These figures are based on the sale of 125 units in 2017 and 250 in 2018. Through this experiment, Alseamar has gained confidence in using CFD simulations to improve their design process, offering an alternative to physical tests.

This experiment enabled K-Epsilon to integrate its in-house tool K-FSI on a HPC cloud, with a pay-per-use service. The results have demonstrated the capabilities of K-Epsilon to address very complex cases with K-FSI. 2 jobs were created during the Fortissimo project, and K-Epsilon expects to create another 3 positions in a five-year plan. K-Epsilon's annual turnover is expected to increase by 8% in 2017, and by 65% over the next five years.

For Bull, this experiment has been an opportunity to reach new potential customers in the maritime market. Bull will earn 20% of the turnover from simulations by K-Epsilon, through the provision of cycles via eXtreme Factory

Companies Involved

End-user: Alseamar

Application Expert and ISV: K-Epsilon

HPC Provider and Expert: BULL

3 Major Achievements

This documents presents an overview of the outcomes of the Fortissimo experiments. It gives a high-level business-orientated view of the markets in which the technical developments and outcomes of each experiment are relevant. This is done on a per experiment basis under the headings “The Company (ies)”; “The Challenge”; “The Solution”; and “The Benefits”. In the “Benefits” section, particular emphasis has been placed on the presentation of benefits such as increased turnover, savings in costs and staff time, faster times to market, creation of employment, increased competitivity and greater accessibility of advanced Cloud-based simulation to SMEs through the use of pay-per-use billing structures, involving both licence and computer cycle costs.

53 experiments have been carried out in Fortissimo under the auspices of Work Packages 4, 5 and 6. Work package 4 had oversight of 20 experiments, Work Package 5 had oversight of 22 experiments and Work Package 6 had oversight of 11 experiments. 15 Success Stories resulted from the Work Package 4 experiments, 18 Success Stories resulted from the Work Package 5 experiments and 11 Success Stories resulted from the Work Package 6 experiments. Of these experiments, the 20 in Work Package 1 were embedded in the initial Fortissimo proposal, the 22 in Work Package 5 resulted from the first open call and the 11 in Work Package 6 resulted from the second open call.

Altogether there are 44 success stories from Fortissimo. This represents a significant body of material promoting the use of Cloud-based HPC in a variety of sectors, the development and collation of which represents a significant achievement. This material is being used in the production of promotional brochures, the project’s and other websites, the promotion of the Fortissimo Marketplace and as supporting material for the open calls for proposals in the follow-on project, Fortissimo-2. Furthermore, the material gathered in this report provided substantial material for use in the Fortissimo Impact Report (Deliverable D 10.11) and the Fortissimo White Paper (D10.12)

The Work Package 4 experiments were specified in the original Fortissimo proposal. The Work Package 5 and Work Package 6 experiments were the result of open-calls 1 and 2 respectively. Based on the observation that 75% of the Work Package 4 experiments resulted in a Success Story, 82% of the 22 Work Package 5 experiments resulted in a Success Story and 100% of the Work Package 6 experiments resulted in a Success Story, one can make the inference that effective open calls, the experience gained in conducting them and the experience gained in managing the resultant experiments in Work Packages 4, 5, and 6, led to a progressive improvement in the overall process of development of Success Stories.

4 Concluding Remarks

53 experiments have been conducted resulting in 44 Success Stories as described above. These Success Stories indicate the challenges overcome in the respective experiments. Most importantly, the emphasis on business benefits, means that these Success Stories comprise a significant body of material for use in the promotion of Fortissimo and its objectives to the target audience of SMEs. With the development of further Success Stories in the follow-on project, Fortissimo-2, these Success Stories are now part of a growing base of knowledge supporting the wider use of Advanced, Cloud-based-HPC simulation to the benefit of European industry.