Nationaal Lucht- en Ruimtevaartlaboratorium
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NLR-TP-98230

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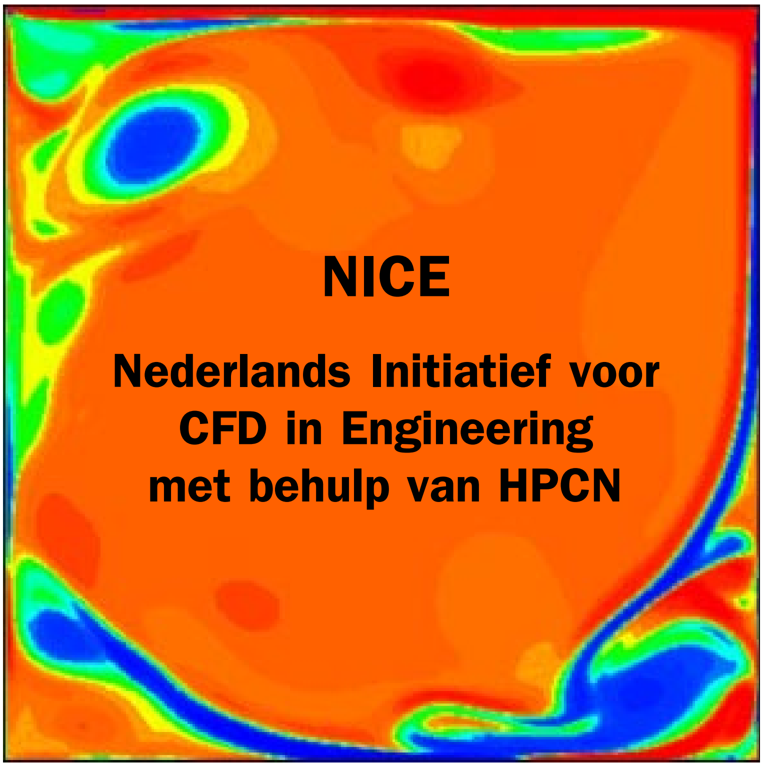

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This investigation has been carried out partly under a contract awarded by the Foundation HPCN, contract number 96009, and partly as a part of NLR's basic research programme, Working Plan number I.1.A.1.

This report is based on a presentation held on the HPCN Europe '98 Conference, Amsterdam, April 21-23, 1998.

Division: Informatics
Issued: May 1998
Classification of title: unclassified

Contents

(9 pages in total)

A NICE HPCN Centre for Flow Simulation

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Abstract. The Netherlands Initiative in CFD for Engineering with HCPN (NICE) aims at increasing the competitiveness of Dutch industry by making available competence in the area of flow simulation on HPCN platforms. The know-how and know-why that is developed is disseminated via a metacomputer for CFD, called HCS. This metacomputer also supports the ability to apply the developed know-how and know-why in industrial engineering problems. The paper sets the outline of the NICE application areas, and presents HCS. The presentation includes a highlight of present experiences with HCS, ongoing developments and finishes with concluding remarks.

1 Introduction

The Netherlands Initiative in CFD for Engineering with HCPN (NICE) aims at increasing the competitiveness of Dutch industry by making available competence in flow simulation on HPCN platforms (see also [2]). NICE is one of the projects partially funded by the HPCN foundation in the Netherlands HPCN programme (see also [1]). It is coordinated by NLR. All major technological and university research institutes in the Netherlands in the area of CFD participate in the project. NICE started in 1996 and will last until 1999. To realize its goal, NICE has two lines of activities.

The first is the development of know-how and know-why in the area of flow simulation applications on HPCN platforms. For this, the (potential) market for these applications has been divided into sectors. For each sector, a sector programme has been defined. Each technological institute participating in NICE is responsible for one of these sectors.

The second line involves the dissemination of the developed know-how/know-why and the ability to use this know-how/know-why with the available HPCN facilities in product engineering in industry. In support of this, a digital working environment (a 'metacomputer') for CFD has been created, covering CFD applications available at the sites of the participating partners. This environment is called the NICE HPCN Centre for flow Simulation (HCS).

This paper sets the outline of the NICE sector programmes, also serving as introduction to the other contributions of NICE partners to the HPCN Europe '98 Conference, and presents HCS. The presentation will include a highlight of

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present experiences with HCS, ongoing developments and finishes with concluding remarks.

2 NICE sector programmes

The NICE sector programmes generate know-how and know-why in the area of flow simulation on HPCN platforms. This know-how/know-why is embodied in application programs, data, documents, work flow definitions, and personal skills. At present, for the following sectors specific programmes are executed:

- the sector 'air': aerospace, aircraft industry (see [3] and [4]);
- the sector 'water': waterworks, harbour companies, offshore industry, oil- and gas industry (see [5]);
- the sector 'ships': shipping, ship-building industry (see [6]);
- the sector 'chemistry': chemical, steal, petro-chemical, and electronics industry (see [7] and [8]).

In other sectors, e.g. glass-, metal-, ceramics, and furnace industries, a limited programme has been performed. Activities in the sector programmes concern parallelization of existing applications. The parallelization strategy depends on the user requirements, the selected computer platform, and the application.

The know-how/know-why is maintained and controlled by the responsible partner in their own local infrastructure. Partners use not only their own computing infrastructure, but also facilities available elsewhere. Particular example is the NEC SX-4/16 at NLR, which acts as the central computing facility for large, demanding (both with respect to through-put time and memory use) application jobs. HCS is built on top of these local infrastructures.

3 NICE HCS

Purpose of HCS is to support the dissemination of the NICE know-how/know-why and to support the ability to realize complete solutions to engineering problems in the area of flow simulation. HCS acts as a metacomputer that can be used by industry, either by industry itself or with support of one or more of the NICE partners. The NICE partners act as consultants for industry and are supported by HCS. Building blocks of HCS are:

- computing infrastructures of the partners, connected via SURFnet;
- know-how and know-why of flow simulation on HPCN platforms made available by the partners in the form of application software, data, documents, and personal skills;
- the SPINEware software package of NEC, which is developed for NEC by NLR.

SPINEware supports the following functions (see also [9]):

- access to the facilities and know-how/know-why as if everything is located on a PC (virtual computer approach); this includes a graphical windows based user interface and tools to execute standard or routine chains of activities;
- environment management, enabling customization of personal environments that are a subset of HCS;
- information management, such as software version management and document repositories.

Moreover, SPINEware can be augmented with specific tool sets, such as tools for porting applications to the SX-4.

The operation of HCS is supported by NICEnet, consisting of the Web site of NICE and a Web based Project Management System (PMS), training courses, and extensive user guidance and support (both via HCS and on-site). HCS supports the quality control of the simulation process in a way compatible with industry (ISO 9001) [2].

HCS has an open structure: it can easily be modified, and new customers can easily connect their own working environment to HCS. This enables the use of know-how/know-why and facilities by third parties, such as industries.

4 Collaboration between partners

All partners in this project have integrated (part of) their local computing infrastructure into HCS. So far, the NLR SX-4 is the only facility that is shared by all the partners. As a result, the present underlying computing infrastructure is star shaped, with the NLR SX-4 as central facility. This is not surprising, since this computer is the most powerful and most accessible one in the Netherlands. PMS is used to share on-line documents between the partners. It is also used for HCS Configuration control, which is supported by electronic forms for error reporting, problem reporting, and change requesting.

Sharing of know-how and know-why is realized in work shops on specific HPCN related topics, in particular domain decomposition and visualization. These topics are of common interest to all partners. Parallelization know-how is also made available in software tools, such as a tool set for porting applications to the SX-4 that includes default settings and guidelines that reflect the experience of the experts using the tools. Flow simulation software is not shared. This is not surprising, considering the distribution of responsibilities. However, the need is emerging to share software tools for pre-and postprocessing, in particular for grid generation and visualization, to share visualization facilities as the CAVE, and to share licenses for commercially available software packages. The commercial software packages are also becoming considered as an appropriate carrier for the know-how conserved in application software. An apparent bottleneck in the extension of the use of the network (nodes and directed arcs), for example for visualization, is security.

Several projects have been executed for third parties that involved the collaboration of several NICE partners (see section 5 for an example). In these projects there always was a clear distribution of responsibilities: one partner was responsible for the external contacts and the application, the other partner was responsible for HPCN aspects (both with respect to hardware and software). In particular, the required use of computer networks has resulted in problems that asked for a solution, specifically with respect to security and to visualization of simulation results (see [3])

5 An example of NICE consultancy

Wärtsilä NSD Netherlands BV is a manufacturer of large Diesel engines, and is constantly trying to improve the products. To optimize the thermal load of the engines, an investigation into the flow of cooling liquid in piston crowns was started. Since this concerns an interior flow inside an oscillating chamber, physical experiments are difficult and do not supply sufficient detail. Computer simulation of the flow was considered to be a better alternative, but the required software and computing facilities were not available at Wärtsilä NSD.

NICE was contacted to act as consultant. Two partners proved to be able to jointly generate a complete solution. The University of Groningen (RUG), member of the J.M. Burgerscentre, acted as contact point for NICE. RUG provided the software, which solves the time-accurate free-surface equations. Since the physical time scale is very small, the simulations are computationally intensive, requiring supercomputing power. NLR provided the HPCN facilities. The NEC SX-4/16 proved to be perfectly suited for the job: simulations run at 600 Mflop/s. For the execution of the computer simulations, a dedicated working environment was created as part of HCS, covering the required know-how/know-why and facilities available at RUG and NLR. For the preparation of the actual batch simulation jobs, visualization was performed simultaneously with the flow simulation. In this environment, university trainees proved to be able to perform the simulations without specific knowledge of the computing facilities, the networking aspects, and the software program itself.

Using HCS in this way, NICE was able to provide Wärtsilä NSD a cost-effective solution (as presented in [10]). The simulations have provided detailed insight in the interior flow of oscillating piston crowns, which could not have been obtained through experiments. The simulations established that the design of piston crowns is optimal with respect to the cooling capability.

6 Support of external parties

Requests by third parties are quite diverse. On one hand requests concern use of computer facilities only, for want of computing power or computer memory, on the other hand requests concern complete solutions to engineering problems. So far, the basic experience is that the dissemination of the know-how/know-why outside the existing market sectors covered traditionally by the NICE partners is hampered by the fact that in general the match is still lacking between software that optimally satisfies user requirements and the hardware platform that performs optimally for this software. NICE provides solutions for the application software developed by the partners. Commercial software vendors, however, primarily target at functionality, and not performance. Many potential HPCN users rely on such commercial software. These users typically approach NICE partners for HPCN know-how, and more specifically for HPCN facilities. Since end users require application software to be validated for their applications, they only rely on software they already are familiarized to. Application of HPCN then requires cooperation with software vendors to port their packages.

Another requirement from external parties is that they should be able to request one party for a complete execution of a simulation process. Increasingly this requires collaboration between partners, in particular in projects for customers not historically associated with one of the technological institutes. HCS supports the NICE partners to operate as one virtual company, with a clean interface to the external party.

7 Ongoing HCS developments

Time and budget constraints, and an increased multidisciplinary approach result in the necessity to accommodate simulation programs and simulation tools developed elsewhere. To be competitive, these results shall be made available with minimal overhead. For this, HCS relies on the industrial standard on application level, the client-server approach. To enable programs to function transparently within the distributed HCS environment, SPINEware will support the integration of tools and applications satisfying the emerging CORBA industry standard.

In reaction to apparent demands from industry for integrated support for management of data, software, and work flows, the SPINEware is enhanced with interfaces to commercially available software packages supporting these facilities. SPINEware enables the integration of the specific management tools required by industry.

With an increase of (distributed) computing resources, the need for a tool for resource management becomes apparent. For this, SPINEware will also be enhanced with interfaces to available software packages.

Since hardware environments at customers sites often is PC based, the suitability of SPINEware on PC's is improved. SPINEware enables the integration of the PC- and the UNIX-environment.

Visualization becomes increasingly important. Not only as a means to compress the information generated by simulations into a comprehensible and electronically transportable form, but also as an efficient means to present the information in discussions between specialists. The emphasis is therefore on (real-time) visualisation tools (see [3]) and on the realisation of a connection between the NLR SX-4 and the CAVE at SARA. This connection is two-way: generation of simulation results with a sufficient information contents requires computing power that is only provided by the SX-4.

8 Concluding remarks

It is tempting to assume that the market for CFD on HPCN platforms will significantly grow beyond the present state in the Netherlands. Such growth is not unconditionally, however. Given the complexity of performing flow simulations and interpreting the results, a successful application requires either a product of sufficient complexity, or a significant reduction of the costs related to the use of HPCN technology. In addition, a significant increase in the understanding of the value for money of HPCN applications is required.

Sharing of know-how and know-why in HCS can contribute significantly to cost reduction. As a simple example sharing of licenses for commercial software packages can be mentioned. It also implies that simulation shall focus on the "first time right" principle. The know-how/know-why shall be used to minimize the required number of simulation runs to answer a specific question. This requires quality management (see also [2]), competence in optimization, and knowledge of the engineering process. Performance models are also considered essential to evaluate in advance the optimal selection of facilities for a specific job.

The success of HCS is significantly based on the assumption of a certain drive and willingness to use HCS as a common means for competence management, to collaborate, and to use know-how/know-why developed elsewhere. The inclusion of know-how/know-why in HCS does not imply the loss of control: the owner still decides who gets access to it and on what (financial or other) terms.

Drive and willingness are essential to be present in engineers and managers, both at the supplier and the consumer side. Since engineers and managers often have quite different objectives, it is considered to be essential that a sufficient degree of commitment of top management to use advanced techniques in the engineering process shall be present. In this context, budget and time constraints are considered as short term guidelines, only. The metacomputer concept of HCS is compliant with the ongoing development of existing organizations into ‘extended enterprises’. Collaboration of industries require the same information and communication technology that is underlying HCS. As such, NICE uses an approach that has shown to be applicable also to other engineering areas than flow simulation (see [2]).

Budget and time constraints also indicate that the funds for development of HPCN technology should be used for build up of know-how on a limited set of hardware platforms. Only in this way, the present mismatch in applications/computers can be solved in time.

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