ERCIM NEWS

Aage Thunem,
Managing
Director of
SINTEF DELAB
(Photo:
SINTEFDELAB)

SPECIAL :

Activities in
Numerical Linear Algebra 6

CONTENTS

Next Issue:

Network Management

EDITORIAL

S INTEF DELAB has entered ERCIM as the first organisation coming from a country outside the Common Market. ERCIM represents for SINTEF DELAB an important scientific network as well as an important link to Europe. We see ERCIM as an European organisation that can put information technology into focus both in scientific and industrial terms.

During the 1990s R&D will increase in importance in order to maintain the competitive edge of industrial companies and of nations focusing on added value. The market-place for research is shifting towards a more "market driven research" with an added value for industry on a short term basis. Maintaining a competitive edge requires also a long term R&D policy, where the framework under which the R&D organisations shall operate is important.

In this prospective the Small and Medium-Size Enterprises (SME) will play an important role for ERCIM both as clients for innovative technology and as strategic partners. By addressing the specific needs for SME's, ERCIM and its member organisations will fulfil its R&D obligations. ERCIM provides to the SME's a network for better access to technology and competence through which they can gain a competitive advantage.

Research in the basic sciences is divided into disciplines between which there is generally relatively little communication. To obtain an added value there is a need for communication and close cooperation between basic research, system vendors and the end-users (applications). The contact network between industry in general and the R&D organisation has to be strengthened. The ERCIM network provides an efficient way of disseminating R&D results in real time to a variety of industrial clients.

A long-term R&D policy should focus on generic-technology areas. The generic-technology projects defined, they should be executed on the basis of needs common to industrial companies active in different sectors and in particular on the basis of SME's needs. The ERCIM pan-european network of members is an ideal forum for identifying these needs, defining and executing the projects.

A closer cooperation between the EEC and EFTA countries influences also R&D policy. ERCIM members are major national R&D organisations representing their national scientific communities, providing ERCIM with real influence both on European and national R&D policy.

Aage Thunem

Strengthening ERCIM

by Cor Baayen — President of ERCIM

Part of the ERCIM meeting in Pisa last May was a workshop in which the directors discussed ERCIM's goals and strategy.

Started in 1988 as a small, loosely organised consortium, ERCIM presently has eight members, with a ninth (the Swedish Institute for Computer Science) expected to join soon and further expansion a standing goal. ERCIM members are national research laboratories or organisations. Apart from the separate missions of its members, which indeed have a large common divisor, ERCIM's constitution defines some overall objectives (stated here somewhat loosely):

• Develop a common ERCIM policy in IT and applied mathematics

• Help modelling European research programmes and identify special attention areas

• Support its members vis-a-vis the EC and other organisations

• Promote joint participation in international projects

• Promote complementarity in the research of its members

• Strengthen Europe's position in research and transfer of innovation

These organisations joined to create corporate strength and to harness their joint power to the post-Maastricht Europe. Hence, ERCIM aims to be a high-profile, powerful and knowledgeable distributed research organisation, considered as a credible and serious partner on the European scene. In order to achieve this, a business-like approach is required, demonstrating itself in activities like:

• Facilitating the mission of its members

• Developing a European IT infrastructure

• Playing an advisory role in European IT policy by, e.g., identifying needs and establishing relations with industry

• Representing Europe in, e.g., its aid to Central and Eastern Europe, and its contacts with Japan
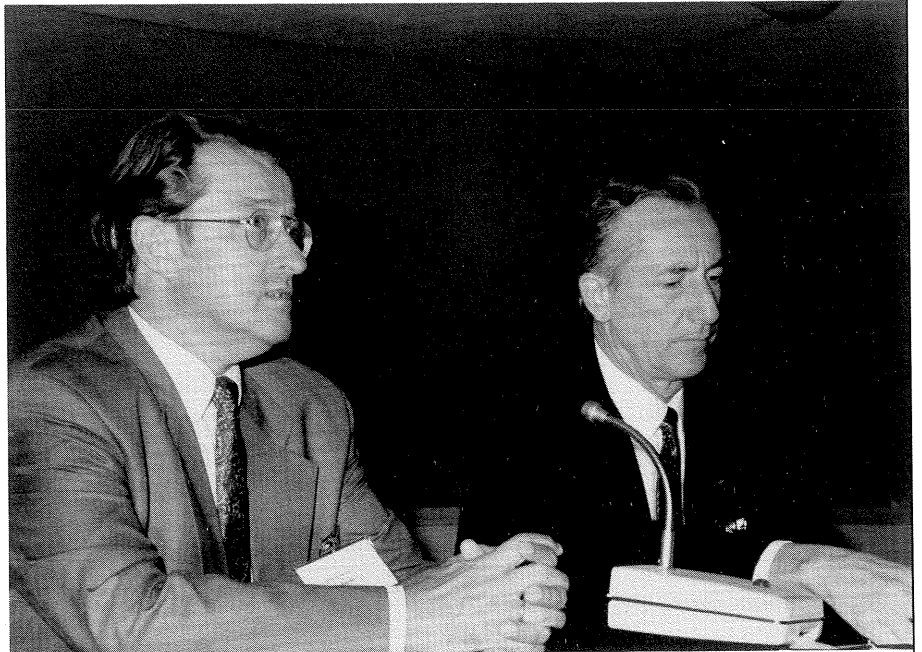
In order to realise these goals an increase of ERCIM's momentum is clearly required. To this end, it was decided in Pisa to form an Executive Committee responsible for executing ERCIM's policy. The Committee is chaired by Bob Hopgood (RAL). Furthermore, a number of concrete short-term actions was agreed upon:

• Make a bid to the EC programme ESSI (European Software and Systems Initiative)

• Make bids to the EC programme HCM (Human Capital and Mobility), viz., its Fellowship, Conference and Networks programmes

• Produce policy papers for use within ERCIM and for the benefit of liaisons within Europe

• Organise an ERCIM stand at the annual ESPRIT week

• Establish a high-speed network between the ERCIM members

• Improve the mobility within ERCIM by secondments to member institutes

• Reassess the current ERCIM workshops in view of integrating its membership

• Target specific industrial partners and define combined programmes of strategic importance

Already the above (non-exhaustive) set of activities requires a substantial increase in dedicated manpower, which must be raised and funded by the members themselves. Clearly, in this phase of its development ERCIM has to rise to the occasion.

Please contact: Cor Baayen – CWI
+31 20 592 4174
email: pcb@cwi.nl
or: Martin Kersten – CWI
+31 20 592 4066
email: mk@cwi.nl

Cor Baayen, Director of CWI and President of ERCIM, and Franco Denoth, Director of IEI-CNR, at the Directors' Workshop in Pisa in May this year to discuss ERCIM goals and strategies.
(Photo: IEI-CNR)

JOINT ERCIM ACTIONS

The 92/93 ERCIM Fellowship Programme

by Helena du Toit

As more research institutes join ERCIM, fellowship opportunities are becoming greater. The third fellowship programme, starting now, invites six fellows from throughout the world to do research in information technology and applied mathematics at the different ERCIM sites.

The difficult process of selecting the 92/93 fellows was finalised this summer. The accompanying table stipulates the names of the new ERCIM Fellows and the institutes which they will visit.

Six of the eight current ERCIM institutes are hosts, with the following allocations:

CNR   2 fellows (total = 15 months)
CWI   4 fellows (total = 30 months)
GMD   3 fellows (total = 21 months)
INESC 3 fellows (total = 18 months)
INRIA 4 fellows (total = 30 months)
RAL   2 fellows (total = 12 months)

Meanwhile, the five ERCIM Fellows for the period 91/92 are completing their fellowships, concluding at the beginning of next year. These fellows are presently at CWI, INESC, INRIA(2) and RAL; the last six months will be spent at CWI, GMD (2), INESC and RAL. Besides reports of research performed at the various ERCIM institutes, to be published in the ERCIM Fellowship Research Reports, summaries will appear in the April issue of ERCIM News on completion of the fellowships. ∎

Please contact:
Annick Theis-Viemont – INRIA
+33 1 39 63 53 78
email: theis@nuri.inria.fr

Name	Institute		
Amar Bouali (Algeria)	CNR 01/01/93	CWI 01/10/93	
Richard Boucherie (The Netherlands)	INRIA 01/09/92	CWI 01/06/93	
David Breslauer (Israel)	CWI 01/10/92	INRIA 01/04/93	CNR 01/10/93
Franz Penz (Austria)	INESC 15/09/92	RAL 16/03/93	GMD 16/09/93
Ellen Siegel (U.S.A.)	INRIA 20/09/92	GMD 21/03/93	INESC 21/09/93
Daniela Rus (Romania)	GMD *to be confirmed*	INRIA	
Charles Wüthrich (Italy)	RAL 01/09/92	INESC 02/03/93	CWI 02/09/93

Research programme of the 1992–1993 ERCIM fellows.

CNR	CWI	GMD	INESC	INRIA	RAL
Bouali 01/01/93	Breslauer 01/10/92	Rus*	Penz 15/09/92	Siegel 20/09/92	Wüthrich 01/09/92
Breslauer 01/10/93	Boucherie 01/06/93	Siegel 20/03/93	Wüthrich 01/03/93	Breslauer 01/04/93	Penz 15/03/93
	Bouali 01/10/93	Penz 15/09/93	Siegel 20/09/93	Boucherie 01/09/93	
	Wüthrich 01/09/93			Rus*	

* to be confirmed

The fellows will, where possible, spend three periods of six months each at three different ERCIM institutes. The 92/93 allocation is shown above.
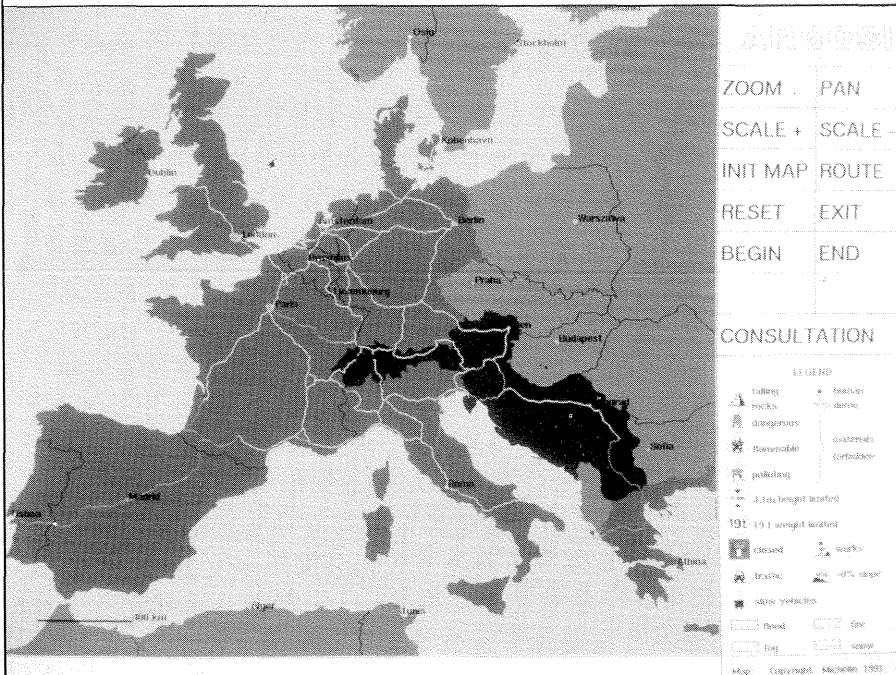
The objectives of the ESPRIT Project, Argosi, are to advance the state of the art in the transfer of graphical information across international networks, as well as to improve the quality and the applicability of standards in this area. The transfer is demonstrated through the medium of a prototype application which has been designed to portray a European road freight operator who wishes to plan a route across Europe, avoiding traffic difficulties, using a graphical interface. The road freight operator uses the application from a consultation workstation where he is able to draw the proposed route on a map, enter the dates of the journey and request details of the traffic difficulties affecting a journey along this route between the dates. The picture on the left gives a view of a typical screen lay-out.
(Photo: Eidelman, INRIA)

ERCIM Partners – Making Collaborative European Research Work

by Bob Hopgood

Scientific research world-wide is increasingly being influenced by counteracting forces: one is the realisation that scientific excellence is a corner stone of technological progress and subsequently, of public welfare; and the other is that science, along with most other sectors, must be accountable, and must make best use of limited resources. The various IT related research programs sponsored by the EC have been very conscious of this latter point.

In ERCIM, all partner organisations are well aware of the forces mentioned above, and there is a growing belief that by working together, synergies can be created which will make European Research more effective than would be possible in isolation. Data communication links between the ERCIM partners are being used to good effect and have already contributed to the forming of an "IT research backbone" across Europe. What's more, ERCIM partners are taking leading roles in the harmonisation of research objectives and directions in European IT. The scale and momentum of the synergies can be appreciated by looking at the list of CEC projects in which one or more ERCIM partners take part.

By mid-1991, ESPRIT had initiated approximately 650 projects, and the call for proposals to the third framework had gone out. In 1992, the research contribution of ERCIM institutes to ESPRIT (as well as other European initiatives such as RACE, BRITE and AIM) is truly impressive: nearly 270 projects with 1 ERCIM partner, 35 with 2 ERCIM partners, 8 with 3 ERCIM partners, and 2 with 4 ERCIM partners, totalling around 315 CEC projects with ERCIM involvement!

The list at the end of this article shows the involvement of ERCIM partners in those European IT programmes (we have listed only those IT projects with at least two ERCIM pertners). We have also endeavoured to make the list as up-to-date as possible, with the proviso that some Esprit III projects may have had some alterations since the lists were compiled.

With research being conducted on a European scale and with long-term plans for the Community, the need for an efficient infrastructure will become ever more apparent. Tasks which will have to be tackled include: well-managed repositories for research results, the monitoring of research directions across the various IT programs to avoid straight duplication on the one hand, and to encourage different approaches to similar problems on the other hand.

The directors of the eight ERCIM partners are currently formulating the policy that will allow ERCIM to be effective in a European context.

Project	Number	ERCIM Partners
ESPRIT		
ARGOSI	2463	GMD, INRIA, RAL
ATMOSPHERE	2565	CWI, GMD, INESC
BECAUSE	5417	INRIA, RAL
CAFE		CWI, SINTEF
COMANDOS	2071	CNR, GMD, INESC, INRIA
COMPARE	5399	CWI, GMD, INESC, INRIA
DELTA 4	2252	CNR, INESC, INRIA
ECIP	2072	GMD, INESC
EDS	2025	INESC, INRIA
EVEREST	2318	INESC, RAL
EWS	2569	INESC, INRIA, RAL
GIPE II	2177	CNR, INRIA
GPMIMD	5404	INESC, INRIA
HARNESS	5279	INESC, INRIA
ITHACA	2121	FORTH, INRIA
IWS	82	FORTH, INRIA
JESSI CAD FRAME	5082	GMD, INESC
LOTOSPHERE	2304	CNR, GMD, INRIA
MADE 1	6307	CWI, INESC
MLT	2154	FORTH, GMD, INRIA
MMI2	2474	INRIA, RAL
Multiworks	2105	GMD, INRI A
MULTOS	28	CNR, FORTH
PPPE	6643	GMD, INR IA
PREPARE	6516	GMD, INRIA
SAM	2589	CNR, INRIA, SINTEF
ESPRIT BRA		
AMODEUS 2	7040	CNR, INRIA, RAL
BROADCAST	6360	INESC, INRIA
CLICS	3003	GMD, INRIA
COMPASS	6112	INESC, INRIA
CONCUR II	7166	CWI, INRIA
CONFER	6454	CWI, INRIA
FIDE2	6309	CNR, INRIA
IS-CORE	6071	GMD, INESC
MIRO	6576	CNR, GMD
QMIPS	7269	CWI, INRIA
VLSI DESIGN ACTION		
EUROCHIP		GMD, RAL
RACE		
AMICS	R2056	GMD, RAL
IPSNI	R2009	CNR, FORTH
LACE	R2068	GMD, INESC
SPECS	R1046	CWI, INESC
COMETT		
ACoPaCo		CWI, GMD
MATARI		CNR, FORTH
AIM		
EURIPACS	A2009	FORTH, INESC
GAMES II	A2034	CNR, FORTH
Libraries		
RIDDLE		CWI, RAL

CEC-funded IT projects with single ERCIM partners

ERCIM Partner	Number of CEC Projects
CNR	47
CWI	31
FORTH	14
GMD	41
INESC	73
INRIA	44
RAL	10
SINTEF	8

CEC-funded IT projects with more than one ERCIM partners

Numerical Linear Algebra: Activities within the ERCIM Institutes

by Bruno Codenotti, Mauro Leoncini, Giovanni Resta

This series of short articles surveys the research activities of the ERCIM partners in Numerical Linear Algebra and related fields. Our intention is to evidence the main activities in the ERCIM laboratories on this subfield of numerical analysis. We also hope to provide a framework which could possibly be a starting point for joint projects and collaborations.

The series includes a general overview on Numerical Linear Algebra and a specific description of work on sparse linear systems at RAL, a presentation of the kind of applications in which Numerical Linear Algebra tools are used at CWI, an illustration of various research themes under way at INRIA, i.e. condition number estimation, direct linear system solution, and domain decomposition techniques, and a description of a very fast parallel algorithm for solving linear systems and related problems at IEI-CNR.

∎

Repeated Matrix Squaring for the Parallel Solution of Linear Systems

by Bruno Codenotti, Mauro Leoncini, Giovanni Resta

Existing very fast parallel algorithms for the solution of linear systems are very complicated and unstable. We propose a simple method that achieves the same asymptotic performance of the best available methods, while having the advantage of being more practical and easier to implement in a variety of parallel machines.

Our algorithm applies to linear systems written in the form

$$x = Px + q \qquad (1)$$

with $\rho(P) < 1$. This is by no means a loss of generality because any linear systems $Ax = b$, with $n \times n$ nonsingular coefficient matrix A and condition number $\mu(A)$ bounded by a fixed polynomial n^k, can be put into the form (1) with limited computational effort.

The solution of $x = Px + q$ can be approximated by the iterative method

$$\begin{cases} x_0 = 0 \\ x_{i+1} = P\,x_i + q, \ i = 0,1,2,\dots \end{cases} \qquad (2)$$

The parallel computation of (2) can then be performed according to the following scheme. Consider the $(n+1) \times (n+1)$ matrix Q, defined as

$$Q = \begin{bmatrix} P & q \\ 0^T & 1 \end{bmatrix}$$

and observe that the matrix Q^k, $k=1,2,\dots$, is given by

$$Q^k = \begin{bmatrix} P^k & \sum_{i=0}^{k-1} P^i\,q \\ 0^T & 1 \end{bmatrix}$$

as can be seen by direct inspection.

It follows that the computation of x^k can be reduced to the computation of Q^k. In turn, Q^k can be computed using "repeated squaring", i.e. computing from

$$Q_0 = Q,\ Q_{i+1} = (Q_i)^2.$$

It is easy to see that the computation of Q^k, and thus of x_{2^k}, can be carried out in $O(\log k)$ steps, each requiring a single matrix multiplication. The complexity analysis that we have performed shows that if the matrix A is well conditioned, then with $k = O(\log n)$ steps the solution $A^{-1}b$ can be approximated to within 2^{-n^d}, for any d independent of n.

Our algorithm essentially reduces to matrix multiplication. As a consequence, it can be efficiently implemented on a number of parallel architectures, with different time performances (ranging from $\Theta(\log^2 n)$) but with the same overall work (product of time and number of processors). This property makes the algorithm of both theoretical and practical interest.

∎

Please contact:
Bruno Codenotti – IEI-CNR
+39 50 593 457
email: codenotti@iei.pi.cnr.it
or:
Mauro Leoncini – IEI-CNR
+39 50 593 452
email: leoncini@iei.pi.cnr.it
or:
Giovanni Resta – IEI-CNR
+39 50 593 452
email:resta@iei.pi.cnr.it

Data Perturbations to Estimate Condition Numbers and Numerical Stability

by Jocelyne Erhel

The condition number and the regularity of a problem reflect the sensitivity of the solution to perturbations in the initial data. The algorithm used to solve the problem leads to new sources of errors, namely the approximation error and the roundoff error.

The idea of the statistical methods is to apply random perturbations in the initial data to get a sample of errors in the solution. These measures yield only the errors in the computed solutions. However, under some reasonable assumptions on the random distribution of the approximation and the roundoff errors, it is possible to distinguish between numerical and problem instabilities.

Indeed, for small perturbations, the computed error reflects only the algorithm errors which become negligible for larger perturbations. Therefore, for sufficiently large perturbations, the computed error approximates the exact error.

On the other hand, for sufficiently small perturbations and if the problem is smooth enough, the exact error may be approximated by $C\,\alpha^q$ where C is the condition number, α is the size of the perturbation and q is the regularity. Our statistical method varies the size of the perturbation α and relies on a domain of regularity $[\alpha_1, \alpha_2]$ where the computed error approximates the exact error and where a log-linear regression of the error estimation upon the perturbations is valid. This regression gives an estima-tion of the regularity and the condition number of the problem.

This method is applied successfully to the direct resolution of linear systems, showing for example the numerical instability of gaussian elimination with no pivot. It also provides an estimation of the regularity equal to one and an estimation of the condition number in agreement with well-known condition numbers. We currently investigate the application of the method to iterative algorithms.

■

Please contact:
Jocelyne Erhel – INRIA/IRISA
+33 99 36 73 39
email: erhel@irisa.fr

Numerical Linear Algebra Research by the Numerical Analysis Group at RAL

by Iain Duff, John Reid, Nick Gould and Jennifer Scott

The Numerical Analysis Group at RAL joined the Laboratory from Harwell in 1990. At Harwell, one of our main activities was the support and development of mathematical software for the Harwell Subroutine Library. At RAL, we are continuing both this support and our underlying research activities in optimisation and numerical linear algebra. We are particularly interested in the case when there are very many variables and the underlying matrices are large and sparse.

In an accompanying article, we discuss current work on two major software packages for solving sparse linear systems. Here we discuss other activities in numerical linear algebra.

We have recently developed many utility routines for sparse matrix calculations, including routines for permuting and sorting sparse matrices which are economic in both space and time. Other work includes routines for implementing Schur complement methods that are useful when solving sequences of problems that differ in only a few rows and columns. These can typically occur in constrained optimisation when an active set method of solution is being used.

Two further software projects concern sparse eigensolution and a new frontal code.

The EB12 code computes either the eigenvalues of largest moduli or the rightmost (or left-most) eigenvalues of a large sparse unsymmetric matrix. This problem arises in many applications, including economic models, Markov modelling, and bifurcation problems. EB12 uses a subspace iteration algorithm optionally combined with Chebychev acceleration. Schur vectors are computed for the basis of this subspace but, after convergence, an option exists for computing the eigenvectors. EB12 does not need the matrix explicitly since it only requires the user to multiply sets of vectors by the matrix. This makes the code suitable for large sparse problems and more general eigenproblems. This interface also allows full advantage to be taken of vectorisation or parallelism. Other novel features of EB12 include a new locking technique, new stopping criteria, and new criteria for choosing the degree of the iteration polynomial.

We are working on a new frontal code for unsymmetric systems, MA42, which will replace the frontal code MA32. Although the frontal method is particularly designed for finite-element calculations, MA32 and MA42 are able to handle matrices from other applications. Principal enhancements of MA42 over MA32 include the use of high level BLAS in all aspects of the code, better modularity, new and more efficient data structures for holding the factors, and more efficient use of disk storage. We intend to use the new code as a basis for further developments in frontal matrix solution including exploitation of parallelism, and the design of codes for complex and symmetric cases.

■

Please contact: Iain Duff – RAL
+44 235 445803
email: isd@IB.RL.AC.UK

Domain Decomposition Methods and Distributed Memory Parallel Machines

by François-Xavier Roux

The recent expansion of fast microprocessors gives rise to a new class of MIMD supercomputers based on massively parallel architecture with distributed memory. These new machines feature large numbers of processors connected through a communication network.

To be efficient for massively MIMD parallel machines, parallel algorithms must allow the distribution of data among the local memories in such a way that each parallel task, allocated to one processor, makes mainly use of local data.

The so-called domain decomposition methods for solving sparse systems arising from finite element discretisations of partial differential equations consist of splitting the global mesh into pieces called subdomains, and solving, via an iterative method, a condensed problem on the interface between the subdomains. At each iteration, local independent problems must be solved in each subdomain. Thus, these methods lead to naturally distributed parallel algorithms.

When direct local solvers are used, domain decomposition methods appear to be a mixing of direct and iterative solution methods. As the dimensions and condition numbers of the condensed interface operators are lower than the ones of the global problems, domain decomposition methods are more robust than classical iterative methods. As only the factorisation of the local matrices associated with the different subdomains have

to be computed, domain decomposition methods require less memory than direct methods, and are often faster, even on sequential computers.

Domain decomposition methods have been successfully used for solving large sparse systems arising from finite element methods in structural analysis or finite volume methods in computational fluid dynamics. Nevertheless, various issues must be addressed in order to implement these methods in industrial codes, including the design of automatic mesh splitting tools and the implementation of direct parallel solution of local problems on cluster nodes. ■

Please contact:
François-Xavier Roux – ONERA, France
+33 1 46 73 44 27
email: roux@onera.fr

Two New Codes for the Solution of Sparse Linear Systems

by Iain Duff and John Reid

The Harwell codes MA27 and MA28 have provided robust solutions to general sparse linear sets of equations for several years. MA27 handles the symmetric case and is unusual in addressing non-definite matrices, while MA28 handles the unsymmetric case. We plan to replace these by new codes that will be called MA47 and MA48.

The main advantage of MA47 will be the better exploitation of sparsity when the original matrix has zeros on its main diagonal. MA27 performs Gaussian elimination and uses 2 by 2 pivots when stability considerations demand them. After

suitable permutations, the submatrix altered by a pivotal step has the general form:

$$\begin{bmatrix} 0 & A_1 & A_2 \\ A^T_1 & A_3 & A_4 \\ A^T_2 & A^T_4 & 0 \end{bmatrix}$$

We call this a "generated element matrix". A 2 by 2 pivot with two zero diagonal entries, which we call an oxo pivot, produces this form explicitly. A 2 by 2 pivot with one zero diagonal entry, which we call a tile pivot, produces the special case of this form where the last block row and column is null. MA47 will work explicitly with generated matrices of this form, whereas MA27 treats them as full matrices. Because of all the overheads of working with this form, we also plan a version for the case without any zeros on the main diagonal of the original matrix.

The main advantage of MA48 comes from the use of the ideas of Gilbert and Peierls for generating the sparsity pattern of the triangular factors when row permutations are included without an overhead of greater complexity than the factorization itself. This allows us to provide a new entry for the stable factorization of a matrix having the same pattern as one already analysed with a cost that is not much greater than that for using a fixed pivot sequence. We have also taken the opportunity to reorganize the code so that there is a driver that provides ready access to block triangular factorization and iterative refinement, and an inner code called MA50 that does not provide these features.

For both codes, we use the Basic Linear Algebra Subroutines (BLAS), particularly at levels 2 and 3, to perform full-matrix subtasks since very efficient versions of these are available on many computers. ■

Please contact:
Iain Duff – RAL
+44 235 445803
email: isd@ib.rl.ac.uk
or:
John Reid – RAL
+44 235 446493
email: jkr@ib.rl.ac.uk

Applications at CWI

by Henk Nieland

CWI does not have a separate research programme in numerical linear algebra, but extensively applies linear algebra methods in various other projects. A short description of some of these projects follows below.

Parallel Modified Newton Processes

Numerical modelling of initial-value problems often leads to large systems of nonlinear equations that have to be solved at each integration step. In many codes, these equations are solved by a Newton-type iteration process that replaces the nonlinear system by a sequence of linear systems. This process can be accelerated by using facilities of parallel computers. The Newton process is parallelised by defining a new sequence of linear systems of smaller dimension which can be solved partly in parallel. By this approach it is possible to improve on the code, LSODE – one of the most widely used codes for initial-value problems for differential equations – by a factor 2 on a 4-processor Alliant.

Please contact: Ben Sommeijer – CWI
+31 20 592 4192
email: bsom@cwi.nl

Coupled Flow and Brine Transport in Porous Media

A 2D groundwater flow model for coupled flow and brine transport in porous media is being studied at CWI. The (implicit) BDF family, as implemented in the DASPK package, is used as time integrator. At each time step the nonlinear PDE's are discretized into a system of algebraic equations which is linearized by the Newton process.

The solution of the resulting linear systems requires the bulk of the computer time. Hence, a performance study was made of a number of linear solvers. Two direct methods were considered: a band solver (SGBFA/SGBSL from LINPACK) and a sparse solver (Y12M of ZLATEV). The iterative solvers included GMRES and CGS + ILU preconditioner (both from the slap library), and BI-CGSTAB (a variant of CGS). It transpired that the iterative solvers are by far preferable, as well in CPU-time as in memory use. In particular, BI-CGSTAB +ILU preconditioners turn out to be very robust. Further research will deal with polynomial preconditioners, testing the GMRESR method (having a built-in preconditioner) and, possibly, the matrix-free Newton process.

This work was sponsored by the National Computing Facilities Foundation (NCF), with financial support from the Netherlands Organisation for Scientific Research (NWO) and CRAY Research.

Please contact: Jan Verwer – CWI
+31 20 592 4096
email: janv@cwi.nl

Fast Iterative Solvers

As part of a project on Steady Boundary-Value Problems, considerable research has been done on the construction of fast iterative solvers for large sparse linear systems with a regular structure. The systems stem from the discretization of general linear second-order elliptic partial differential equations in two dimensions.

Iterative methods are attractive because both the memory and CPU requirements are essentially smaller than for direct methods. Multigrid methods are of special interest because problems with N unknowns can be solved with only an $O(N)$ amount of work. Realising this ambition requires expertise and a substantial effort which may be an obstacle for the uninitiated user. Especially the communication between coarse and fine grids and the set-up of coarse grid problems is a delicate matter. Therefore we developed several black box solvers for which the user only needs to specify his problem on the finest grid, and for which no additional information or the tuning of parameters is required. Multigrid methods can be viewed as accelerators of standard relaxation procedures. In this respect we focussed on incomplete decompositions and line relaxation type methods.

Our codes are written in standard FORTRAN 77 and most of them have been vectorised and parallelised on the Cray Y-MP. The codes range from ones destined for relatively smooth problems and demonstrating high vector performance, to one for hard problems and demonstrating fast convergence in a mathematical sense. Recently we also implemented a variant of a stabilised Bi-Conjugate Gradient (Bi-CGSTAB) method of Van der Vorst for an application to semi-conductor equations. On the one hand the multigrid solvers show essentially faster convergence, but Bi-CGSTAB is easier to generalise to systems of equations and to three space dimensions. The latter generalisation is a possible topic of future research for our multigrid codes.

Please contact: Paul de Zeeuw – CWI
+31 20 592 4113
email: pauldz@cwi.nl

3D Shallow-Water Equations

Flows in rivers and shallow seas are studied more and more in connection with, e.g., coastal protection and the environment. These flows are mathematically described by the shallow-water equations and a large number of numerical models, based on those equations, have been developed. Such models are nowadays much cheaper and more flexible than scale models. In The Netherlands, the Water Control and Public Works Department, Delft Hydraulics and the Informatics Centre for Civil Engineering and Environment cooperate in the development of models aiming at the computation of time-dependent 3D hydrostatic flows (multi-layer models). Compared to the 2D (one-layer) case, 3D

models require much more computing power.

At CWI, work was commissioned to develop efficient, accurate and stable models, fully exploiting the potential of vector and parallel computers. The unconditionally stable two-stage time splitting method was satisfactorily tested in realistic cases like the Continental Shelf and the IJsselmeer on an Alliant FX/4 and on CRAY supercomputers, and was also theoretically verified as a good method. It requires the solution in two stages of a sequence of linear systems by, successively, a Jacobi-type iteration method and a preconditioned conjugate gradient method. Both methods are highly suited for vector and parallel computers. These results suggest that the unconditionally stable time splitting method can also be successfully applied to inhomogeneous flows, thus enabling the accurate prediction of the dispersion of pollutants by adding features such as salinity and turbulence to the model.

Please contact:
Piet van der Houwen – CWI
+31 20 592 4083
email: senna@cwi.nl

Parallelisation/Vectorisation of Multigrid Codes

Three different multigrid codes for the solution of linear systems, derived from general linear second order 2D elliptic PDE's and developed at CWI in the mid-eighties, are being tuned on vector-register machines and parallelized in standard Fortran on a shared-memory multiprocessor. A new, optimally efficient Galerkin approximation algorithm for the generation of the coarse-grid operators is used, in which the number of scalar operations is reduced from 191 to 74 floating point operations per grid point, which are also suitable for highly parallel processing. The new codes are written in autoparallelizable and autovectorizable ANSI Fortran 77. They run very efficiently on high performance (parallel) computers like the Cray Y-MP4.

Secondly, a Fortran multigrid code performing 2D Euler flow computations with automatic mesh adaptation, is being

vectorized on a Cray Y-MP. A library of vectorized subroutines was developed with the same entry point names and calling sequences as the original data structure and multigrid subroutines. Research focuses on vectorization of the original module (EULER) for performing the adaptive multigrid Euler flow computations, keeping the data structure unchanged. The vectorization of the relaxation process in the multigrid algorithm is considerably enhanced by using Van Leer's scheme: for one FAS cycle in the multigrid algorithm the observed vectorization speed-up factor on one processor of the Cray Y-MP4 is about 4.3.

Please contact: Walter Lioen - CWI
+31 20 592 4101
email: walter@cwi.nl

A Linear System Solver

by Bernard Philippe and Miloud Sadkane

Iterative methods often fail when solving an ill-conditioned linear system. To overcome this difficulty, the usual technique consists in preconditioning the system. The technique, although very efficient, depends strongly on the preconditioner selection. It even appears that the direct methods are the most robust procedures when the order of the considered matrix remains in a feasible range.

We propose here a method that partitions the algorithm into two steps such that the iterative part solves a better conditioned problem. The second part is a linear least-square problem on a small dimensional subspace. The approach cannot avoid the use of preconditioners, but it may push the limit of feasibility further.

Let us consider the initial problem, $Ax=b$, where A is a non singular matrix and b a

vector. We denote by P the projector onto the orthogonal complement of b. The solution, x, satisfies $PAx=0$ and $A^TPAx=0$. Therefore, the problem is transformed into the computation of a null vector y of the matrices PA or A^TPA. Since the null space of these matrices is a one-dimensional subspace, the solution x can be obtained by solving a one-dimensional linear least square problem.

When several singular values of A are very small then it can be better to compute the subspace spanned by their corresponding singular vectors. The algorithm becomes:

- first step: compute a basis of the subspace containing the singular vectors corresponding to the given l lowest singular values of PA.
- second step: compute in the subspace the vector x which minimizes the residual.

In the first step, a block-Arnoldi procedure is selected. When the normal equations are considered, the procedure leads to a block-Lanczos procedure. For the Arnoldi procedure, two techniques for restarting can be used:

- use the l eigenvectors corresponding to the l eigenvalues of smallest modulus of the Hessenberg matrix.
- use the l right singular vectors corresponding to the l smallest singular values of the Hessenberg matrix.

The second restarting technique is less sensitive to perturbations in the right-hand side, b, than the former one. Furthermore, for problems with several eigenvalues of PA close to zero, the block-Arnoldi method has proved to be very helpful and even necessary for capturing the corresponding eigenvectors/singular vectors.

Numerical experiments prove promising for handling some difficult PDE problems.

Please contact:
Bernard Philippe – INRIA-IRISA
+33 99 36 73 38
email: philippe@irisa.fr
or:
Miloud Sadkane – INRIA-IRISA
+33 99 36 73 15
email: sadkane@irisa.fr

Integrated Communications Management

by Stelios Sartzetakis

One of the research areas of primary interest to the networking group at ICS-FORTH is the management of ATM networks. ICS is one of the 17 research laboratories, R&D and University departments, and companies that participate in the RACE II project ICM. FORTH's Institute of Computer Science is active in this area since 1988 taking part in NEMESYS, another CEC project.

ICM started this year with the main objectives to integrate Advanced Information Processing (AIP) technologies for Telecommunications Management Network (TMN) systems and to validate selected TMN functional specifications. The main result of the ICM project is the development of a test bed laboratory where the integration of AIP technologies for TMN systems and platforms can be tested for performance. The emerging TMN technologies must be tested before they can actually be integrated into IBC networks. Laboratory testing of complex networks, whether by software, hardware, or hybrid simulation is of utmost importance given that live testing on real networks is not viable.

The TMN is a large distributed processing system consisting of interconnected data processing and storage devices, performing its tasks partly under strict real-time conditions and interacting in a sophisticated way with human operators. The use of AIP techniques will enable such a complex system to be possible. AIPs can be applied throughout the TMN: TMN platforms, Applications, Management Information Base, and Operator Interfaces.

ICM project will have access to a sufficiently complex network so that the AIP technologies can be adequately tested. This network may consist of actual hardware components, as well as software components which simulate some functionality of the network. The simulators will complement rather than duplicate the functionality of the real networks. Interfaces between the hardware and software will also be established in order for the system to operate as a complete network. It is a goal of ICM to achieve one single management system for different networks and network types.

The actual components required by the network include a number of ATM switches, a broadband medium connecting these switches in some network configuration, terminals and a User Network Interface (UNI) providing a point at which user traffic enters the network. The network will allow for user traffic (in the form of ATM cells), broadband signalling capabilities, network management functionality, and testing facilities. Finally, the network will be furnished with the traffic that is necessary for testing the effectiveness of the AIPs that will be employed.

FORTH will concentrate on setting up the parts for this test bed, taking advantage of and enriching its large installed base of medium-to-high speed networks, as well as the study of Quality of Service and Performance Management issues, mainly through the Call Control functions. Apart from the actual transport of information, the functions of a network which are most transparent to a user are those of Call Control. They include such visible functions as handling of connection and service requests, as well as less obvious actions such as real-time routing decisions, internode signaling and re-connection in the case of component failure or malfunction.

Specific functions considered under Call Control are Virtual Path Bandwidth Management, Call Acceptance Management, and source policing.

Call Acceptance Management (CAM) is concerned with determining whether the network has adequate resources to service an incoming call such that the desired Quality of Service (QoS) as seen by all current customers is maintained. The CAM is also concerned with maximising network utilisation (i.e., statistical multiplexing). In order to statistically guarantee a certain level of QoS to all calls, an incoming call must be able to provide some parameters which will characterise its behaviour. These parameters provide a basis for a bandwidth "contract" to be established. If calls are accepted according to their peak bandwidth (no statistical multiplexing), the QoS seen by the customers will be high, but the network load will always be low. If, on the other hand, calls are accepted according to their mean bandwidth (maximum statistical multiplexing), the network may achieve a higher utilisation, but the QoS will degrade. The CAM must reach some type of balance between these two extremes in making the call acceptance decisions.

Virtual Path Bandwidth Management (VPBM) is responsible for managing the allocation of bandwidth to the various Virtual Paths (VPs) in the network. The ATM architecture allows for Virtual Circuits (VCs) to be routed along Virtual Paths which span a number of links and nodes. Bandwidth is reserved on a VP so that when a new call arrives, a VC can be established on this VP with very little overhead. The only processing necessary for setting up the VC is at the endpoint of the VP, not at any of the transit nodes which it traverses. The problem of Virtual Path Bandwidth Management is then how to optimise the allocation of bandwidth to Virtual Paths so that utilisation of the network resources will be maximised and call blocking will be minimised.

∎

Please contact:
Stelios Sartzetakis – ICS-FORTH
+30 81 22 93 02
email: stelios@ics.forth.gr

Innovative Testing and Verification Tools for Integrated Broadband Communication

by Rudolf Roth

At the initiative of the GMD Institute for Open Communication Systems, the international research project TOPIC (Toolset for Protocol and Advance Service Verification in Integrated Broadband Communications (IBC) Environments) has been commenced within the framework of RACE II (Research and Development in Advanced Communications Technologies for Europe), a promotional programme of the Commission of the European Communities. TOPIC's objective is the development of methods and tools for verification and testing purposes in integrated broadband environments. Eleven leading research establishments and enterprises from the telecommunications industry from six different European countries are participating in TOPIC. The results of the project will constitute important milestones along the road to integrated broadband communication in the next decade.

RACE is a major initiative of the European Community which is intended to provide Europe with integrated broadband communication on the approaches to the next millenium. TOPIC is part of the second phase of the RACE programme and will run almost three years until the end of 1994.

Other German institutions involved in TOPIC are the Technical University of Berlin and Siemens AG. French involvement is through Dassault Automatisme et Télécommunications and Verilog, a leading European company in the field of CASE technology (Computer Aided Software Engineering). Verilog will be responsible for administrative management in TOPIC and will act as representative vis-à-vis the European Commission. Also represented are COSI and Etnoteam S.p.A. from Italy, Electronic Centralen from Denmark, Intracom S.A.. and the Technical University of Athens from Greece and Sterling University from the U.K.

TOPIC will provide comprehensive verification technology for IBC. This objective comprises three fields of activity: verification methodology for IBC, verification tools for QoS (quality of service) and protocol conformance and, finally, a demonstrator for IBC verification experiments.
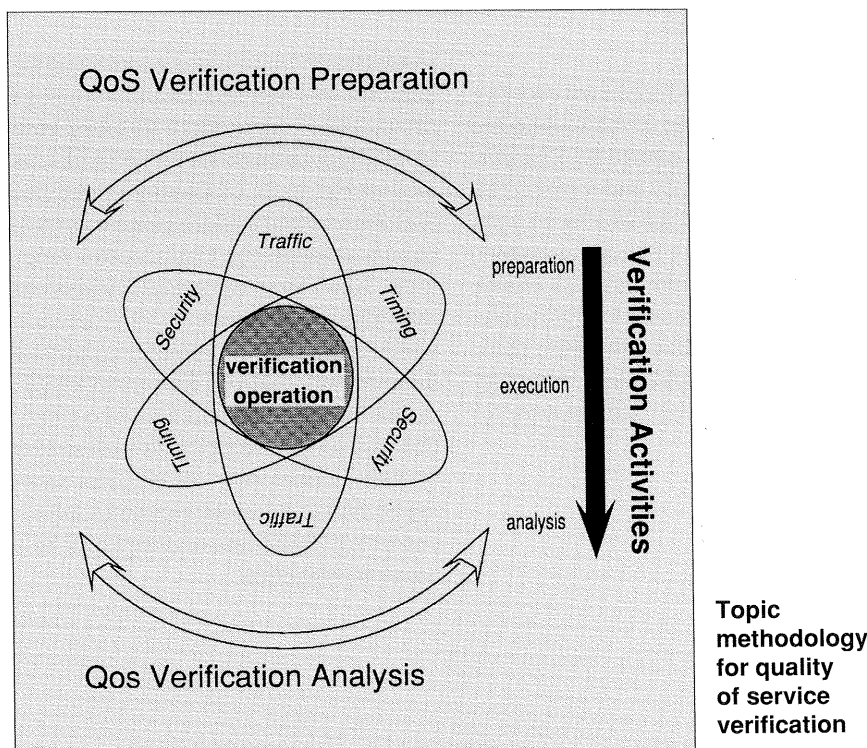
Verification is an important task in IBC systems and ensures that the user is provided with services in the required quality. Verification is oriented here to two aspects, namely service verification and protocol verification. TOPIC will cover both fields.

The project concentrates primarily on the development of new types of verification tools. The TOPIC Toolset will embrace the entire verification cycle, with support for the verification preparation, embedded and results analysis phases. TheTOPIC tools will be incorporated in a methodological framework for service and protocol verification. Due to the extraordinary complexity of theIBC systems, particular emphasis will be attached to strictly formal methods. The TOPIC project also involves the creation of a demonstrator which will allow methodology and tools to be tested and assessed in a real IBC environment and will thereby establish confidence in the procedure devised. Moreover, it will function as a pilot study for future reference.

TOPIC is based on the results drawn from projects in the RACE I phase such as ITACA, ROSA, NETMAN and QOSMIC and on work conducted by the international standardisation bodies in this field, such as 'Protocol Conformance Testing Methodology and Framework' and 'Formal Description Techniques'. The innovative results of the project will provide important aids to other RACE projects which are dependent on the substantiation and verification of QoS. TOPIC will provide an important source of motivation for further international standardisation activities.

∎

Please contact: Jan de Meer – GMD
+49 30 25499 239
email: jdm@fokus.berlin.gmd.dbp.de

QoS Verification Preparation

QoS Verification Analysis

Topic methodology for quality of service verification

PYTHAGORAS Investigates Quality of Modern Databases

by Henk Nieland

There is an urgent need for developing tools for early quality assessment of new database management systems (DBMS). The ESPRIT project PYTHAGORAS aims at providing such tools.

The project runs for three years on a budget of 4 MECU. Coordination rests with CWI in Amsterdam (project manager Martin Kersten). The other participants in PYTHAGORAS are: the multinationals ICL (UK) and BULL (France), and Heriot-Watt University (UK), CCIP, Infosys and IFATEC (France) and ECRC GmbH (Germany).

Databases take a key position in most automation projects. Modern applications make high demands upon their reliability and efficiency. New systems appearing on the European market often exhibit instabilities and low performance, due to lack of extensive field tests in the application areas they are intended for. Furthermore, little is known about the most efficient way of operating with databases in a parallel or distributed environment. Customers (e.g., European industry), however, require reliable information in advance about the expected performance of a new DBMS.

For example, an important condition is that a database server does not collapse in practice under heavy load (many data or users). New systems often contain implementation errors and bottlenecks, unnoticed during construction or only becoming manifest in new application areas. An important part of PYTHAGORAS is the development of a Software Testpilot, in operation similar to test flights of an aeroplane, which can take over to a considerable extent human test-ing of a system's reliability and performance. Moreover, simulation models for DBMS will be developed in connection with highly parallel systems.

PYTHAGORAS builds on some earlier projects with intensive CWI participation: PRISMA, TROPICS and EDS (development of a parallel DBMS for the European market).

■

Please contact:
Martin Kersten – CWI
+31 20 592 4066
email: mk@cwi.nl

RACE Project CASSIOPEIA Started

by Jan de Meer

The CASSIOPEIA project was started at the beginning of 1992 as part of RACE II, the promotional programme of the Commission of the European Communities. The objective of this new RACE project (Research and Development in Advanced Communication Technologies for Europe) is to support integrated service engineering through an open service architecture, i.e. to facilitate the design and implementation of integrated services in applications involving integrated broadband communications (IBC technology) from technical and commercial aspects.

A consortium of 13 partners – including research laboratories of various PTT administrations (CNET, British Telecom, PTT-NL), R&D departments of industrial undertakings (CSELT, DOWTY, Ericsson AB) and scientific establishments (GMD, University of Twente) – has been formed for a period of four years. GMD is represented by the "System Engineering and Methodology" group of the GMD Institute for Open Communication Systems in Berlin.

The object of the integration work is the differing needs encountered in the utilisation of services and the operation of service-providing systems. Through the possible assignment of roles as service users, service providers and service conveyors, the initial definition phase must take into consideration the performance features which allow the management tasks required during subsequent utilisation of the service. Furthermore, thanks to the performance features of the new IBC technology, these services allow the integration of both conventional data and digitised audio-visual information. Typical examples of this include distributed multimedia services.

In this task definition, the term "architecture" is used in the project to denote not so much a concrete assignment of different function components and their interplay, but rather is understood as characterising a set of principles whose application is further supported by management aids. This approach is intended to facilitate the design of integrated services. In this regard, the principles of the architecture determine recurring "patterns" which can be used as modules, and management aids which can be used – like recipes – to create reliable, integrated services.

The goal of the architecture is to design integrated services which are not based on technological dependencies but which are open for both future technical advances and other service providers.

The project is also expected to determine and evaluate a group of methods, technologies and tools for supporting the design of integrated services throughout all phases. Furthermore, validation of the selected architectural approach outlined above can be anticipated through the use of examples and selected methods and tools.

■

Please contact:
Jan de Meer – GMD
+49 30 25499 239
email: jdm@fokus.berlin.gmd.dbp.de

Variational Methods and Computational Vision

by Riccardo March

Early computational vision aims at understanding how geometrical and physical properties of the visible world may be inferred from two-dimensional images. However, images of an object generally contain only limited information about the structure of visible surfaces and, consequently, the reconstruction problems arising in computer vision are often mathematically ill-posed. The development of a unified mathematical framework for visual reconstruction problems is thus an important goal of computational vision.

Solutions of ill-posed problems can be computed by using regularization methods that impose additional constraints derived from suitable a priori knowledge. Many problems arising in computational vision have been solved by using a smoothness constraint, based on the physical assumption that the coherence of matter tends to give rise to smoothly varying characteristics in a visual scene. Through regularization, an ill-posed problem is reformulated as a variational method whose solution is numerically computable.

However, spatially localized physical transitions, such as sharp changes in surface geometry, surface color, or illumination, lead to discontinuities in the scene characteristics, and the smoothness constraint is clearly inadequate across visual discontinuities. Furthermore, such discontinuities are the most significant locations in any image, since they often indicate the boundaries of objects. Hence, their detection is an important task in computer vision.

The research activity currently in course at IEI-CNR, Pisa, aims at the formulation of regularization methods when discon-tinuities are involved. We use variational methods of a new type that impose a piecewise smoothness constraint on the solutions. The image domain is divided into regions within which the solution is smooth, while these regions are surrounded by contours across which continuity is not required. The variational method looks for a set of discontinuity contours which are determined dynamically as the regularized solution is being computed.

By means of variational convergence techniques these methods yield algorithms that are suitable for implementation on parallel hardware. A wide variety of reconstruction problems arising in computer vision may be unified mathematically by using this approach. ■

Please contact:
Riccardo March – IEI-CNR
+39 50 593 481
email:march@iei.pi.cnr.it

MANIFOLD: a Model for Parallel Systems

by Farhad Arbab

In parallel computing an important problem is how to organise the communication among a set of autonomous processes in a complex system. A possible solution is MANIFOLD, a model for parallel systems under development at CWI. Its basic feature is the separation of functionality and communication.

The hardware technology of parallel computers is still drastically underutilised in today's applications. A major cause lies in the organisation of parallel programs, where the coordination and control of the communications among its sequential fragments is still an unsolved problem. There is no coherent model of how parallel systems must be organised and programmed. This type of model should be sufficiently open, in that it facilitates the migration of existing software to this new parallel environment. Reusability is promoted by separating the communication issues from the functionality of the component modules in a parallel system, thus making them more independent of their context. This is in particular an important issue in distributed computing.

The goal of CWI's MANIFOLD project is to develop a system for managing complex interconnections among independent, concurrent processes. It is based on separation of functionality and communication. MANIFOLD bears some similarities to shell scripts, event-driven programming and dataflow programming, but there are also significant differences. For example, the possibilities for defining and dynamically changing the interconnection among processes go far beyond what is offered in shell scripts. Contrary to dataflow networks, connection patterns among processes change dynamically, and processes are created and deleted dynamically as well. MANIFOLD is also characterised by the coexistence of event-driven and data-driven control.

The MANIFOLD programming language is well suited for describing complex and dynamic interaction patterns in user interface software and accords nicely with the concept of agents (intelligent autonomous entities). It can also express the lower levels and hardware related aspects of user interfaces, as was shown in our MANIFOLD implementation of the GKS input model.

A visual interface will be designed to give the MANIFOLD programmer the indispensable overview of a parallel program during execution. Also the use of visual interaction techniques in MANIFOLD programming itself will be explored.

The first implementation of the MANIFOLD system is nearly complete. It can run on a network of Sun SparcStations, or (potentially) on a network of Silicon Graphics workstations. ■

Please contact: Farhad Arbab – CWI
+31 20 592 4056
email: farhad@cwi.nl

Object Store at CNR in Pisa

by Gianni Mainetto and Fausto Rabitti

The object-oriented paradigm has proven to be quite successful, from the programmer's point of view, in the domain of data intensive applications, including new application areas such as CAD, office systems, software engineering support, etc.. However, the main limitation remains the efficiency of such systems. The reason is that database techniques developed for traditional (e.g. relational) database systems are not always suitable for object database systems (OODBS). We are now revising these techniques, and studying new techniques, in order to improve the efficiency of the next generation of OODBS.

Researchers at CNUCE and IEI, involved in the CNR Project "Progetto Finalizzato Sistemi Informatici e Calcolo Parallelo - Obbiettivo DATABASE++" and in ESPRIT BRA 3070 "Formally Integrated Development Environment", are participating in the development of a prototype Object Store capable of satisfying the new reliability, integrity, capacity, concurrency, and performance requirements of OODBS. It is possible to meet these requirements if ad hoc techniques for accessing, storing and retrieving objects are developed, and if the Object Store implements optimisation techniques that use static and dynamic knowledge obtained through a careful revision of components of the object-oriented language processor. The following issues are currently being studied:
• physical independence;
• indexing techniques;
• short transactions management.

Physical Independence

In current OODBS implementations, the physical database organisation is generally hard-coded in the system, i.e. the strategy for storing data is fixed and usually reflects the logical object definition. However, if system efficiency is to be improved, the most suitable organisation for an OODB must be selected. A canonical object data model and storage object data model have been defined: in the former, objects are organised in classes; in the latter, physical objects with similar structures are grouped in collections. A mechanism for mapping data structures and operations from the logical level to the physical level has been defined. Moreover, we are developing a software tool, based on analytical modelling techniques, for the performance analysis of the physical storage organisations that we obtain from the mapping process. This is intended to evaluate the performance of certain query classes on specific physical object data structures.

Indexing

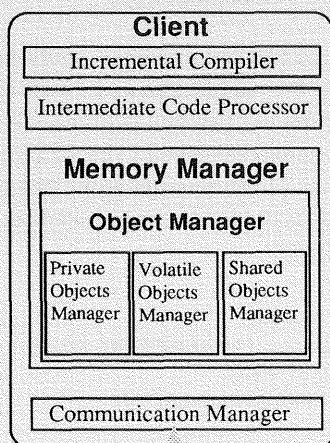The execution of different data manipulation operations must be supported by auxiliary data structures (accelerators, indexes). Navigation through various types of references among objects is the performance bottleneck of OODBS since the traditional techniques used for navigation are by no means adequate. A new organisation, called the Navigation Index, has been proposed in which the navigation is performed by computations based on the theory of simple continuous fractions. These computations are performed in temporary memory, minimising the access to secondary storage structures. The performance problem has been formalised and the Navigation Index evaluated in relation to other implementation techniques.
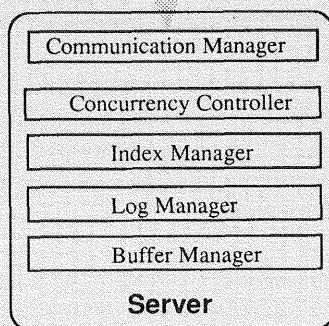
Transactions

Traditional database systems enforce serializable executions of transactions with respect to read and write operations because of the lack of static knowledge about type-specific operations. In OODBS, the transaction manager component has the possibility of knowing the type of an object. If the object-oriented language, used to program object definitions and transactions, allows side-effects on type-specific objects, this can result in a better performance of the transaction manager. The performance can further be improved using static analysis techniques to: predetermine the set of objects that a transaction is going to read and write; manage object caching and prefetching; influence temporary and secondary memory management; automatically collect secondary memory-garbage.

Prototype implementations of components of the final Object Store have already been developed. As far as transaction management is concerned, a prototype of a distributed OODBS based on a statically and strongly typed object-oriented language and on a simplified version of the Object Store has been realised on SUN workstations connected in a LAN.

■

Please contact: Gianni Mainetto –
CNUCE-CNR
+39 50 593285
email:gmsys@icnucevm.cnuce.cnr.it
or Fausto Rabitti – IEI-CNR
+39 50 593408
email:rabitti@iei.pi.cnr.it

Software

Client
- Incremental Compiler
- Intermediate Code Processor

Memory Manager

Object Manager

Private Objects Manager	Volatile Objects Manager	Shared Objects Manager

- Communication Manager

Server
- Communication Manager
- Concurrency Controller
- Index Manager
- Log Manager
- Buffer Manager

Static and dynamic knowledge of transaction behaviour
Protocols: Strict and Conservative 2PL
Granularity of locking: Objects
Commit protocol: Distributed 2PC
Distributed Atomic Garbage Collection
Navigation Index

Distributed software client-server architecture for OODBS

RIPE Recommends Integrity Protection Techniques to EC

by David Chaum

The RIPE project (RACE Integrity Primitives Evaluation) has submitted its recommendation for techniques to cryptographically ensure the integrity of information to the EC, which funded the three-and-a-half year project under its RACE programme. The recommendations were derived from 30 submissions made by industry and academia in 7 countries responding to two rounds of published calls. Extensive evaluation by the project revealed inadequacies or previously unknown weaknesses in most of the submissions, leaving only the recommended 7. Release of the results will be at the discretion of the Commission.

The RIPE project was carried out with the same partners, funding, workplan and schedule called for in its original contract. Of the three security-related projects funded under the programme, RIPE is the only one that will make its final delivery, all the others having been disbanded.

Additional work remains, however, if the recommendations are to have enduring usefulness. For one thing, as new approaches to breaking cryptographic integrity primitives continue to surface at scientific meetings and in the literature, security of primitives should periodically be reviewed. Furthermore, the types of primitives recommended are only adequate for the most widely perceived basic needs of today. But as cryptography becomes more pervasive, and its possibilities better appreciated, substantially more sophisticated functionality will be required.

The RIPE consortium members are: CWI (prime contractor), Siemens AG, Philips Crypto BV, PTT Research Netherlands, and the Universities of Leuven and Aarhus.

■

Please contact:
RIPE Secretariat, c/o CWI
+31 20 592 4104
email: ripe@cwi.nl

A Study of Software Vulnerability

by Alain Cazes and Veronique Donzeau

The objective of this study is to define and observe vulnerability points, that may cause, in short or the long term, failures in the behaviour of software. Vulnerability points may originate from flaws in the design, the development or implementation of the software.

This work fits in the more general approach of software quality measurement in which no tools yet exist to evaluate the quality of a software product. Software quality factors depend on various elements such as the software type (real-time, communication, information systems ...), the producting language, the development process or usage environment.

The scope of this study is limited to the specification of rational tools for the valuation of the vulnerability of real-time software developed in C or C++ for the military industry.

In this regard, we first chose a generic model of vulnerability and then specified a model relevant to the intended scope of this study.

The vulnerability generic model structure is that of the quality measurement model.

Is it based on the definition of:

● a set of external facters that caracterise the user approach to vulnarility,

● a set of internal criteria that are the software attributes allowing the definition and valuation of external factors of vulnerability,

● a set of measurement tools to quantify each of the criteria,

● a dependency graph between the external factors and the internal criteria explaining them,

● heuristics and functions to quantify the factors and the criteria, for each phase of the software development cycle.

The specific model is meant to instanciate the generic model development of this model will be achieved through:

● the identification of factors, criteria and measurements needed to specifically define the vulnerability for the retained software class and the scope of this study,

● the definition of the factors/criteria dependency graph,

● the attempt to quantify the model through the specification of vulnerability heuristics and functions allowing the valuation of criteria and factors, and this, for each phase of the software development cycle,

● the valuation model, and more specifically, the validation of the heuristics and functions chosen. This validation will be achieved by comparing the results derived from the model and the results obtained from experimentation with real pilot software.

The intended duration of this study is 15 months. Is it supported by the DRET (Direction des Recherches et Etudes Techniques) and conducted by the MTB society. The CNAM (Conservatoire National des Arts et Metiers) is a consultant in this project.

■

Please contact:
Alain Cazes – CNAM/CEDRIC, France
+33 1 40 27 20 37
email: cazes@cnam.cnam.fr
or:
Veronique Donzeau-Gouge –
CNAM/CEDRIC, France
+33 1 40 27 22 92

Solution of Differential Equations using Computer Algebra

by Fritz Schwarz

Computer algebra will help make the task of resolving differential equations both easier and more elegant in future. Scientists from GMD are working on the development of suitable software systems.

The solution of differential equations is of fundamental importance in virtually all areas of the natural sciences. A knowledge of analytical solutions in closed form is of particular significance here since it allows insights into the structure of the fundamental problem which are not possible by means of a numerical solution. Indeed, it often exerts a decisive influence on further advances made in this field.

The task of determining analytical solutions of this type is generally associated with very considerable computing work. Furthermore, the solution methods employed are usually only heuristic since the amount of computing work involved is even greater for systematic methods. In a similar way to integration, tables of resolved examples are employed –Kamke's compilation is a standard work–in an attempt to trace the problem in hand to one of these examples. If no solution can be found for a specific differential equation, it is nevertheless impossible to be completely certain that a solution does not indeed exist.
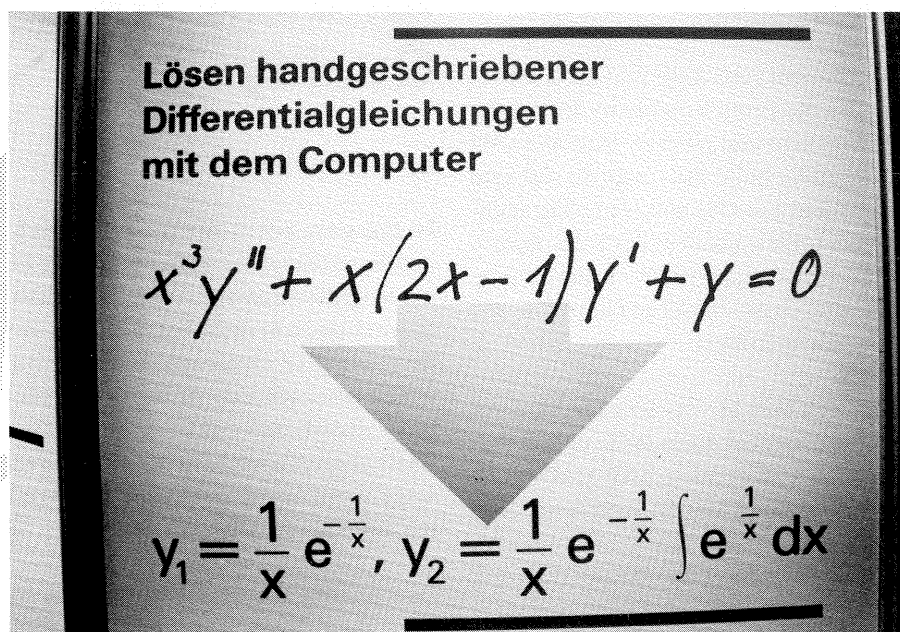
Computer algebra allows a fundamentally new approach. The computing work involved in analytical calculations is of only minor importance and is performed free of errors on the computer. The methods which are employed are therefore algorithmic. They work for entire classes of equations and permit definitive state-ments to be made on solutions to the problem under examination.

Scientists at GMD are working on the development of software which can be employed for resolving linear homogeneous equations whose coefficients are rational functions. This software will fully revolutionise work with differential equations. Within a few years, similar algorithms will have been developed and implemented for virtually all classes of equations which are of practical interest. The laborious use of reference works and the search for as yet unknown solutions will then give way completely to work with the computer. Savings in time and the accuracy and quality of the results represent an enormous gain and provide more time for creative work. The fundamental importance of this software for all fields of activity involving the solution of differential equations is evident for all to see.

The graphics tablet has been developed under the leadership of Prof. Günter Hotz at the University of Saarland. It employs a neuronal network for pattern recognition and employs new methods of analyzing mathematical formulae.

■

Please contact: Fritz Schwarz – GMD
+49 2241 14 2782
email: fritz.schwarz@gmd.de

Lösen handgeschriebener Differentialgleichungen mit dem Computer

$$x^3 y'' + x(2x - 1)y' + y = 0$$

$$y_1 = \frac{1}{x} e^{-\frac{1}{x}}, \quad y_2 = \frac{1}{x} e^{-\frac{1}{x}} \int e^{\frac{1}{x}} dx$$

Resolving differential equations by computer algebra (Photo:Münch, GMD)

Acceptance of these new possibilities will be facilitated by a user-friendly interface. Where input is concerned, this embraces the capability of transferring hand-written equations in the usual mathematical form into the system. Operation of a graphics tablet is very similar to performing calculations on a sheet of paper and therefore does not need to be learnt. The solutions to the differential equations entered are calculated by the computer algebra software and output on the screen in a print-like format.

ESPRIT III Project MADE: Multimedia Application Development Environment

by Henk Nieland

MADE (Multimedia Application Development Environment) is a large-scale ESPRIT III project, aiming at the development of an object-oriented software basis for multimedia applications and providing its users with software toolkits.

The project runs until mid 1995 and is led by the French company Bull, with CWI as its main partner. Bull and CWI will jointly build the complete software basis and provide the tools and techniques for integrated multimedia objects. CWI is also responsible for developing the basic object-model and modelling the database interface.

MADE's budget – as an exception not substantially cut down in the ultimate allocation – amounts to 16,6 MECU (EC-contribution 7,5 MECU). It comprises 120 man-years (CWI share 22 man-years). The other partners are: INESC (Portugal, ERCIM member), IAO (Fraunhofer Gesellschaft, Germany) and four European industries in the aerospace, automobile, medicine and tourism sectors, who will base their applications on the MADE software.

Several applications exist for single components, but in particular industry demands a uniform approach to the basic software, from which it will develop its own user software. Although companies already form world-wide clusters with a preference for particular hardware and software, Europe still lacks a special strategy for multimedia. The American OMG consortium (Object Management Group) pursues objects suitable to those of MADE, whereas the Japanese till now adhere to participation in clusters overseas. Brussels insists on an independent and competitive European software market (the hardware lost that battle) and requires that its R&D efforts lead to concrete product marketing. Thus MADE will play a key role in the European software industry.

Please contact: Paul ten Hagen – CWI
+31 20 592 4133
email: paulh@cwi.nl

Project KONKORDE for Software Quality

by Stefan Jähnichen

In the past years the need for high quality systems has been increasing in many application areas of information technology, e.g. in civil aviation, traffic control or electronic banking, in which errors in soft- or hardware can have disastrous consequences. The GMD project KONKORDE will help to solve some of the problems concerning software quality.

One possibility to reduce errors is to apply the rich set of mathematics based techniques, developed by academia in the last decade, in systems construction. Among these techniques are dedicated specification languages, program development methods and correctness preserving program transformation schemas.

A second possibility is to use very high level programming languages that enable the combination of various programming paradigms, like functional, logic, object-oriented or parallel programming. This allows for the expression of algorithms in the most appropriate manner and thus leads to a reduction of errors in programs.

These considerations have been the driving forces for GMD Institute for Computer and Software Technology to set up a new project called KONKORDE (Konstruktion korrekter Systeme der Informatik). In the framework of this project, formal methods and techniques will be investigated and applied to develop case studies. Another focal point of work is the definition and application of programming languages allowing for the theoretically sound combination of programming paradigms.

Part of the work starts from results and tools that were developed at the GMD institute in Karlsruhe. One of these results is the meta-calculus DEVA and its support environment. The implementation is able to type-check developments to ensure the correct application of the development laws. The prototype can be used in connection with a graphical editor, which was produced by instantiating the graphical editor generator G^2F.

One concrete line of work is to define a specification language for graphical layouts for G^2F, and to use transformation techniques to enable the generation of graphical editors from these specifications. This activity combines the more theoretical issues with the practical work of providing appropriate tool support for formal program development.

In cooperation with the Technical University of Berlin, another effort within the KONKORDE project deals with the investigation of general principles underlying the production of reliable software. A conceptual framework for the formalisation of program development methods has already been developed and implemented in a program synthesis system. The future goal is to develop similar principles for the specification and maintenance of software.

Please contact:
Stefan Jähnichen – GMD
+49 30 6704 2089
email: jaehnichen@kmx.gmd.dbp.de
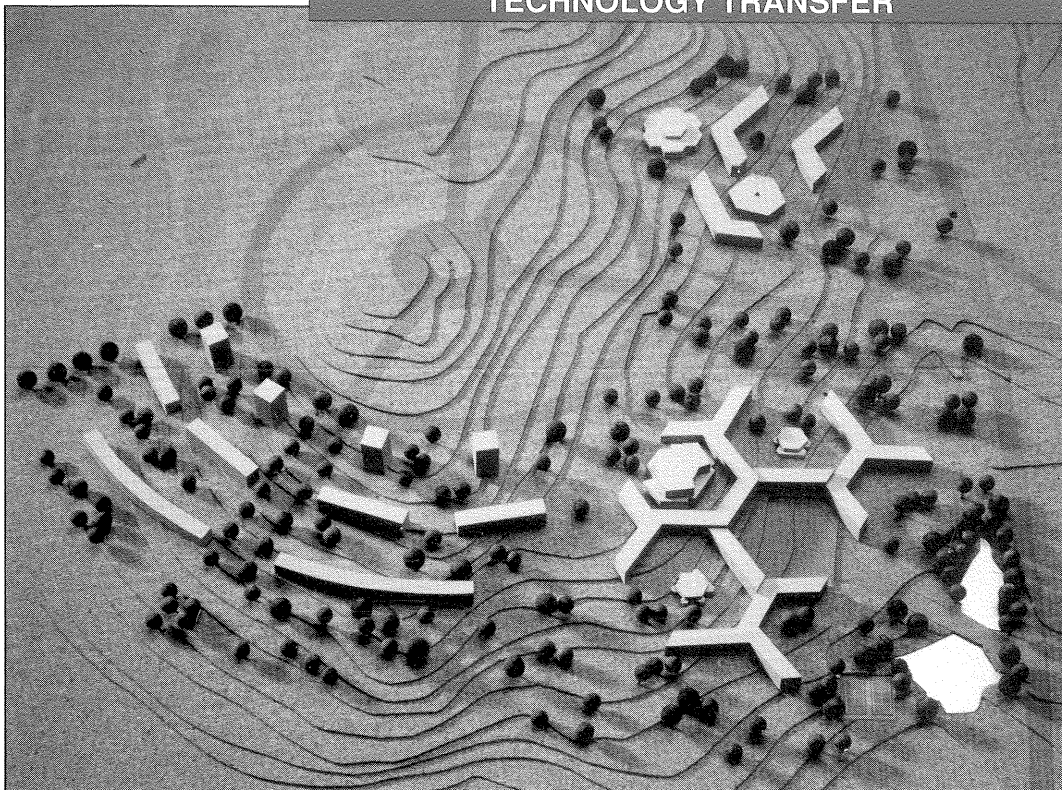
An architectural model of the Lisbon Science and Technology Park (Photo: INESC)

INESC at the Lisbon Science and Technology Park

by João Bilhim

The private company responsible for managing the Lisbon Science and Technology Park has just been incorporated . The Park is located in Oeiras (about 15 kilometres outside Lisbon) and covers an area of roughly 200 hectare. Universities, research centres, local councils, banks and companies are the prime movers behind the project.

INESC will be responsible for 10% of the company's capital and investment, which in conjunction with the university environment as a whole, will enable it to play a strategic role in the establishing of guidelines for the Park's future activities.

The objective of the Lisbon Science and Technology Park is to create surroundings for improving the relationship be-

tween science, technology and society in general in open, attractive surroundings which are designed as a point of cross fertilisation between higher educational establishments and advanced vocational training, R&D, and technology based companies.

The Park's promoters firmly believe that this initiative could represent one solution for reorganising the Portuguese R&D system with the objective of leading to officially sanctioned alterations in the educational sector and advanced vocational training as a stimulus for the creation of a new business culture in Portugal.

The park environments, as mentioned above, appear to represent an ideal mix of the essential ingredients for the creation of a tier of activities ranging from R&D and including the training of human resources, company penetration and, finally, reaching the market by establishing a compact network of scientific, technological and business activities with the free flow of ideas and discussion of problems in an area specifically designed to encourage interaction.

It is extremely unusual for this to occur in an integrated manner, with due respect for the values of scientific ethos and taking the autonomy of each geographically distinct component part into account, with each of the component parts in ques-

tion imagining how to get the better of the other. As such, the creation of conditions which make it possible to encourage high degrees of synergy as a sort of "breeding ground" or "nursery" for the birth of added value projects may well represent the quantum leap which will force Portugal to play a major role within the framework of modern science and technology. In order to achieve this goal, science and technology must be made into sources of strategic opportunities for development within a context of global competition in which the intelligent use of competitive advantages is a paramount factor.

This should remind us of the fact that the most innovative companies in the USA during the eighties were small and medium sized companies, in close proximity to centres of intellectual excellence: Stanford-Berkeley and MIT (Massachusetts Institute of Technology Harvard) which have brought the scientific and technological communities together in an interactive manner.

■

Please contact: João Bilhim – INESC
+351 1 572895
email: jafb@inesc.pt

A fabricated chip including the wafer on which it is fabricated and part of the design. (Photo: GMD)
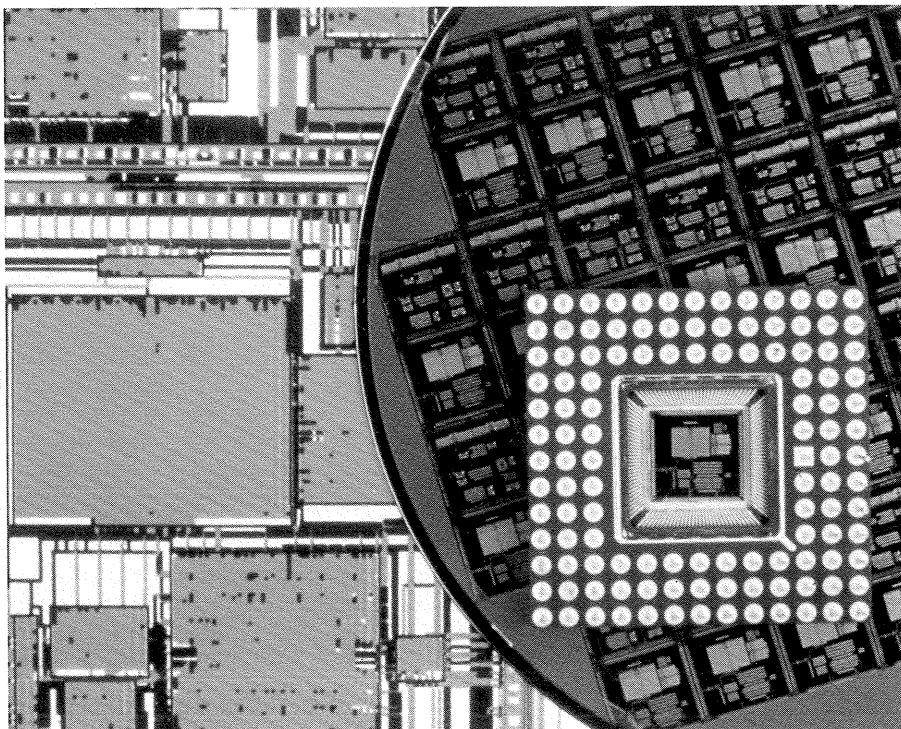
Eurochip: A Campaign for Training VLSI Designers

by Augustin Kaesser

The member states of the European Community are experiencing a rapid growth in demand for designers of very-large-scale integrated (VLSI) circuits. The Eurochip joint campaign involves five European partners who, with the support of technical colleges and universities, are working on extending or improving research and training in the field of designing integrated circuits: Circuits Multiprojects (France), GMD (Germany), Danmarks Tekniske Hojskole (Denmark), IMEC (Belgium) and the Rutherford Appleton Laboratory (U.K.).

Studies conducted at the end of the eighties showed that, while colleges and universities throughout the Community have considerable development potential, their training capacity of some 1500 chip designers per year is too low and ought to be extended to at least 4500 students per year. To cover this urgent need, General Directorate XIII of the Commission of the European Community started the training campaign in 1989 within the framework of the ESPRIT basic research work.

More than 120 colleges and universities have since enjoyed free access to the production of microchips together with additional support allowing them to augment the infrastructure which is required for training purposes. Motivated by the benefits offered by the campaign, a further 100 colleges and universities participated at their own cost. Consequently, more than 220 academic institutes from the countries of the European Community and the European Free Trade Area are currently involved in the campaign. A large number of requests to participate have also been received from other European and non-European countries.

The VLSI designer training campaign is based on over 500 agreements which have been concluded between Eurochip, the campaign service organisation, colleges and universities and industrial concerns. Around 2700 software packages for computer-aided circuit design have been installed to date. The campaign service organisation has supplied 80 computer workstations and test systems to selected colleges and universities and 600

additional systems have been procured by the various institutes at their own cost, these being able to make use of the high discounts on market prices allowed by manufacturers. 320 college and university lecturers have attended courses to familiarise themselves with use of the design software.

More than 5000 students – i.e. 500 more than originally planned – participated in the campaign during its first year. The 120 colleges and universities involved in the campaign have conducted some 1200 courses to date in which over 1000 circuits have been designed and more than 600 manufactured. The number of designs being produced and tested is growing constantly.

The results of the training campaign are documented by more than 2000 internal reports and publications, these including some 800 dissertations and 190 doctoral theses. The provision of design facilities as part of the training programme and access to industrial production of prototypes has provided colleges and universities with a gateway to chip manufacture. The participants have been quick to utilise these opportunities and have also invested their own resources, thereby substantially multiplying the effect of the campaign.

The campaign, which was originally planned for a two-year period only, is being extended by a further three years. In this second phase, the campaign will be opened to all approved colleges and universities in the Community. Around 300 colleges and universities are expected to participate. Additional measures will incorporate advanced design tools and technologies which have since become available in Europe. There are also plans to introduce a coordinated training programme which will also provide training for academic lecturers. Personnel from industry will also be involved as instructors.

∎

Please contact: Augustin Kaesser – GMD
+49 2241 14 2580
email: kaesser@gmd.de

# Lexicographic Workstation

by Eugenio Picchi

Over the last few years, at the "Istituto di Linguistica Computazionale" in Pisa, an open-ended modular set of tools, known as the PiSystem, has been designed and developed to meet the various requirements of literary and linguistic text processing and analyses. The main module of the system is the DBT, a textual database management and query system that has been implemented in different configurations to perform specific text and dictionary processing tasks. Other components can be integrated with this system kernel, depending on the needs of a particular application. Within this general framework, a lexicographic workstation has been implemented to assist the lexicographer in the various activities involved in the creation and revision of dictionaries.

The main components of the lexicographic workstation are a full text retrieval system that has been developed to query and analyse all kinds of texts and textual corpora – including bilingual reference archives –, and a lexical database system that has been implemented to handle mono- and bilingual dictionary acquisition and processing activities; a morphological procedure is associated with the text and dictionary query systems. The lexicographer can use these two systems to interrogate on-line text archives and electronic dictionaries and retrieve and extract reference and citation material. At present, the system languages are Italian and English; however, the procedures are designed to be generalisable: given the necessary lexical components, they could easily be modified to handle other languages. The core module of the workstation is a procedure for on-line dictionary editing which includes functions for windowing into and copying data from the dictionary and text archives, and is integrated with a structured indexing procedure that can be used to query the dictionary in compilation in order to check the regularity and consistency of the input.

The workstation has been implemented on personal computers under the MS/DOS operating system and is intended to run on a Local Area Network, so that a team of lexicographers can work in unison, using the same tools and accessing the same reference data. At the same time, the procedures are easily transportable onto smaller desk-top systems for the lexicographer working at home. The system is menu-driven and context sensitive Helps are accessible at all times during a query session. The main consideration has been to provide tools which are not only efficient but also user-friendly. The system is currently being transported under Unix.

∎

Please contact:
Eugenio Picchi – ILC-CNR
+39 50 560481
email: picchi@icnuce.vm.cnuce.cnr.it

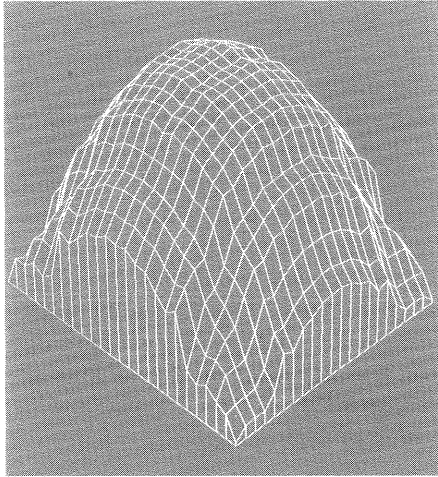

Components of the lexicographic workstation
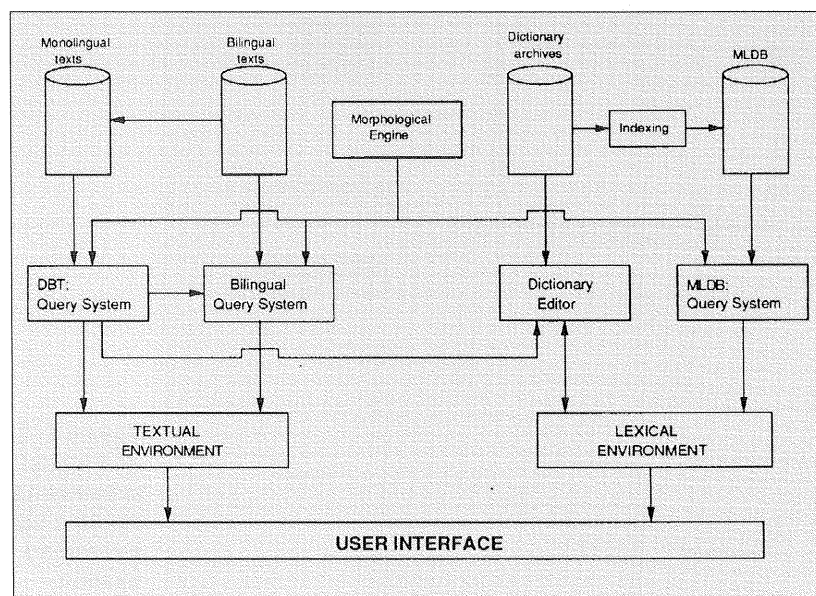
CNR-ENEL Collaboration for Thermal Image Reconstruction

by Mauro Bramanti, Sauro Pasini, Emanuele Salerno and Anna Tonazzini

Within the framework of a collaboration between CNR and the Italian National Electricity Board (ENEL), contracts have been signed for research in the field of *reconstructive sonic pyrometry*. This type of technique allows the reconstruction of the temperature field inside a power station boiler on the basis of acoustic time-of-flight measurements between pairs of acoustic transducers located on the walls of the boiler.

Knowledge of the local values of the boiler temperature is very important in a thermal electricity generating plant as it can be used both to optimise the overall efficiency and to reduce the emissions of certain pollutants, such as the NOx's. In this particular application, the reconstruction of a 2D temperature map is an extremely difficult task, in that only a very small data set is usually available. The research activity at IEI-CNR consists in the development of ad hoc reconstruction algorithms and the comparison of their features with those of already used techniques.

Since 1983, IEI-CNR has been collaborating with the Thermal and Nuclear Research Centre (CRTN) of ENEL, Direction of Research (DSR), in the development of special instrumentation for combustion control and diagnosis and information technology. In 1988, a research
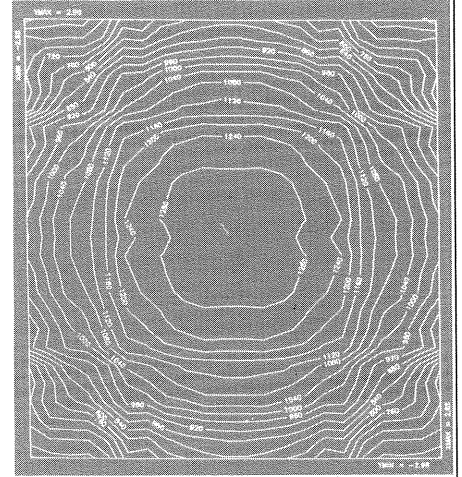

Figure 2: stereogram (a) and the related contour plot (b) for a typical temperature field reconstruction.

contract was signed for the assessment of an already proposed reconstruction algorithm for a computer-aided sonic pyrometry technique. This algorithm is based on a 2D Fourier parametrisation of the slowness-of-sound field in the probed

domain and a subsequent least-squares estimate. The temperature values can be reconstructed on the basis of the known relation between the slowness of the sound and the temperature in a gaseous medium. The number of data points typically available for this type of application is comparable to the number of unknowns and the image reconstruction problem is thus very difficult to solve. The algorithm examined has been found to be extremely unstable if a sufficiently detailed map is to be reconstructed.

Since 1990, the collaboration has been extended to the study of image reconstruction algorithms which are stable when working with a limited number of data. Standard regularisation procedures, with different regularising functionals, have been applied to reconstruction algorithms based on 2D Fourier series or different parametrisations, such as sampling, bilinear interpolation and polynomial approximation. A special and very stable reconstruction algorithm has been developed, and is based on 1D reconstruction and subsequent 2D interpolation. These algorithms have been shown to give stable solutions even with particularly reduced and noisy data sets.
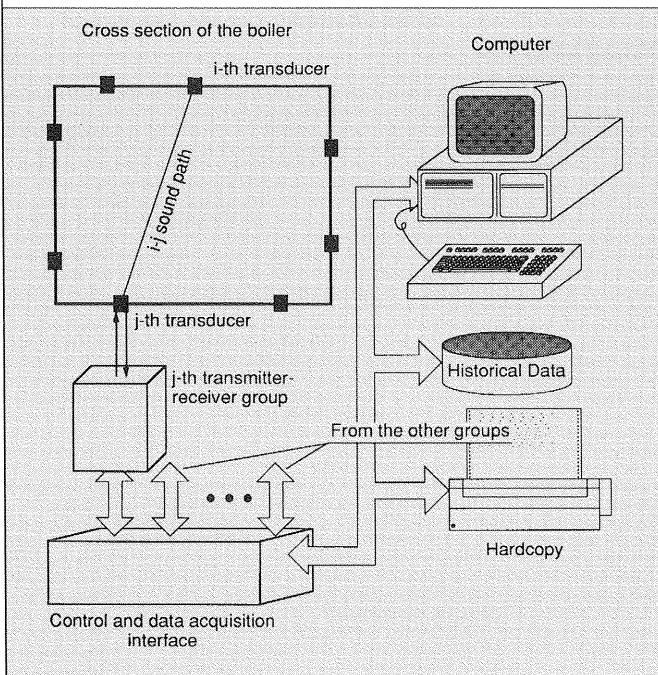
Please contact: Mauro Bramanti, Emanuele Salerno, Anna Tonazzini – IEI-CNR
+39 50 593400
email:salerno@vm.iei.pi.cnr.it
or: Sauro Pasini – CRTN-ENEL, Pisa
+39 50 535630

Figure 1: Test and signal processing set-up for a sonic pyrometry system.

GMD Concludes Cooperation Agreement with the Russian Academy of Sciences

by Michael Agi

GMD has laid the foundation for a co-operation with the Russian Academy of Sciences. The two partners concluded a framework agreement on a four-year period of cooperation on 8 May 1992.

On the invitation of Prof. Dennis Tsichritzis, Chairman of the Board of GMD, a delegation of the Russian Academy of Sciences under the leadership of Prof. Vladimir A. Melnikov visited GMD from 6–8 May 1992. Prof. Melnikov is Director of the Institute for Problems in Cybernetics and a member of the Council of Experts to the Head of Government of the Russian Federation. The Russian scientists accompanying him were also from the Institute of Cybernetics in Moscow.

The Russian computer scientists – "cyberneticists" in Russian – conducted talks with scientists and teams of researchers from several GMD institutes. The key question surrounding this German-Russian meeting were the possibilities for cooperation between the two research centres. The scientists from both institutes agreed on a catalogue of themes for future cooperation projects as well as on measures to promote cooperation between the Russian Academy of Sciences and GMD. The following themes were considered important for the envisaged cooperation:

• Automatic parallelisation for computers with distributed memories

• Numeric cores, parallel algorithms
• Parallel SPICE2
• Computer algebra
• Visualisation
• Expert systems
• Pattern recognition
• Further training/technology transfer

Twelve Russian scientists will be invited to GMD, each for four-week periods, during 1992. GMD institutes have also submitted four proposals for projects. These proposals are to be discussed and developed in the coming weeks. They will then be incorporated jointly within the framework of the special programs of the European Community for the promotion of cooperation with Russia in the field of research and technological development, and possibly in conjunction with institutions of the European Research Consortium for Informatics and Mathematics (ERCIM). ∎

Please contact: Michael Agi – GMD
+49 2241 14 2672
email: agi@gmd.de

ICOT Management Committee visits GMD Scientists

by Dieter Mönch

A delegation from the Japanese Institute for New Generation Computer Technology (ICOT) recently paid a visit to GMD Birlinghoven in Sankt Augustin. The delegation consisted of the eight members of ICOT's Managing Committee, under the leadership of its chairman Sukeyoshi Sakai (Fujitsu), as well as ICOT director Hiroichi Hiroshige and two heads of department.

The visitors were introduced to the current GMD research programme, and ex-

pressed particular interest in GMD activities in Germany's five new Federal states.

ICOt, which was founded in 1982, is planned to be dissolved in the course of 1992. There is little doubt, however, that a similar institute will be founded afresh as part of the Japanese programme for the advancement of New Information-Processing Technology (NIPT) currently under preparation. ∎

Please contact: Dieter Mönch – GMD
+49 2241 14 2271
email: moench@kmx.gmd.dbp.de

Memorandum of Cooperation Understanding between INESC and SUNLABS

by João Bilhim

SUN Microsystems Inc., a leader in the market for workstations with a market share of 35%, has just signed a memorandum of understanding in Lisbon for scientific and technological cooperation with INESC. The agreement, which is the first of its kind in Portugal and one of the first in Europe, was signed by John Guslin, Company Vice President, and Professor Alves Marques, a member of INESC's Corporate Board.

Significant sums have been placed at the disposal of the teams involved in order to allow them to undertake joint projects in Object Based Systems, Parallel Architecture, Multiprocessors and Multimedia. ∎

Please contact: João Bilhim – INESC
+351 1 572895
email: jafb@inesc.pt

ESORICS 92: European Symposium on Research in Computer Security

Toulouse, France, 23–25 Nov. 1992

Computer security is concerned with the protection of information in environments where there is a possibility of intrusion or malicious action. The aim of ESORICS is to further the progress of research in computer security by establishing a European forum for bringing together researchers in this area, by promoting the exchange of ideas with system developers and by encouraging links with researchers in related areas. To achieve this aim under the best conditions, ESORICS 92 will be a single track symposium and the selected papers will be presented in a conference hall whose capacity is 290 attendees. ESORICS 92 is the second symposium of a series started with ESORICS 90 held in Toulouse in October 1990.

Topics:

- Access Control: Towards security in an open systems federation (John Bull, Li Gong, Karen Sollins); Type-level access controls for distributed structurally object-oriented database systems (Udo Kelter); On the Chinese wall model (Volker Kessler)
- Formal Methods: Formal methods and automated tool for timing-channel identification in TCB source code (Jingsha He, Virgil Gligor); Separating the specification and implementation phases in cryptography (Marie-Jeanne Toussaint); Formal specification of security requirements using the theory of normative positions (Andrew Jones, Marek Sergot)
- Authentication: Verification and modelling of authentication protocols (Ralf Hauser, E. Stewart Lee); KryptoKnight authentication and key distribution system (Refik Molva, Gene Tsudik, Els Van Herreweghen, Stefano Zatti); As-

sociating metrics to certification paths (Anas Tarah, Christian Huitema); Freshness assurance of authentication protocols (Kwok-Yan Lam, Dieter Gollmann); A formal framework for authentication (Colin Boyd); Timely authentication in distributed systems (Kwok-Yan Lam, Thomas Beth)

- Distributed Systems: An object-oriented view of fragmented data processing for fault and intrusion tolerance in distributed systems (Jean-Charles Fabre, Brian Randell); The development and testing of the identity-based conference key distribution system for the RHODOS distributed system (M. Wang, A. Goscinski); Policy enforcement in stub autonomous domains (Gene Tsudik)
- Database Security: Polyinstantiation for cover stories (Ravi Sandhu, Sushil Jajodia); On transaction processing for multilevel secure replicated databases (I. Kang, T. Keefe); Security constraint processing in multilevel secure AMAC schemata (G. Pernul)
- System Architectures: M2S – A machine for multilevel security (Bruno d'Ausbourg, Jean-Henri Llareus); GDoM, a multilevel document manager (Christel Calas)
- Applications: UEPS – A second generation electronic wallet (Ross Anderson); A hardware design model for cryptographic algorithms (Joan Daemen, Rene Govaerts, Joos Vandewalle); ASAX – Software architecture and rule-based language for universal audit trail analysis (Naji Habra, B. Le Charlier, A. Mounji, I. Mathieu)

Registration:

A detailed programme of the symposium and registration forms can be obtained from:

AFCET - ESORICS 92
156, boulevard Pereire
75017 Paris, France
Fax: +33 1 42 67 93 12
Tel: +33 1 47 66 24 19

Please contact:
Yves Deswarte – INRIA, Toulouse
+33 61 33 62 88
email: deswarte@laas.fr

SPA'93: Stochastic Processes and their Applications

Amsterdam, The Netherlands, 21–25 June 1993,

This conference (the 22nd of its kind) focuses on theoretical and applied probability. Special emphasis will be put on probability in mathematical physics, in finance and in communication networks.

Topics:

In addition to those mentioned above, topics include:

- reliability and queueing theory
- discrete probability and random graphs
- stochastic geometry, image processing, random sets
- stochastic analysis, stochastic control
- optimal stopping and partitioning
- stable processes
- large deviations
- population genetics
- limit theory for sums, extrema, samples, Brownian motion
- statistics for stochastic processes
- symbolic calculus in probability

The opening lecture will be presented by W. Whitt (AT&T, Murray Hill). The program committee is chaired by A.J. Baddeley (CWI), secretary is W. Vervaat (University of Nijmegen). The conference will be held at the Vrije Universiteit Amsterdam. It is organized under the auspices of the Committee for Conferences on Stochastic Processes and the Bernoulli Society for Mathematical Statistics and Probability, and is supported by the Vrije Universiteit and CWI.

Please contact: Adrian Baddeley – CWI
+31 20 592 4050
email: adrianb@cwi.nl
or: Frans Snijders (conference administrator) – CWI
+31 20 592 4171
email: spa93@cwi.nl

EuropIA'93: Applications of Artificial Intelligence, Robotics and Image Processing

Delft University of Technology, The Netherlands, 21–24 June 1993

These European events (previous EuropIA conferences were respectively held in Paris (1988), Liege (1990) and Athens (1991)) aim at bringing together professionals and scientists, providing a forum for the exchange of ideas and experiences related to the integration of the new technologies and to discuss terms and conditions for introducing new tools (offered by the latest developments in the fields of artificial intelligence, robotics and image processing) and the new strategies (required by the inevitable changes of the professional working environments of civil engineering, architecture, building engineering, urban design and urban planning in the light of implementing these new technologies).

The conference is followed by a one-day workshop in parallel sessions. There is no limit to the number of participants for the workshop and all accepted refereed papers will be given the opportunity for a short presentation during a forum discussion.

Participants are invited to centre their papers around: "The prerequisites for and the impacts of new technologies in civil engineering, architecture, building engineering, urban design and urban planning". This concerns the integration of these technologies in the following fields: research, development, education and professional environments.

Suggested topics:

Relevant subjects and themes may include, but are not limited to domains of: intelligent design support environments, decision support systems, knowledge representation, human and machine intelligence, image processing, robotics, computer vision (applications and components), machine training and learning systems, case-based reasoning systems, construction robotics, intelligent design and planning tools, computer graphics, interactive virtual realities for design and planning, intelligent CAD/CAM/CIM, design and planning informatics, etc.

Contributions:

Five copies of unpublished papers must reach the Conference Secretariat before 2nd November 1992. The length of the paper, including figures and references, must not exceed 25 double-spaced A4 pages, starting with a cover page including title of paper, author(s)' affiliation, address, telephone and fax numbers and email address. The second page will only include the title of paper, an abstract of no more than 150 words in English and a maximum of 5 keywords. The papers for the EuropIA'93 can be in English or French. Papers submitted for the workshop must be in English. All papers submitted will be automatically considered for the inclusion in either EuropIA'93 or the workshop.

Deadlines:

Full papers due – 2 November 1992
Notification of acceptances – 4 January 1993
Revised camera-ready papers due – 15 February 1993

Papers and enquiries should be sent to:

EuropIA'93 Conference Secretariat
POO - k.2.24
Faculty of Civil Engineering
Delft University of Technology
Stevinweg 1, 2628 CN Delft,
The Netherlands.

Please contact: Reza Beheshti – Delft University of Technology
+31 15 784893
email: wwbnbeh@tudrva.tudelft.nl

EMG'93: European Multigrid Conference

Amsterdam, The Netherlands, 6–9 July 1993

The fourth European Multigrid conference (preceding conferences in 1981, 1985, and 1990) focuses on the general area of multilevel methods.

Suggested topics:

Conference themes range from basic research to industrial applications, including but not limited to the following subjects:

• computational fluid dynamics,
• reservoir engineering,
• semi-conductor device modelling,
• statistical physics,
• parallel computing,
• adaptive computing,
• numerical analysis of multigrid methods.

The programme includes invited lectures by A. Brandt, C.C. Douglas, L. Fuchs, W. Hackbusch, S. Vandewalle, C.H. Venner and G. Wittum. Contributions should be submitted not later than December 15, 1992. Proceedings will be published by Birkhäuser.

Please contact:
Piet Hemker – CWI
+31 20 592 4115
email: pieth@cwi.nl
or:
Pieter Wesseling – Technical University Delft
+31 15 78 3631
email: witawes@dutinfh.tudelft.nl
or:
Simone van der Wolff (conference administrator) – CWI
+31 20 592 9333
email: simone@cwi.nl

ISADS 93: International Symposium on Autonomous Decentralised Systems

**Kawasaki, Japan,
30 March – 1 April 1993**

An "International Symposium on Autonomous Decentralised Systems (ISADS 93)" will take place from March 30 to April 1, 1993 at Hitachi Systems Plaza, Kawasaki, Japan.

Continuous growth in the power, intelligence and openness of computer, communication, and control technologies has made it possible to realise highly bene-

ficial and dependable business and control systems. Consequently, the adaptability, reliability, and expandability of application systems are steadily improving. Also, dynamically changing social and economic situations are requiring new-age systems based on newly emerging technologies and applications. Such systems are expected to have the characteristics of a living thing composed of largely autonomous and decentralised components. The systems may thus be called Autonomous Decentralised Systems (ADS).

ISADS seeks papers that will foster increased interactions among researchers and practitioners in computer, control and other related fields from academia and industry.

Suggested topics:

The scope of discussion on ADS shall include but not be limited to:

- Distributed and parallel computer systems/Large scale systems;
- Cooperative architectures (CSCW, ODP, DAF);
- Local and wide area networks/Intelligent networks;
- Fault-tolerance, real-time, expansion and maintenance, and software engineering technologies for ADS;
- Heterogeneous distributed information systems;
- Decentralised-control, self-organising and robotic systems;
- Manufacturing systems;
- Biological and ecological systems.

Papers dealing with research, development, implementation, and applications of ADS, as well as surveys of the field, are welcome. A plant tour of leading-edge industries in Japan is planned as part of Symposium activities.

**Please contact:
Radu Popescu-Zeletin – GMD
+49 30 25499 200
email: embox@fokus.berlin.gmd.dbp.de
or: Domenico Ferrari –
University of California, Berkeley
email: isads@tenet.berkeley.edu**

ERCIM Workshops in Norway

Røros, Norway, 26–28 May 1993

The next ERCIM workshop will be hosted by SINTEF DELAB and is scheduled for 26-28 May 1993 in Norway. The format of the workshops will be altered from the current conference style to a more genuine workshop style with much interaction among the participants.

The first morning the participants will be given a presentation of the research work and the facilities of SINTEF and the Norwegian Institute of Technology. Opportunities will be provided for workshop participants to meet the appropriate research groups at SINTEF.

After lunch the participants will go on a 2 hour bus ride to the mountain town of

Røros, where the remaining part of the workshop will take place at a local conference hotel. Røros is an old mining town dating back to 1640. Its unique atmosphere has given Røros a place on the UINESCO World Heritage List.

Three separate workshop are arranged. The topics are:

- Storage and Retrieval of Multimedia Information
- Modelling and Simulation of Industrial Processes
- Interactive Modelling, Simulation and Visualisation in Large Scale Scientific Computing

The general objectives of the workshops are to identify priority research problems within each topic, to discuss approaches to solving the selected problems, and to identify possible collaborative efforts in solving the problems.

Each workshop will consist of 4 sessions. Session 1 comprises a tutorial of the workshop topic, and a poster session where the participants are supposed to present their relevant work. Session 2 is

dedicated to identification and discussions of issues, and will consist of plenaries and more detailed work in smaller syndicates. In Session 3 we will discuss the issues in even more detail, and suggest approaches to resolutions of these issues. The format will be plenaries and syndicates. In Session 4 the syndicates will formulate plans for future work.

The organisers of the different syndicates will prepare input to a technical report that will be available shortly after the end of the workshop.

The dates we have chosen for the Norway workshop, end of May, will give the participants a possibility to experience the very special feeling of having almost 24 hour daylight. If a sufficient number of people are interested we will also offer a weekend tour of "mountains and fjords" to show some of Norway's most spectacular scenic views along the country's West Coast.

**Please contact:
Truls Gjestland - SINTEF-DELAB
+47 7 59 26 45
email: gjestland@delab.sintef.no**

Eurographics'93

Barcelona, Spain,
6-10 September 1993

Eurographics'93 is the 14th annual conference of the European Association fro Computer Graphics. It is the leading international Computer Graphics conference in Europe, and a vital meeting point for researchers, practitioners, teachers, vendors and users.

The event will include a conference (8–10 September), tutorials (6–7 September), as well as slide, video and film competitions and an exhibition.

Topics:

Main topics at Eurographics'93 will be:
• Advanced Interaction
• Cooperative Working
• Visualisation
   in
• Computer Aided Design
• Animation
• Electronic Publishing
• Geographical Information Systems

Contributions on any topic related to computer graphics and interaction are invited. Contributions should be sent to the following address:

Eurographics'93
Fira de Barcelona
Palau de Congressos
Dept. de Convencions
Avda. Reina Ma Cristina s/n
E-08004 Barcelona

Deadlines:

8 January 1993 – Deadline for papers received by Conference Secretariat
12 March 1993 – Notification of acceptance/rejection
12 April 1993 – Final copy of papers due
30 May 1993 – Deadline for entries to slide/video competition

■

**Please contact: Conference Secretariat
+34 3 423 31 01
fax: + 34 3 426 28 45**

International Conference for Statistics Experts in Bonn

by Willi Klösgen

"New Techniques and Technologies for Statistics" (NTTS-92) was the subject of an international conference convened in Bonn at the invitation of GMD and EUROSTAT, the Statistics Office of the European Community. 230 participants from statistics offices worldwide and from the scientific world attended the conference which was held from 23–26 February 1992 at the Gustav Stresemann Institute in Bonn.

Decision makers, scientists, representatives of official statistics institutes, members of national and international organisations responsible for devising R&D programmes in the field of statistics and users interested in new statistical techniques spent two days discussing problems, user requirements, solutions and research strategies. New technologies have exerted a considerable influence on the theory and practice of statistics over recent years. Geographical information systems, knowledge processing systems and telecommunications are some of the information technologies opening up new types of statistics applications.

The conference presented and discussed the possibilities for these new technologies, their effects on the design of statistical information systems, the acquisition and evaluation of data, the quality of data, and statistical theory. In particular, results obtained from the DOSES (Development of Statistical Expert Systems) programme conducted by the European Community were also incorporated. Areas of application were discussed where important advances could be expected in the next few years. New developments are to be promoted in these areas and additional research programmes established. An exhibition involving demonstrations of data acquisition and distribution systems, visualisation systems and geographic information and expert systems was also received with particular interest.

A total of 40 contributions to NTTS-92 can be found in the new book "New Techniques and Technologies for Statistics". The conference was funded from the DOSES programme of the European Commission.

■

**Please contact: Willi Klösgen – GMD
+49 2241 14 2723
email: kloesgen@gmd.de**

230 participants attended the international conference for statistical experts in Bonn. (Photo: Münch, GMD)

First RAPS Workshop at GMD

by Guy Lonsdale

Leading computer manufacturers and users with applications requiring high performance computers met at the first RAPS Consultative Forum Workshop, held at GMD from 4–6 May 1992. This workshop was the first activity of the RAPS Project (Real Applications on Parallel Systems), in which partners from research and industry have come together in order to produce a portable parallel benchmark suite with a core comprising large production codes.

The RAPS Consultative Forum provides all computer manufacturers a means of introducing their point of view into the RAPS Project. A level of financial support will be provided by members of the Working Group of this Forum; the current members of the Working Group are: Convex, Cray Research, Fujitsu, IBM and Intel. The RAPS Consortium itself comprises the following institutes and companies: AVL (AVL Prof. List GmbH, Graz), CERN (European Laboratory for Particle Physics, Geneva), ECMWF (European Centre for Medium-Range Weather Forecasts, Reading), ESI (Engineering Systems International, Rungis), GMD, Pallas GmbH (Gesellschaft für parallele Anwendungen und Systeme mbH, Brühl) and the University of Southampton.

It is now generally accepted that the future of High Performance Computing lies in the efficient use of highly parallel systems: only parallel systems offer the performance necessary for the solution of the "Grand Challenges" of tomorrow. The step towards parallelism must, and can, be taken now. However, users in both research and industry will be prepared to make this transition only if efficient portable programming models are available - tested for practical applications. By constructing a benchmark suite from real applications, based on a portable interface, RAPS aims to convince the users in research and industry that it is possible to make this transition today.

The purpose of the workshop was to evaluate existing parallel programming models and interfaces in order that the RAPS Consortium be able to select the initial RAPS Programming Model. In this way, the computer manufacturers could directly contribute to the decision process. Particularly pleasing from the GMD viewpoint was that the closing panel discussion and ensuing debate clearly recommended the choice of the PARMACS macros, developed in GMD-Institute for Foundations of Information Technology.

The great response to the workshop was reflected in the large number of participants, 72, from 12 countries (including Japan and the USA) with representatives from 9 computer manufacturers. Invited speakers gave and overview of standards in parallel computing, existing portable interfaces and developments in the direction of future languages for high performance computing. The participating computer vendors presented their future plans and their current stage of development.

∎

Please contact: Guy Lonsdale – GMD
+49 2241 14 2769
email: gmap35@f1euler.gmd.de

Only parallel systems offer the performance necessary for the solution of the "Grand Challenges" of tomorrow: RAPS workshop in progress at GMD. (Photo: Münch, GMD)

Computational Fluid Dynamics: Upwind Methods

by Manjit Boparai and Conor Fitzsimons

The Computational Fluid Dynamics Community Club of the Science and Engineering Research Council (SERC) held a Seminar on Upwind Methods in CFD at RAL on Tuesday, 26 May 1992. The seminar was chaired by Prof. Phil Roe (Michigan) and Peter Sweby (Reading). It was attended by 65 people from industry and higher education institutes.

Peter Sweby (Reading) began the morning session with an introduction to flux-limiter schemes for conservation flows. He reviewed the design criteria for high resolution TVD (Total Variation Diminishing) schemes, before going on to discuss flux corrected transport (FCT) and flux limiter schemes.

Richard Hillier (ICSTM) presented the use of a high resolution Gudonov-type scheme for a range of practical problems in steady and unsteady aerodynamics,

e.g. an unsteady shock wave diffracting at a sharp convex edge, unsteady shock propagation through convergent-divergent nozzles and an application to steady hypersonic viscous flows.

"Tito" Francisco Toro (Cranfield Institute of Technology) discussed the economic use of upwind schemes in a Riemann solver adaptive procedure approach. He proposed the adaptive use of a cheap linearised solver (based on primitive variables) for smooth parts of the flow and a robust solver (for example, exact Riemann solver, the Harten-Lax-van Leer approach, curve fitting) for use elsewhere, with a switching criterion.

Professor Phil Roe (Michigan) gave a keynote address on the current status of research on multi-dimensional upwind methods. Although many problems could be solved reasonably accurately this was not the case for flows which are not aligned with the mesh or are separated, where neither central nor current upwind methods seem to offer a sound basis for economical Navier-Stokes codes. He then gave the requirements for a truly multidimensional explicit method with maximal time-step and illustrated its application to viscous flows.

Professor Derek Causon (Manchester Polytechnic) discussed the use of TVD schemes applied to steady and unsteady flows. He illustrated a method of constructing a high order accurate flux limited scheme with the development of a 6th order accurate monotonicity preserving TVD scheme.

Professor Ken Morgan (Swansea) presented the application of the methods discussed earlier to more general meshes. He addressed the problems of computational efficiency and the need for storage reduction for unstructured meshes.

Peter Sweby then brought an informative and interesting meeting to a close. A copy of the presentations can be obtained by contacting Dr. Conor Fitzsimons at the email address given below. ■

Please contact:
Conor Fitzsimons – RAL
+44 235 445712
email: cfdcc@inf.rl.ac.uk

International Workshop on Open Distributed Processing

by Jan de Meer

The first international "Workshop on Open Distributed Processing" by the International Federation for Information Processing (IFIP) was held in Berlin from 8 to 11 October 1991. It was organised by the GMD Research Institute for Open Communications Systems (FOKUS) and the Institute for Computer Science and Computing Technology (IIR). The Programme Committee was chaired by Jan de Meer (GMD) and Prof. Volker Heymer (IIR).

Open Distributed Processing characterises the next generation of information-processing systems and determines the development of new telecommunications technology. The International Organisation for Standardisation (ISO) and the International Advisory Committee for Telegraphy and Telephony (CCITT) are currently working on proposals for a common reference model. Activities in the field are not limited to standardisation however: computer manufacturers are also exploring the challenges of Distributed Environments, while suppliers of telecommunications services are designing architectures for intelligence in networks. There is clearly an urgent need for a mutual exchange of information and for joint discussion.

The workshop was held in the Japanese-German Centre in Berlin, housed in the former Japanese Embassy in the Tiergarten district, and was attended by 138 experts from the worlds of science, commerce and industry. This first IFIP "Workshop on Open Distributed Processing" aroused worldwide interest: participants came from 23 different countries, spread across five continents. Of the 54 papers originally entered, a panel of experts selected 17 for presentation. Round-table discussions provided a forum for representatives from the academic field and industry to introduce their current research projects, while in-

vited lectures provided a more general introduction to the main themes of Open Distributed Processing.

■

Please contact: Jan de Meer – GMD
+49 30 25499 239
email: jdm@fokus.berlin.gmd.dbp.de

First German-Japanese Workshop on Deduction

by Stefan Jähnichen

The first German-Japanese workshop on deduction took place on 4 and 5 October 1991 at GMD Birlinghoven. Upon the invitation of Prof. Dr. Wolfgang Bibel, from Darmstadt Technical College, a group of eight Japanese scientists attended the workshop, drawn from the Institute for New Generation Computer Technology (ICOT) in Tokyo, the NTT Basic Research Labs, and Toshiba. On the German side, the German Research Centre for Artificial Intelligence (DFKI) in Saarbrücken, the Max Planck Institute of Computer Science, IBM, the ECRC in Munich and the GMD were all represented, together with a number of universities active in the deduction field.

The four half-day sessions were each devoted to one of the workshop's major themes, namely: "Theorem-proving", "Deduction methods", "Program synthesis and program verification" and "Logical programming". In between lectures there were opportunities for developing informal contacts. A number of systems were demonstrated to participants.

The closing discussion focused upon the state of deduction methods in Japan and their applications in Japanese industry. It is planned to hold another workshop in Japan in 1992, when the state of theorem-proving in Germany, its industrial applications and its future will be discussed.

■

Please contact: Stefan Jähnichen – GMD
+49 30 25199 101
email: jaehn@first.gmd.de

Events organised to celebrate the 25th anniversary of INRIA

INTERNATIONAL CONFERENCE

Computer Science and Control

In celebration of its 25th Anniversary, INRIA is organising a conference for the scientific community that will feature 28 leading scientists from throughout the world presenting lectures in research fields covered by INRIA.

Presentation topics include:
- Parallel Processing, Databases, Networks, and Distributed Systems
- Symbolic Computation, Programming, and Software Engineering
- Artificial Intelligence, Cognitive Systems, and Man-Machine Communication
- Robotics, Image and Vision
- Signal Processing, Control, and Manufacturing Automation
- Scientific Computing, Numerical Software, and Computer Aided Engineering

Ten advanced specialised Workshops will also be organised at the Conference. In addition, a software exhibit will be held to present the most recent and inno- vative software products issued from the French research community.

Date: December 8–11, 1992
Place: Ministry of Research and Space, Paris

TWO FORUMS

Forum: "Ph.D.Students"

The future prospects for Ph.D. students in research and industry: Which professions? Which carreers? (Morning)

Forum: "Enterprise"

A realistic challenge: Europe, worldwide leader in High-Technology and Software Industry. (Afternoon)
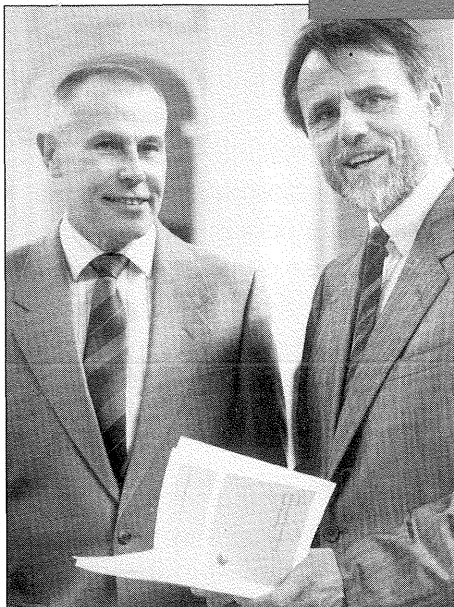
Date: December 7, 1992
Place: Palais de la Découverte, Paris

For more information, please contact:
INRIA, Communication Department, Domaine de Voluceau, B.P. 105 – Le Chesnay Cedex, France
Tel: +33 1 39 63 55 01
email: Therese.Bricheteau@inria.fr

INSTITUT NATIONAL DE RECHERCHE
EN INFORMATIQUE ET EN AUTOMATIQUE

1992
ème
anniversaire

Prof. Bob Hopgood , who was awarded the degree of Doktor-Ingenieur Ehren Halber, and Prof. Bibel at the award ceromony at the Technical University of Darmstadt. (Photo: Grüser, Darmstadt)

RAL – Prof. Bob Hopgood, Head of the Informatics Department at Rutherford Appleton Laboratory was recently awarded the degree of Doktor-Ingenieur Ehren Halber (Honoris Causa) from the Technical University of Darmstadt, Germany. Bob is the first computer scientist to achieve this distinction. The degree is a very high honour in the University – only having been awarded 20 times in the 156 year history of the University. It is awarded to individuals who have made outstanding contributions in their chosen field.

The citation reads "... recognising his trend-setting scientific achievements in the field of computer science, especially computer graphics, and the transformation of his research results into applications and the solution of problems". The University also also recognises his efforts in fostering a fruitful cooperation with Darmstadt's computer science department and European computer graphics groups, and honours a scientist who has achieved exemplary results in the area of computer science.

Prof. Hopgood has had a full and varied career. He worked at the Harwell Laboratory (near Oxford) and AWRE Aldermaston, on early IBM computers, before joining Atlas Computer Laboratory in 1963 (which later merged with RAL). He went on to become Head of the Computing Division. During his career he has written several books, which have become classics of their time. He is a leading figure in the European Informatics

scene and currently, chairman of the ERCIM Executive Committee.

INESC – Prof. Luis Vidigal, a specialist in microelectronics and member of INESC's National Corporate Board, was elected as President of the Engineering, Electrotechnical Electronics and Computer Department of IST (Higher Engineering Faculty) last July. IST is the largest engineering faculty in Portugal and a partner of INESC.

CNR – A system for LANs interconnection via satellite (FODA/IBEA-TDMA System) is presently tested by Nedo Celandroni and Erina Ferro at CNUCE-CNR. The system permits the simultaneous transmission of synchronous and asynchronous data and is able to counter signal fading caused by bad atmospheric conditions, especially in the 20-30 GHz band, by acting on the coding, the bit rate of the data and the transmitted power. The TDMA controller and the burst modem are both prototypes. The modem is the only existing prototype which allows the dynamic change of the data bit rate on a sub-burst basis (1-8 Mbit/s).This system will be used on the Olympus satellite.

GMD – Prof. Thomas Lengauer, PhD, Professor of Computer Science at the University of Paderborn, became head of the GMD Institute of Methodological Principles on 3 April 1992. The appointment is accompanied by a full professorship at the University of Bonn. As successor to Prof. Carl Adam Petri, Prof. Lengauer will be in charge of develop-

ing GMD's new major area of research "Efficient algorithms and their applications in the natural sciences and technology". The algorithmic applications which the Institute will handle problems relating to the design of circuits, industrial production and, in particular, "Molecular bio-informatics", an informatics field new to Germany.

INRIA – An agreement for cooperation between France and China in the domain of Computer Science and Applied Mathematics has been signed last December. The chairman of the French Committee is Alain Bensoussan, President of INRIA. At their meeting in China in May '92, the two partners decided to launch nine projects on the following topics: CIM and Production Management; Image processing for medical applications; Multimedia computer; Videotext; Object oriented data bases; Numerical analysis; Stochastic control; Discrete event systems; Artificial intelligence and computer graphics.

GMD – Dr. Siegfried Dickhoven, scientist at the Institute for Applied Information Technology, assumed charge of the GMD Department of International Affairs on 21 April 1992. His predecessor, **Dr. Hans G. Klaus**, has been granted three years leave by GMD so as to allow him to act as scientific adviser for the Foreign Office at the German Embassy in Peking.

European Research Consortium for Informatics and Mathematics
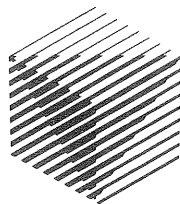
ERCIM

The European Research Consortium for Informatics and Mathematics (ERCIM) is an organisation dedicated to the advancement of European research and development, in the areas of information technology and applied mathematics. Through the definition of common scientific goals and strategies, its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry. To further these objectives, ERCIM organises joint technical Workshops and Advanced Courses, sponsors a Fellowship Programme for talented young researchers, undertakes joint strategic projects, and publishes a newsletter.

ERCIM News is the in-house magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community.

CNR

Consiglio Nazionale delle Ricerche

IEI-CNR
Via S. Maria, 46
I-56126 Pisa

Tel: +39 50 593 400
Fax: +39 50 554 342

CWI

Centrum voor Wiskunde en Informatica

Kruislaan 413
NL-1098 SJ Amsterdam

Tel: +31 20 592 9333
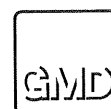Fax: +31 20 592 4199

FORTH

Foundation of Research and Technology – Hellas

Institute of Computer Science
P.O. Box 1385
GR-71110 Heraklio, Crete

Tel: +30 81 22 93 02
Fax: +30 81 22 93 42

GMD

Gesellschaft für Mathematik und Datenverarbeitung mbH

Schloß Birlinghoven
Postfach 1316
D-5205 Sankt Augustin 1

Tel: +49 2241 14 -0
Fax: +49 2241 14 2889

INESC

Instituto de Engenharia de Sistemas e Computadores

Rua Alves Redol 9
Apartado 10105
P-1017 Lisboa Codex

Tel: +351 1 310 0217
Fax: +351 1 572 897

INRIA

Institut National de Recherche en Informatique et en Automatique

Domaine de Voluceau,
Rocquencourt, B.P. 105
F-78153 Le Chesnay Cedex

Tel: +33 1 39 63 55 11
Fax: +33 1 39 63 53 30

RAL

Rutherford Appleton Laboratory

Chilton
DIDCOT
GB-Oxon OX11 0QX

Tel: +44 235 82 1900
Fax: +44 235 44 5831

SINTEF DELAB

Stiftelsen for Industriell og Teknisk Forskning ved Norges Tekniske Høgskole

SINTEF DELAB
N-7034 Trondheim

Tel: +47 7 59 26 00
Fax: +47 7 59 43 02