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HPC-Europa

Pan-European Research Infrastructure on High Performance Computing

Transnational Access

THE SUCCESS STORY

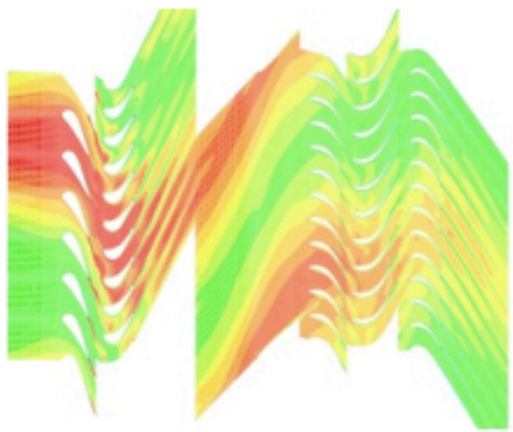
Haidong Li

In the spring of 2004, ITS (Information Technology Service centre) of Durham University sent messages around about the call for proposals of HPC-Europa program. The technical problem I am dealing with is unsteady turbomachinery flows. To accurately simulate such a problem, multistage multi-passage domain is often needed and it is suitable for parallelization as the computational domain is naturally passage decomposed. Therefore, I submitted a proposal immediately after I heard of the news. The confirmation of approval came in August and I arranged to stay at HLRS in Stuttgart, which turned out to be a wonderful supportive place essential for the success of my project.

I arrived in Stuttgart on a Sunday afternoon and I was warmly welcomed by my host, Dr. Sabine Roll and her family. After attending one week training course on parallel computing, I started to parallelize my code. The first few weeks were very frustrating as the whole program (~15,000 lines) needed to be rewritten and the amount of work was much more than I thought. The data structure, array index, dynamic memory allocation and the communication strategy had to be designed very carefully. Nevertheless, some subroutines had to be redesigned to cope with localized data structure. One difficulty worth mentioning is that the communication between adjacent blade rows is very complicated due to the relative rotation. During this very difficult period, I got tremendous support from the HLRS parallel computing group.

Dr. Rolf Rabenseifner and Dr. Sabine Roll had many discussions with me on the data structure and communication strategy. Mr. Panagiotis Adamidis helped me on code debugging issues and Mr. Rainer Keller helped me on performance measurement as well as accessing issues. Soon after overcoming those difficulties, the parallelized code started to work and behaved very well during my six weeks visit. A speedup about 10 times can be easily achieved without extra effort on balancing loading on each processor. Even more significant than the speedup is the fact that the parallelized code can simulate the whole annulus multistage machine which is impossible using computing. Thus new physical phenomena could be and have been discovered in the follow-on studies. The attached picture illustrates one successful example, which shows entropy contours at mid-span section of a power turbine with inlet hot streak distortion and film cooling.

Away from work, I had a great time in visiting museums and castles in different cities and made international friends through the stay. After returning to my office, I parallelized one of my sponsor company's production line codes and another research code of our group. These parallelized codes are generating important research outcomes now. The impact of my HPC-Europa visit is not only limited to the project I finished, but it has also benefited the whole group's research work back in Durham University.



Entropy contours at the mid-span section of a power turbine (with inlet hot streak distortion and film cooling)

Curriculum

Dr Haidong Li is a Research Fellow at the School of Engineering, Durham University. He had a Ph.D of Fluid Mechanics, CFD (1997) in Tsinghua University, Beijing, P.R. China and a MSc and BSc of Engineering Mechanics (1994, 1991) in Shanghai Jiaotong University, Shanghai, P.R. China. His research areas are Unsteady aerodynamics, Aeromechanics of turbomachinery, Advanced numerical methods of CFD, Parallel computing, Design optimization

The second Annual Meeting was organised by HLRS in Stuttgart in September 2005. During the four-day meeting, focused on the project management activity, two main events were organised: the Scientific Users Selection Panel (SUSP) meeting, in which the applications submitted under the 8th call were reviewed, and the Transnational Access User Group Meeting, in which current and former HPC-Europa visitors had the opportunity to present their work. More than 90 people attended TAM'05. The conjunction of these two events also gave the selection panel members, who are internationally-renowned scientists from a variety of disciplines, the chance to attend the TAM '05 meeting and to discuss and appreciate the great results presented by the researchers.

projects

Networking Activities

Transnational Access

Research Activities

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CORDIS

The TAM'05 in Stuttgart

by Giovanni Erbacci - CINECA

The Transnational Access Meeting (TAM) is the annual user group meeting for the researchers who have benefited from HPC-Europa's research visits programme. The TAM'05 was held on September 22 and 23 in Stuttgart, organised by HLRS, and represents the second event in this series since the start of the HPC-Europa programme in January 2004. This second meeting with the researchers reinforced and enhanced the structure of the first one: TAM'04, organised by EPCC last year in Edinburgh.
In fact, in TAM'05, the research talks and the poster sessions spanned two days, and each day was enriched by a specific event: the *scientific workshop* in the first day and the *technology demo* in the second one.
The *scientific workshop* aimed to provide the HPC-Europa visitors with a precise overview of the state of the art in computational sciences in Europe. The subject selected for this year was "*Computational Engineering*" and four high-profile European researchers presented an in-depth overview of the research activity in their own scientific fields:
Prof. Gode, *Institute of Fluid Mechanics and Hydraulic Machinery (IHS), University of Stuttgart;* Prof. Kolditz, *Center for Applied Geoscience, University of Tübingen;* Dr. Badcock, Computational Fluid Dynamics Group, Department of Aerospace Engineering, University of Glasgow; Prof. Wittum, *Interdisciplinary Center for Scientific Computing, Ruprecht-Karls-University of Heidelberg.*

The goal of the technology demo, organised during the second morning as part of the Networking Activity 4, was to present to the researchers the state of the art of the achievements of the Networking and Joint Research activities of HPC-Europa. In this way the audience had the chance to learn more about:
- Access grid and collaborative environments (NA2);
- Performance Analysis tools for HPC (JRA1);
- Data Handling in Computational sciences (NA3);
- Single point of Access to HPC resources (JRA2).

Some of the results will soon be available for researchers to test during their access visits. This highlights the effective integration between HPC-Europa's NAs and JRAs and the access programme, demonstrating the potential of emerging technologies as a vital resource for researchers across Europe.

This year a great number of interesting scientific talks were submitted to the TAM so two parallel sessions and a poster session (with 9 posters displayed) were organised for each day in order to present the most groundbreaking works. TAM '05 brought together 41 researchers from 16 different countries who had visited research institutes associated with the participating HPC-Europa centres in Amsterdam, Barcelona, Bologna, Edinburgh, Paris and Stuttgart. Attendees presented the results of the work undertaken during their visits, and also had the opportunity to meet and exchange ideas with other researchers who had visited one of the other centres or had carried out their visit at a different time.

Four sessions were organised in the first day: CFD, Computational Chemistry I, Meteorology - Earth Sciences and Computational Chemistry II. In the second day, after the technology demo, 4 further sessions on Computer Science, Bio-Informatics - Life-Sciences, Mathematics, and Computational Physics took place. In all these sessions, a total of 31 researchers presented very interesting and, in some cases, ambitious results in different fields, ranging from heavy particles in turbulence to Lattice Boltzmann Models, from density functional theory to nanotubes and metal-organic nanostructures, from linguistic and stylistic computational analyses on greek and latin texts to molecular dynamic simulations of Peptide-RNA Interactions in the HIV Complex and many other topics.

In total more then 65 people (researchers, SUSP members, HPC-Europa members from the partner Institutions) attended TAM '05. This was a great opportunity to interact with each other and to share and discuss the results obtained and in this way strengthen the computational community within the HPC-Europa project.
In 2006, the HPC-Europa TAM will be hosted by BSC so...see you in Barcelona in June 2006!

Transnational Access

THE SUCCESS STORY

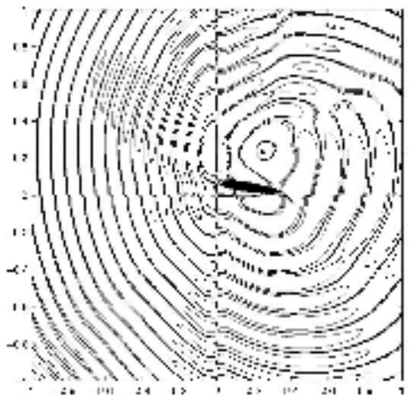
Panagiota Pantazopoulou

Computational Aeroacoustics and Aerodynamics Group, University of Bath

Aeroacoustics has been an important field for the aerospace industry, due to the environmental issues and technical challenges. The problems of noise control in aviation, which arose in the middle of the twentieth century with the beginning of intense operation of jet airliners, are becoming more and more threatening for the global environmental balance and for the structural integrity of aircraft. Various techniques have been developed to address the problems and to provide effective solutions. A boundary integral scheme is implemented in order to deal with scattering problems in aeroacoustics. The method that is followed combines both aerodynamics and aeroacoustics principles in non-uniform potential flow. The test case is a wing in flow with an acoustic source nearby. This novel method is particularly useful because it takes into account the wake phenomenon and examines its effect on the sound radiation.
In this work the parallelisation took place on a particular part of the code. The part that was considered eligible to be parallelised was the solution procedure of the final linear system. The reason for that is because in acoustics problems the stiffness matrix is usually of a big size as it contains information for both the real and the imaginary part of the acoustic pressure and it gets bigger for higher operation frequencies. The parellelisation was performed at one of the High Performance Computing centres in Europe.

Curriculum

Ms Panagiota Pantazopoulou received a degree in Mechanical Engineering and Aeronautics at the University of Patras, Greece in 2002. In 2004 she participated in the European Doctorate on Sound and Vibration at Trinity College, Dublin. She is now completing her PhD in Computational Aeroacoustics and Aerodynamics in University of Bath, UK, under the supervision of Dr Michael Carley.



Sound pressure pattern around a wing with an acoustic source.

At Cineca in Bologna, Italy, I benefited from the computing facilities and was introduced to MPI programming tools. After my three month visit I was able to produce some very promising results and to develop the parallel version of an iterative solver implemented at the University of Bath. A representative picture that shows the pressure radiation around a wing with high lift devices is shown on Figure 1.
Last September I had the opportunity to attend the Transnational Access Meeting (TAM) in Stuttgart to present my research activity in Cineca, and to meet visitors from the other HPC centres to exchange opinions and experiences. I would like to specially thank Giovanni Erbacci for his great support and useful advice for the completion of this task and Francesca Garofalo for her excellent help on all the practical and accommodation matters. If it was to describe my three month staying in Bologna I would say that it was a fantastic opportunity and a great experience. In conclusion, I would encourage any researcher to participate in this programme to gain useful experiences and computational knowledge.