ERCIM NEWS

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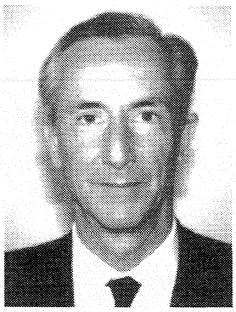

Franco Denoth

Director of IEI-CNR (Photo: CNR)

SPECIAL :

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Activities in User Interfaces and Multimedia

EDITORIAL

The reason for CNR's adherence to ERCIM is because we are firmly convinced that its objectives are of great relevance to the European research community. In particular, we believe that ERCIM could make a significant contribution to the definition of the policies and research programmes of the European Communities in the information technology and applied mathematics areas in order to raise the level of European research in these sectors and thus helping to render European IT fully competitive throughout the world.

The role of CNR in Italian research is both to promote basic and applied research through the activities of its centres and institutes, and to finance research activities through the definition and funding of nation-wide strategic projects which see the collaboration of its member institutes with Italian industry and academia. Other members of ERCIM play similar roles in their own countries. There is thus a need to create links between national initiatives and those of the EC. This would help to avoid an over fragmentation of European research activities into many small initiatives, with the consequent risks of duplicating efforts and financing, and would also render important synergisms possible.

In this respect, CNR believes that ERCIM has a very important function: the harmonisation of national strategies and objectives between its members and the European Community.

We are convinced that ERCIM is a suitable organisation to perform this crucial task, which in our opinion can be best conducted through a series of initiatives of the following type:

- the promotion of an increasingly active participation by ERCIM members in EC research, training, and exchange activities;
- the definition and coordination of a certain number of its own projects;
- the establishment of panels between representatives from the member states and from the EC for the definition and coordination of research programmes;
- the organisation of workshops with the participation of the most qualified experts in the area to define the future direction of research in information technology and applied mathematics;
- the creation of forums for discussion between representatives from the research and the industrial communities in order to ensure that the objectives of the academic world are kept in close relationship with those of industry.

Finally, in the future, we would hope to see a more active participation of ERCIM institutes in research in the microelectronic and VLSI architecture fields. It is well known that many of the most significant recent developments in basic and application software have been stimulated by the rapid advances in hardware technology; we feel there is a real need to encourage and support European industry in this area if it is not to remain far behind that of the U.S. and Japan.

Franco Denoth

ERCIM Meeting at INESC

The last ERCIM meeting took place at INESC in Lisbon, Portugal, on 14 and 15 November 1991. Three workshops, as well as the Director's, Steering Committee and Editorial Board meetings were held at this well organised event.

Important decisions were taken, in particular with regard to new members joining. Two institutes were invited to become members of ERCIM: SINTEF (Norway) and FORTH (Greece).

Researchers from the above mentioned institutes, as well as NCC (Norway), also participated in the workshops.The themes were: Distributed Systems, User Interface and Multimedia, and Decision Support Methods and Applications. Reports by the three coordinators of these workshops appear below.

Welcoming dinner at Castelo de S. Jorge in Lisbon (Photo: INESC)

Distributed Systems Workshop

by Paulo Veríssimo

"What are the current challenges for research in distributed systems?"

So started the call for contributions for the ERCIM Workshop on Distributed Systems, which took place in Lisboa, on the 14th and 15th November.

In response, 28 papers were presented during the two days, before an attentive and very lively audience, revealing that distributed systems is an area deserving a lot of attention these days among ERCIM associates. A diversity of issues was covered: operating system and communications support; architectures; applications; dependability; design and development tools and language support; debugging. Buzzwords often emphasised at the workshop were: objects, multimedia, groups, formal specification, collaborative work.

If one would point out the missing themes, those would be: real-time, and system administration and management. The role of time has been minimised in generic distributed systems until recently. The proliferation of complex interactive systems and the advent of multimedia put real-time requirements on the first page of the issues to tackle in the distributed systems of tomorrow. Management is becoming by far one of the most important issues in distributed systems design and operation. An overall standardised framework for open systems interconnection and open distributed processing is far from being mature, and there is plenty of room for research and reflection in this domain.

A panel, on the theme "Distributed Systems Research in Europe: trends and strategy", took place at the end of the workshop. While there was a diversity of opinions on the subject — both from the panelists and the audience — adequate time was not available for drawing elaborate conclusions. Some consensus seemed nevertheless to have emerged on a few points:

- even in an applied research framework, it is of paramount importance to keep fundamental research alive, since it is the upstream source of innovation leading to new technologies;
- while the notion of a vertical pipeline, from research, through development, to production, was recognised as the preferred organisation structure (against horizontal modular partition of functions common in, eg., ESPRIT projects), it was also acknowledged that such an organisation applies rather to institutions than to projects, since:
  i) it is difficult to materialise this complete route from fundamental research to production in a single product, and
  ii) different phases of the pipeline require different implementations of the executing team, with regard to dimension, degree of cooperation, skills, etc., which is hard to ensure in one project.
- current and past European initiatives (eg. ESPRIT), together with their players (academia, institutes and industry) have not completely succeeded in establishing a sound organisation leading to technology creation from research and its transfer to industry.

ERCIM and its role as a major research player in the European technology arena, will depend on the synergy and complementarity of its various teams and groups all over Europe, and on their collective initiative. Workshops such as this one have certainly contributed to those aims. ■

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User Interfaces and Multimedia Workshop

by Nuno Guimarães

Researchers from the six current ERCIM members, CNR, CWI, INRIA, GMD, RAL and INESC, came together at the ERCIM Workshop on User Interfaces and Multimedia to present their activities and discuss common interests.

After two days of pleasant and interesting discussions, three types of conclusions were drawn. These conclusions refer to technical issues, multidisciplinarity and organisational issues.

1. The technical presentations and discussions highlighted a set of major research directions such as multimedia, user interface models, multimodality, hypermedia and formal specifications. To summarise, the following questions were raised:

- How do we make an interaction language out of multimedia?
- How do we build better, adaptive and responsive user interfaces?
- How do we structure all the media to present them together?
- How do we prove theories regarding user interfaces?

2. The issue of multidisciplinarity was raised as a consequence of the common interests shared by the three workshops taking place at Lisbon: Distributed Systems, Decision Support Systems and this one. Terms such as multimedia, domain experts, formal specification techniques, collaborative work were used and discussed in all of the three workshops.

This observation highlights the existence of cross-links between the various areas, which may be considered as possible criteria for future meetings.

3. The organisational issues were another topic of discussion. The general impressions about this issue can be summarised as follows:

- The overall feeling was that big meetings like this one were mostly targeted at general information and mutual acquaintance. These meetings should foster the creation of smaller groups, with more focus, and with an improved interactive nature.

- Particular attention has to be given to the relation between ERCIM and the IT industry and users, particularly in the User Interface and Multimedia area. A first approach that was outlined is to arrange informal meetings between industry, users, representatives and researchers, where prototypes could be presented.

- Finally, the need for sharing tools and results borne from common research activities was stressed, and the simple idea of announcing public domain results in ERCIM News was mentioned as a beneficial step.

Overall, we believe that this ERCIM Workshop was successful in bringing the researchers of the various institutes together, from both technical and social viewpoints. ■

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A workshop in progress (Photo: INESC)

Decision Support Methods and Applications Workshop

by Carlos Antunes

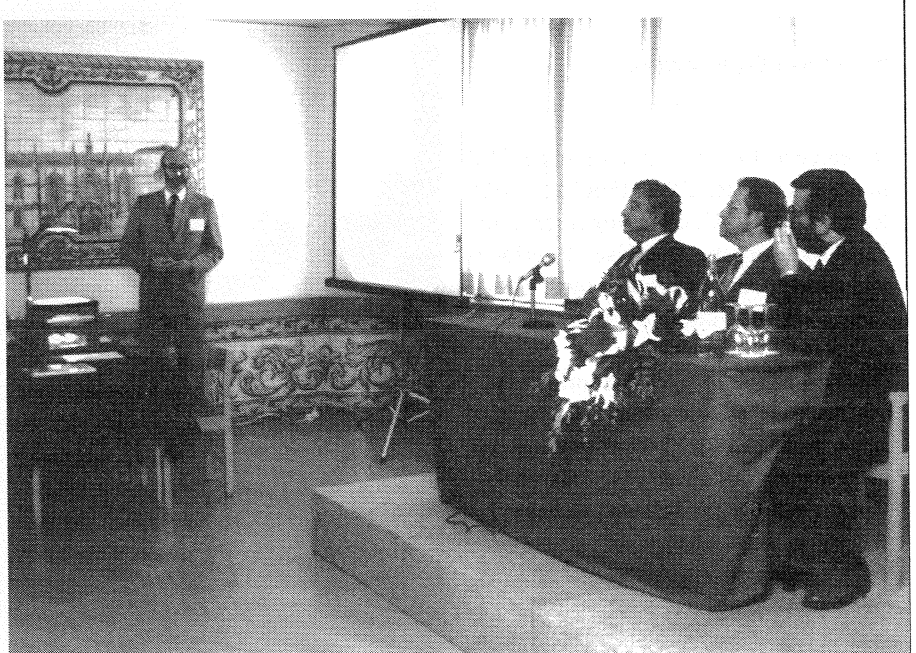
The workshop on Decision Support Methods and Applications brought together a variety of researchers from the ERCIM institutes to discuss ongoing research in this field. Besides presentations, discussion sessions were held in which the role of decision support methods and systems in the organisational framework of our institutes was discussed.

The increasing complexity of the social and economic environment and the development of computer and communication technologies have created situations which require, not only the modernisation of the productive systems, but also new types of planning and management. In these circumstances, the need arises to develop computer/based interactive systems, aimed at supporting and improving the decision process, especially in complex and/or ill structured tasks which require critical evaluation by decision makers {DMs}.

The development of decision support systems {DSS} is a interdisciplinary area receiving cross/enrichment from disciplines such as: operations research/management science, artificial intelligence, data bases, software engineering, statistics, simulation, etc. Some key aspects for the implementation of DSS are the development of tools to aid, and not replace, DMs by creating confidence by means of prototypes, and the need for understanding the cultures of the organisations where the DSS are to be used.

Decision support techniques and tools are of crucial importance in laboratories to resolve well structured problems, as well as to approach engineering and/or management problems where the integration of human factors raises less well-known and ill-structured problems. It was shown during this Workshop that researchers from the different ERCIM member institutes are using heterogeneous approaches to deal with decision problems, having distinct expertise in tools and techniques, and different understandings of the role of DSS to make practice work better.

Applications in the following areas were reported at the workshop: state taxes planning, credit rating and reporting, water supply industry, cutting and packing optimisation in wood industry, waste collection vehicles routing problems, power systems management and planning, modelling, planning, control and management of production systems, telecommunication network planning, and knowledge discovery in data bases.



Paul Williams addresses the participants during the plenary session, chaired by José Tribolet, Cor Baayen and João Fernandes. (Photo: INESC)

This first workshop on DSS were an essential step to lay the foundation for future collaboration projects. What we need to construct in the near future is a framework of "reference models" which will enable a common understanding, not just of what we are doing, but also how organisations work and how to approach them. Moreover, DSS is a crucial area for the survival of institutions like ours, as it is the only channel to the "non-information systems" part of the world, in which a great potential for wealth creation actually exists. In this context it would be interesting to have a "more aggressive" marketing strategy in this area, for example by promoting the presentation of projects being carried out, as well as actual DSS at a big international fair. ■

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The Fellowship Programme

The ERCIM Fellows for the period 91/92 have now been selected following a large response with well over 200 candidates from all over Europe. It is our pleasure to welcome: Choi Hong Lai, Stefan Covaci, Steve Eker, Peter Dickman and Monica Bordegoni to the ERCIM institutes (see table).

As the new fellows are just starting their research, the first three ERCIM fellows are now approaching the conclusion of their fellowships at CWI, GMD, INRIA and RAL. We would like to take this opportunity to present short papers by these scientists, giving an overview of their activities thus far.

Name	Institute		
Choi Hong Lai Great-Britain	INRIA 01/09/91	RAL 01/03/92	CWI 01/09/92
Stefan Covaci Czechoslowakia	GMD 01/02/92	INRIA 01/08/92	INESC 01/02/93
Steve Eker Great-Britain	CWI 06/01/92	INRIA 07/06/92	RAL 06/01/93
Peter Dickman Great-Britain	INRIA 04/11/91	INESC 01/05/92	GMD 01/11/92
Monica Bordegoni Italy	RAL 16/08/91	CWI 01/03/92	GMD 01/09/92

The 91/92 ERCIM Fellowship programme

Michal Haindl...

I started my ERCIM fellowship at the beginning of October 1990 at the Rutherford Appleton Laboratory, UK. During my first half year period in Informatics Department of RAL I worked together with Dr. Edwin Hancock on the problem of hierarchical probabilistic relaxation, applied to edge detection. We developed several new hierarchical relaxation algorithms. The results of this work will appear in two conference papers, one of which has already been published.

Besides these activities, I also finished some previous work, a multispectral image reconstruction method, which was presented on the 7-th Scandinavian Image Analysis Conference in Aalborg, a generalised version of this article for book publication, and an article submitted to IEEE Transection on Geoscience and Remote Sensing, where it is being reviewed at present.

The second period of the fellowship programme started in April 1991 at CWI in Amsterdam. Here I developed a random field based texture synthesis part of graphical system in the Interactive Systems Department. Results of this work were submitted to the CWI Quarterly.

My final period has started in October 1991 at INRIA in Rocquencourt, where I have joined the Satellite Highways Recognition project.

Working conditions in all three institutes are very good and with high level research teams and very good computer equipment and I especially appreciate the excellent libraries and prompt services in the institutes.

Comparing my past experience in the Prague Institute of Information Theory and Automation of Czech Academy of Sciences and Arts to the research world in Britain, the Netherlands and here in France, there are nearly no differences apart from, of course, peculiarities stemming in the past from the general life in a Orwellian communist society, such as the ban of contacts with western researchers, poor availability of scientific literature, old-fashioned computer equipment (our institute was an exception on this point), and even restricted access to copying machines because ot their potential threat to governing regime. The isolation of "the less equal" from the rest of world scientific community was probably the most painful and here I see the greatest benefit of ERCIM, providing it will not remain limited to EC countries.

Alexander Malyshev...

My first fellowship period at CWI, ERCIM member in Amsterdam, finished at the end of May 1991, followed by the second at INRIA-IRISA in France, which lasted until the end of November 1991. The last part of my fellowship is being spent at GMD, in Germany, ending on 30 May 1992.

For the past few years I have been engaged in numerical linear algebra. The aim of this activity, initiated by Prof. S. K. Godunov, Head of the Mathematics Department in Novosibirsk USSR, is to collect together all efficient algorithms for which one can provide a rigorous mathematical theory of computational errors with realistic estimates. We worked out a set of such algorithms which are suitable for solving the main problems in linear algebra. My work in this area is presently continuing in the following two directions: further development of pure mathematical aspects and implementation of these algorithms on various computers, concentrating mostly on the latter.

The stay in CWI was very fruitful. I had the possibility to work in a research team of top scientific level and with excellent

equipment. During this time, I obtained experience in working with parallel computer systems. As a consequence, the first version of a routine package, LINA, has been developed for parallel computers with shared memory, based on the BLAS routines.

This package contains, in particular, routines solving the following problems:

- the eigen-decomposition of a symmetric matrix;
- the singular value decomposition of a matrix;
- the least squares solution for a system of linear equations;
- the eigen-subspaces of a non-symmetric matrix or of regular matrix pencil.

These routines are suitable for matrices of a moderate size.

At INRIA-IRISA, I was involved in equipping LINA with a full error analysis facility and developing implementations for parallel computers with distributed memory. In particular, I investigated high precision calculations with guaranteed accuracy. Here I worked in a research group under the leadership of B. Philippe. The research closely resembled that developed by Godunov's team.

The ERCIM fellowship programme has a number of benefits, such as enabling young scientists, mainly from the Eastern Europe, to visit some of the best scientific centres, which would otherwise have been impossible. In particular, it gives one the opportunity to establish direct contacts with the leading specialists during each stay, thus helping to recognise one's place in the scientific community. However, for an effective exchange of expertise to take place, at least one year at each institute is required, in my opinion.

Eric Rutten...

My ERCIM fellowship has enabled me to work at INRIA Sophia Antipolis, in the PRISME Robotics project with Bernard Espiau, from 15 September 1990 to 15 March 1991, followed by a six months period at GMD Sankt Augustin, in the F3.KI/QWERTZ Artificial Intelligence project with Joachim Hertzberg, until 15 September 1991. The last six months are being spent at CWI Amsterdam, in the Interactive Systems department with Paul ten Hagen, ending on 15 March 1992. The perspective of my work is related to the use of languages for specifying behaviours at task-level, from a robotics applications, artificial intelligence, and programming languages point of view.

My activities at INRIA Sophia-Antipolis concerned task-level programming in robotics. The context was the Open Robot Controller (ORC) developed while working in Bernard Espiau's team. At the robot-task and applications level, it involved collaborating with the CMA of the Ecole des Mines de Paris (EMP) at Sophia Antipolis, for the use of Esterel (also a joint INRIA-CMA project), a real-time language of the "synchronous" family, to which Signal (IRISA/INRIA-Rennes) and Lustre (IMAG, Grenoble) also belong. My contribution consisted of defining the Applications Programming Language, i.e. determining the primitives of the language, inspired by my previous work, as well as their encoding into Esterel. The work is described in detail in the INRIA Sophia Antipolis Research Report no. 1441, co-written by Eve Coste Maniere, Bernard Espiau and myself, and titled: "Task-level robot programming combining object-oriented design and synchronous approach: a tentative study". Part of this work was presented at a seminar on "Task-level robot programming: from temporal reasoning to real-time", organised at INRIA Sophia Antipolis, on March 14 1991, by Daniel Simon and ourselves.

At GMD Sankt Augustin, I worked on the automatic generation of action or task planning, from an artificial intelligence point of view. In the framework of the QWERTZ project, lead by Joachim Hertzberg, research is being carried out in the area of planning on the aspects of problem-solving algorithmics, as well as representation of actions and plans, involving non-classical logics and the constraint satisfaction problem. I made use of their earlier work on non-linear plan generation methodologies, and in the domain of time map management (the MTMM system, maintaining a network of consistent temporal constraints). I investigated the integration of these two subjects into a non-linear temporal planner, generating temporal arrangements of tasks to achieve a goal, featuring parallelism. The use of the time map manager in the generation process leads to the redefinition of the processing share between the algorithm handling logical dependencies, and MTMM managing the temporal constraints. It is described in my report (GMD Arbeits-Papier, in print) "A temporal non-linear planner: TRIPTIC".

The third step of my fellowship has now begun at CWI, Amsterdam, in the Interactive Systems Department, lead by Paul ten Hagen. My participation in the group was prepared in our meetings at earlier ERCIM Workshops. I am contributing to the definition of Manifold, a parallel, data-flow and event-driven programming language, developed by Farhad Arbab, Ivan Herman and their colleagues.

To conclude, the fellowship has allowed me to experience the diversity (and likeness) of some European laboratories, and, even though each six month period is rather a short time, learn much about each visited team's speciality. ■

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User Interfaces for Picture Systems

by Henk Nieland, CWI

ERCIM's Advanced Courses Programme is now getting well off the ground. A new 5-day course on User Interfaces for Picture Systems was organised by the Dutch Academy for Computer Science at CWI on 9 - 13 December, 1991. Lecturers came from INRIA, GMD, RAL and CWI. Course director was Paul ten Hagen (CWI). The course, mainly aimed at designers of information systems, was partly sponsored by the European COMETT Programme. There were 15 participants. The course is envisaged to be repeated at GMD (Bonn, Spring 1992), RAL (Chilton, September 1992) and INRIA (Rocquencourt, December 1992).

User interfaces have moved to the forefront of IT research. Increasingly complex software systems and rapid developments in hardware technology require high-quality interfaces in which pictures are essential for an easy access to the system. At present the possibilities of including pictorial facilities in user interface tools are only beginning to be seriously explored. Such possibilities were studied in the course. The programme included the following topics:

- Basic concepts for user interfaces
- Computer graphics and imaging in user interfaces
- Picture editing
- Pictures in VIEWS
- User interface generation
- User interfaces in scientific visualisation
- Perception of pictures

■

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SCAFI'91 Studies in Computer Algebra for Industry

by Henk Nieland, CWI

Some ten case studies of applications of computer algebra in industry formed the core of the first in a series of seminars on this topic, organized in the framework of the ERCIM Advanced Training Programme.

Another major topic was the integration of numerical and symbolic computational software. This first meeting, organized by the Expertise Centre Computer Algebra Netherlands (CAN) in collaboration with ERCIM, took place on 10-11 December 1991 at CWI in Amsterdam. There were 40 participants. Course directors were Arjeh Cohen (CWI) and André Heck (CAN). Some case studies were presented by Dutch industrial researchers, others were an outcome of close cooperation between industrial laboratories and CAN. Lecturers came from The Netherlands, the UK, France and Spain. The opening address was given by James Davenport (University of Bath, UK). ERCIM President Cor Baayen participated in a panel of prominent research managers to discuss various aspects of the field, such as educational issues and were: J. de Groot (Philips Research Eindhoven), G.Y. Nieuwland (Free University Amsterdam), L.A. Peletier (University of Leiden) and C.J. Stok (PTT Research Leidschendam). The seminars are supported by the European COMETT II Programme.

■

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1992 ERCIM Advanced Training Programme

18 - 21 February
Multigrid for Computational Fluid Dynamics
INRIA, Sophia-Antipolis

6 - 10 April
Partial Differential Equations and Group Theory
GMD, Bonn

April
Paradigms and Programming Techniques for Parallel Architectures
GMD, Bonn

12 - 14 May
High Speed Microprocessors
INRIA, Rocquencourt

29 July - 9 August
Distributed Operating Systems
INESC, Lisbon

September
Parallel Scientific Computing
RAL Chilton

13 - 16 October
Distributed Memory Architecture
INRIA, Rocquencourt

■

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ESPRIT Basic Research Actions in Distributed Systems

Distributed Systems being the central theme of this issue of ERCIM News (see page 10), we took the opportunity to invite the coordinators of two ESPRIT BRA actions, CEDISYS and SPEC, to report on the progress of these projects. Both projects are currently in their completion stages, terminating early this year.

ESPRIT BRA 3011 (CEDISYS)

Compositional Distributed Systems

by Ugo Montanari

The overall objective of CEDISYS is to develop a fundamental understanding of the nature of concurrency and to provide a formal framework useful for describing concurrent and distributed systems. This framework should support the specification and development of distributed systems and should lead to methodologies for deriving their properties and for proving them correct.

Aims

More precisely, the aim of CEDISYS is to develop a theory of concurrency where the distributed nature of processes is properly taken into account. To this purpose, the traditional approach based on interleaving is felt as inadequate, since it interprets concurrency or parallelism as a linguistic shorthand for non-determinism. Instead, we choose a framework which reflects the inherent concurrent and distributed nature of processes more correctly. This framework is sometimes known in the literature as the "true concurrency" approach. The action consists of comparing existing formalisms, of developing models, languages and logics with compositionality and abstraction capabilities, and of experimenting techniques and tools for supporting the implementation and animation of the proposed formalisms.

Methods and Results

Among the various proposed models of concurrent distributed behaviour, particular attention is paid in CEDISYS to Petri nets and event structures. Petri nets have been extended with compositional and observational mechanisms based on algebraic and categorical techniques. Event structures (of several kinds) and Petri non-sequential processes are the preferred semantic domains for the theories developed within the action.

Process description languages (like CCS, CSP, ACP, Meije etc.) originally defined for the interleaving approach have been equipped with a truly concurrent semantics by adapting structural operational semantics and algebraic techniques. Several notions of testing and observational equivalences have been introduced and compared. Also, the issues of atomicy of actions (i.e. the property of being decomposable but non-interruptible) and of action refinement have been studied in depth, with the aim at providing process description languages with the means for hierarchical system design and specification.

Reasoning about distributed systems is an important goal in many computer science applications. We have taken the combined approach of defining, on one side, testing and observational equivalences for process description languages and, on the other side, modal or temporal logical languages. We have stated the close relationships between particular behavioural equivalences and particular assertion languages in the form of adequacy or expressivity results.

Potential

In the future, most of the existing practical methodologies and tools based on the interleaved models of concurrency could probably be transferred to the true concurrency context. We expect however a more substantial breakthrough. Completely new methods and tools will become feasible, taking advantage of the superior descriptive power of true concurrency. They will provide ground for direct improvements in at least three areas: design methods for distributed systems, expert systems for reasoning about time and architecture of distributed systems.

Partners

The activity lasts 35 months and will terminate on March, 1992. CEDISYS is a small action: the participating institutions are only four. We list them below together with some key members:

- Computer Science Department, Aarhus University, Denmark: Glynn Winskel, Mogens Nielsen and Uffe Engberg.
- Computer Science Department, University of Pisa, Italy (coordinator): Ugo Montanari, Pierpaolo Degano and Gianluigi Ferrari.
- INRIA Sophia-Antipolis, France: Gerard Boudol and Ilaria Castellani.
- Computer Science Department, Sussex University, UK: Matthew Hennessy.

Luca Aceto, Rocco De Nicola, Roberto Gorrieri and Astrid Kiehn recently moved to other institutions, but they are still working within the Action. ■

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ESPRIT BRA 3096 (SPEC)

Formal Methods and Tools for the Development of Distributed and Real-Time Systems

by Michiel Wijers

The task of developing concurrent, distributed and real-time systems is addressed. Deficiencies of the four basic approaches to concurrency are perceived as largely complementary, and the combination of these formalisms seen as possibly very effective. Besides combining formalisms, research is proceeding into broadening the scope of existing formalisms towards real-time and probability, and narrowing the gap between the specification and executable code of concurrent systems by extending the model checking paradigm with recent techniques such as on-the-fly searching space generation, partial order, and symbolic techniques.

Aims

Research into the four basic approaches to concurrency (temporal logic, automata, process algebra and assertional methods) has produced specification formalisms and associated development and verification tools that had successful applications, but none of the formalisms completely solves the concurrency problem and all have their deficiencies. E.g., temporal logic performs splendidly when proving global eventuality properties, while performing badly for local precedence properties. For automata this is exactly the other way around.

The overall objective of the SPEC Action is to alleviate these deficiencies and to provide frameworks for the specification and development of distributed real-time systems that are both practically adequate and theoretically sound. So why cannot these two techniques of temporal logic and algebra be combined. In general this extends to a combination of temporal logic and algebraic techniques. Especially worthwhile has been the extension of both to real-time.

Special attention is given to the development of more efficient (both in time and in space) model checking and other machine assisted verification algorithms and tools. In this respect, besides giving attention to the topics mentioned above, the aim is to extend Xesar with time and make it faster, and to extend and investigate into the possibilities of the Statechart formalism.

Approach and Methods

- Combining existing formalisms:

Combined formalisms, the result of fusing complementary formalisms, are being considered. One suggestion is to combine transition-based formalisms, such as finite-state automata or process algebras, with a logic-based formalism such as temporal logic. Transition-based formalisms are ideal for describing local sequencing requirements, whereas logic-based formalisms are well-suited for representing global requirements and timing constraints. This combination has already partially been investigated in the past; in future their crossbreeding is foreseen within the context of an extension towards real-time and probability.

- Broadening the scope of existing formalisms:

Investigations are proceeding into the ability to handle real-time constraints. Other extensions of existing formalisms are planned, such as adapting them to genuinely distributed models of computation (e.g., synchronous communication) or to models containing probabilistic information (and possibly handling reliability). Especially worthwhile is the extension to timed automata, timed process algebras and timed logics. A similar extension towards including probability is undertaken. Finally, a merging of timed process algebra formalisms with Statecharts is undertaken.

- Narrowing the gap between formal specification and executable code:

Two complementary efforts are being pursued. The first follows the development paradigm, and contains recommendations for an environment providing partially automated support for development within the context of process algebra. The second effort will strive to obliterate traditional dividing lines between specification and implementation languages, especially focussing on executable subsets of Temporal Logics and the language for real-time embedded systems LUSTRE.

Results

A short survey of the progress and results up to now are given below:

1. Executable temporal logic has been extended, by adding a second dimension of time, to updates of temporal databases.
2. Model checking of an important class of continuous time stochastic systems has been reduced to a finite state verification problem.
3. A process algebra and logic for time and probability has been designed, and a theory of refinement of probabilistic processes developed.
4. The temporal logic methodology has been improved to such an extent that book about it will appear in the fall of 1991.
5. A denotational model for infinite timed CSP behaviours has been developed as a basis for a temporal logic and future extension to the description of probabilistic systems.
6. A general, generic, mathematical model for asynchrony has been given.
7. Two compositional proof systems for real-time distributed system verification including prioritised scheduling of processes have been developed. One proof system uses metric temporal logic; the other uses Hoare-triples.
8. Methods for "on the fly" automatic verification have been extended to model checking, the implementation of behavioural equivalences based on bisimulation semantics, and minimalization. The latter has been implemented in LESAR, a verification tool for LUSTRE.
9. A new approach to model checking based on partial-order semantics has been introduced and implemented, and improved even more for safety properties.

A list of deliverables is available at the administrative coordinator in Eindhoven.

Potential

Based on the SPEC Action's results, considerable advances have been made towards the mechanised or semi-mechanised verification of VLSI designs and finite-state real-time systems in practice. The incorporation of real-time and probability into process algebra theory allows for its further exploitation in work-benches, but will remain mainly of theoretical interest as far as probability is concerned until new breakthroughs are made on account of the time factor. The fundamental assertional concurrent process refinement techniques have been clarified and extended to the point of application, and are generalisable to real-time and probabilistic systems. Unification of sequential refinement and reification techniques is very nearby (only Back's techniques must still be included), while for concurrency considerable advance towards unification of refinement techniques has been made, with a potential of extension towards real-time.

Partners (10)

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Grenoble, F: IMAG
Heraklion, GR: Forth Institute of Computer Science Crete
Kista, S: Swedish Institute of Computer Science
Liege, B: Universite de Liege
London, UK: Imperial College of Science, Medicine and Technology
Manchester, UK: University of Manchester
Nijmegen, NL: Katholieke Universiteit Nijmegen
Oxford, UK: University of Oxford
Rehovot, ISR: Weizmann Institute of Science and Technology

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Activities in Distributed Systems in the ERCIM Institutes

by Paulo Veríssimo

In this issue of ERCIM news, you will find a very interesting collection of articles, illustrating some of the activities of ERCIM members in distributed systems. For those who attended the recent ERCIM workshop on distributed systems in Lisboa, these papers complement what has been seen and heard there.

Parallelism and distribution go hand in hand. Multiprocessors for parallel processing are using techniques, paradigms and protocols originating from distributed systems research. "Languages and Parallel Systems", by Michel Banatre, describes a parallel object-oriented language for GOTHIC, a system which combines fault-tolerance, distribution and parallelism.

Also in an object-oriented framework, Sacha Krakowiak reports the results and achievements of the GUIDE project, whose main activity has taken place within the ESPRIT project COMANDOS. Its objective is to explore distribution based on heterogeneous hosts interconnected by LANs. The main goals and components, as well as the current status, are reported.

STARFISH is a project seeking transparency of hardware heterogeneity, through the use of a common operating system ported to he different platforms. Amoeba is the selected OS, in this report by Martin Kersten from CWI. The main objective in order to obtain support for generic application building, is to construct a complex object server, with emphasis on dynamic query load balancing and active database support.

Security is becoming a great concern for everyone in information processing, in the measure where people depend more on computers, computer interconnection and internetworking is growing everyday, and hackers are becoming more aggressive. Saturne is a well-tested technology to tolerate accidental faults and intrusions in distributed systems. Based on cyphering, fragmentation, replication and dissemination, Saturne's main features are reported in this issue by Yves Deswarte.

Fabio Tarini reports on "An Italian Project for the Development of Distributed Computing Systems". It seeks to define a set of guidelines for the design and evaluation of distributed systems architectures. The core idea is to pursue the achievement of performability, the combination of high levels of reliability and performance. The PACS project in particular, is described.

Peter Ochsenschlager (GMD) and Tommaso Bolognesi (CNR), propose to address a problem which is gaining importance currently: the complexity and robustness of the specification and analysis of distributed systems. Formal specification methods are proposed in order to reduce design inconsistencies and to remove design faults. The tool proposed in "The Product Network Machine" is implemented in CommonLisp on

Symbolics or MacIntosh. The tools reported in "Formal Specification and Verification of Distributed Systems" belong to the framework of the well-known ESPRIT project LOTOSPHERE, which uses the LOTOS formal description language.

An image processing workstation for medical and industrial diagnostic purposes is reported by Ovidio Salvetti in "Pictorial Distributed Systems". Its main components and the hardware and software architecture are discussed.

In the evolution of distributed systems research there are two challenging and related topics: the combination of distribution, fault-tolerance and real-time in the designing of the recently called responsive systems; and distributed algorithms and protocols solving problems for several flavours of the systems above. The paper by Noel Plouzeau reports work on the development and debug of "Distributed Algorithms and Protocols". The paper by Gerard LeLann describes the main goals of "Project REFLECS", which seeks algorithms and protocols, analytical models and verification measurements for responsive systems. The paper by Paulo Verissimo, "Group Orientation in Distributed Systems", reports reflections about a systematics for structuring and programming with groups in distributed systems, since groups are gaining importance as a paradigm to program distributed applications, and simultaneously a notion that pervades all layers of an architecture. ■

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Languages and Parallel Systems

by Michel Banâtre

A significant aspect of work on distributed systems in the "Langages et Systèmes Parallèles" (LSP) group is based on results obtained within the GOTHIC project. This continued work is, in particular, focussed around parallel object-oriented languages and the design of fault-tolerant architectures based on the stable transactional memory (STM) technology.

The parallel object-oriented language defined in GOTHIC has been redesigned in order to integrate exception handling mechanisms and to provide an appropriate solution to the difficult problem of making inheritance and synchronisation fit together. A new version of object run-time support on the multiprocessor architecture is also being designed. Particular consideration is being given to problems related to:

- protection, in order to get benefit from the object concept at the run-time level;
- load-balancing, and in particular the study of the relationship between load balancing and distributed virtual memory management strategies;
- data allocation, in order to optimise underlying cache management;
- distributed garbage collection;
- transparency of fault-tolerant mechanisms at the object programming level;

Our research in fault-tolerant architectures are based on the use of the stable transactional memory (STM) technology, a STM can be considered as a generalisation of the stable memory provided in the GOTHIC architecture. It contains a coherent state (checkpoint) of each process running on any processor of the architecture. In loosely coupled architectures, the STM is visible from the kernel and its facilities are used to build a fault-tolerant kernel. Starting from a standard kernel (MACH/OSF-1), the basic fault-tolerant mechanisms (atomic transactions, etc.) are integrated in order to provide reliable servers. In tightly coupled architectures, the STM is used instead of the common memory, thus only caches "see" the STM. Hence, the STM can be considered to contain current checkpoints of every process running on processors, which are updated when caches flush data. In this case fault-tolerant aspects are transparent to the processors. ■

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STARFISH

Design, Implementation, and Application of a Transparent Distributed Computing System

by Martin Kersten

One of the major trends in modern computing is the grouping of many computers, rather different among themselves, into one system. Transparency of all the system's resources to the user is an important requirement. The Starfish project is a collaborative action between CWI, Vrije Universiteit, University of Twente, and University of Amsterdam, to create such a distributed system. The project runs until 1993 and involves about 10 researchers. It is partly financed by the Foundation for Computer Science in The Netherlands (SION).

As computers get less expensive and more numerous, many organisations find that they have many computers that need to co-operate. This requires a single, uniform, operating system that allows all the computers to work together in a seamless way. Processes on any machine must be able to communicate with remote processes in the same way that they communicate with local ones, in order to make it possible to reconfigure the system. For example, if two processes need to communicate, it is highly undesirable that they use one mechanism, if they happen to be on the same processor, and a different one, if they happen to be on different processors. Similarly, there should be a single way to access a file, whether that file happens to be on the local machine, on a file server in the same building, or in a distant city. In general, the physical location of processes, data, and all resources should be transparent, with access handled automatically and efficiently by the operating system.

Within the Starfish project, we believe that transparency should be achieved by running the same operating system, possibly on different kinds of hardware. The system chosen is Amoeba, a distributed operating system designed and implemented at the Vrije Universiteit and CWI. On top of this operating system we need several generic application systems, providing the required functionality and exploiting the distributed platform efficiently. Therefore, a prime objective is to develop an extensible complex object server, which provides the user with a data model and query language to describe and manipulate graph-like objects. The task of the object server is to efficiently implement this model under the Amoeba system, shielding the complexity of maintaining the fragmented representation by means of clustering, indexing, and query evaluation strategies.

The research actions focus on the software architecture of an extensible complex object server, with the emphasis on dynamic query load balancing and active database support. To illustrate, an active database system is characterised by a set of event-condition-action pairs, which describe actions to be taken upon encountering an event in a particular database state. The correctness criterion for transaction management, i.e. serialisability, is a serious handicap in achieving a more efficient system and limits the modelling of cooperative behaviour of autonomous systems. Well-founded execution models and efficient algorithms are needed in both research areas mentioned. In addition, research questions related to efficient WAN communication protocols, fault tolerance, data distribution, language interworking, and application of the system in robotics are being addressed.

■

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A Project for the Development of Distributed Computing Systems

by Fabio Tarini

CNR is funding a 3-year project (1991-1993) for the study of "Programming environments and architectures for distributed systems development". The project addresses the robustness, fault tolerance and high performance required by critical applications and by some of their operating environments. These requirements can be satisfied exploiting the redundancy and/or parallelism available in distributed architectures. The main purpose of the project is to define a set of guidelines for the design and evaluation of distributed system architectures on which such applications can be developed and run.

Operating units from several Italian universities (Rome, Pisa, Bologna and Modena) and CNR (IEI and CNUCE) are collaborating in the project, investigating problems regarding both system and application aspects, which include:

- definition of programming tools for non transparent management of fault tolerance at application level;
- design of reliable and fault tolerant algorithms and data structures;
- analytic and simulative models for evaluation of reliability and performance;
- development and testing of parallelism models aimed at optimising system reliability and performance;
- system architectures for fault tolerance in distributed environments, both on the basis of existing systems and prototyped according to a new computational model.

The CNUCE and Pisa University operating units are working on a sub-project

named PACS (Performability Achieving Computing Systems), aimed at studying and proposing a class of distributed computing systems with high "performability", intended as high level reliability and performance, with wide scalability between these two features to attain the required level of dependability. The motivation is the conviction that future computer applications will require increasingly improved reliability and performance. Von Neumann's model can no longer be expected to determine further substantial progress, except for technological evolutions. Other computational models are thus being proposed as alternatives.

PACS is based on BSM, a dataflow-like computational model, extended to nondeterminism. In this model, asynchronous entities with variable granularity behave atomically (without interactions during their execution); global handling of such entities and dynamic allocation of their instances to the execution units are controlled by an interpreter, whose strategies can be defined as a function of the reliability and performance levels that the target machine should achieve.

During the PACS project, the aim is to complete the definition of this model and to propose computer architectures; some systems are being simulated and two prototypes are under development in order to verify at which level the desired "performability" features are achieved.

The resulting prototypes consist of a set of components, used both for execution and for control handling. One is a "Search Mode Configurable Computer", so called because the interpreter resides on a special component, while the other components just execute interpreter assigned modules; this prototype is based on Transputer cards. The second prototype is based on a distributed UNIX environment and is an "Interconnection Mode Configurable Computer", in which both interpretation and execution functions corresponding to a single module are carried out on each unit. ■

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Distributed Algorithms and Protocols

by Noël Plouzeau

The objective of project ADP (Algorithmes Distribués et Protocoles) is to design a complex and still badly understood class of objects: distributed algorithms.

Distributed algorithms emerge from

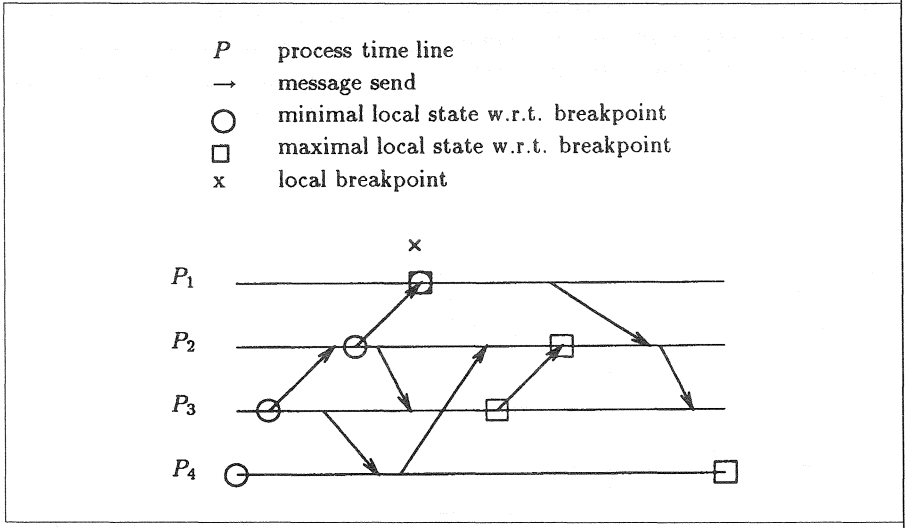
- the network research field (protocols are indeed special cases of such algorithms, aiming at communication implementation),
- operating system concepts (because of their parallel nature), and
- programming methodology (because of their algorithmic issues).

This triple nature is characteristic of distributed algorithms and their complexities. The INRIA project ADP aims at studying these objects by using three different approaches:

1. understanding their foundations,
2. defining and implementing a distributed kernel,
3. defining and implementing a distributed debugger.

Looking for basic concepts and mechanisms helps in understanding the foundations and in defining new paradigms for the construction of basic algorithms, which provide common system services: resource sharing, detection of occurrence of global properties on a distributed computation, gathering of distributed data, etc.

A good knowledge of distributed algorithmic issues also needs experiments and implementations of algorithms on distributed memory machines. To this aim, a distributed kernel providing a virtual time facility is under development; its main function will be distributed simulation.



A typical time diagram for a distributed computation

Correct definition and implementation of distributed algorithms is a difficult matter; providing a user with facilities to monitor and debug programs during execution on a distributed memory machine, is at need.

The ADP project is currently developing a distributed debugger environment, called Erebus. This tool has facilities for replaying a distributed computation, setting global breakpoints and displaying the sequence of states reached by the distributed computation. ■

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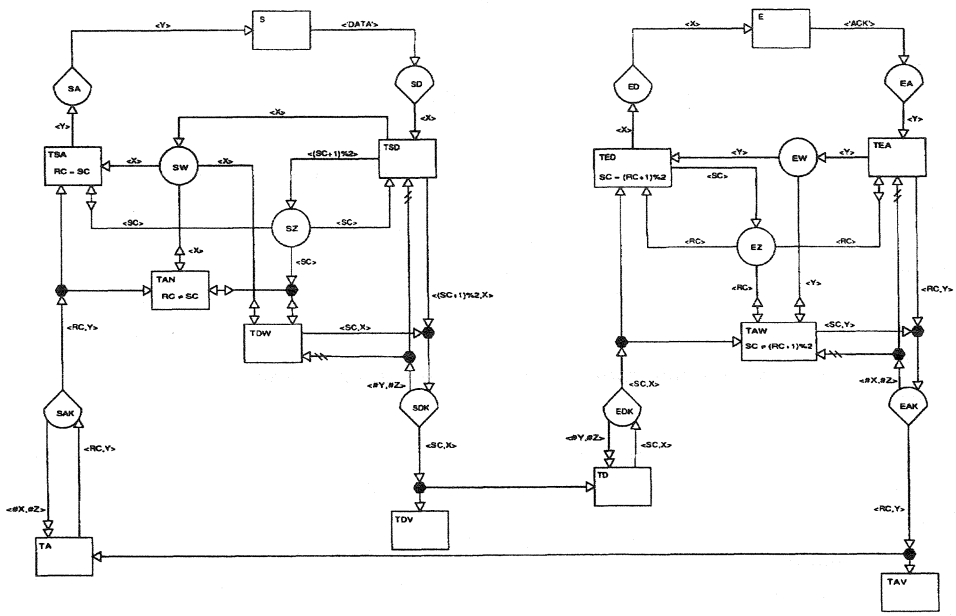
The Product Net Machine: An Integrated Tool for the Formal Specification and Analysis of Distributed

by Peter Ochsenschläger

Over the last few years, the GMD Institute for Systems Engineering in Darmstadt has developed and tested product nets techniques as formal descriptive tools for distributed systems.



Product Net specification of the alternating bit protocol

Conventional forms of human interaction and cooperation are increasingly being supplemented or even supplanted by the use of computer systems and new communications media. This results in complex distributed systems, made up of different individual components. To ensure the necessary reliability and security of such systems, a clear and straightforward design concept is required. In view of the heterogeneity of the systems, e.g. different components supplied by different manufacturers, this necessitates a uniform descriptive tool for the entire system.

The relevant descriptive tool must permit a level of abstraction which emphasises the mutually adapted behaviour of the respective parties that is essential to successful cooperation, while ignoring their different types (human being, computer or communications medium) and ways of generating it. It must be used to develop specifications which are not confined to describing individual partners in cooperation, but whose essential task lies in the mutually corresponding arrangement of all parties involved in achieving a cooperative target.

The product nets developed in the Institute for Systems Engineering are labelled Petri nets with individual tokens. They permit formal and uniform definition of all aspects essential to the description of interactive cooperation, in particular:

- the consistent change of state caused in the relevant parties by the achievement of a cooperation target,
- the individual behaviour of each individual partner,
- the interaction between the partners, and
- the combination of identical individual behaviour to form behavioural patterns.

In addition, the product nets allow comprehensive computerised analysis of the dynamics of the specified system which ultimately makes it possible to check that the interplay between the individual system components is correct.

The product net machine is an integrated tool for the designing and analysis of product net specifications which masters the degree of complexity involved in specifications of practical relevance. The designing of product nets is supported by a graphic editor which also ensures syntactical accuracy. For analysis of the dynamic behaviour of a specification, both the complete reachability graph can be determined and random or user-oriented simulation can be performed. In the case of simplified analysis of the dynamics, e.g. of the type required for verification purposes, it is also possible to computer so-called "reduced" reachability graphs.

The product net machine is implemented in CommonLisp on Symbolics or Macintosh with MacIvory. It is the core element of a tool box whose expansion with further verification, implementation and test tools is planned. ■

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Project Saturne: Fault and Intrusion Tolerant Distributed Systems

by Yves Deswarte

Saturne is a joint research project of INRIA and LAAS-CNRS aiming at developing new solutions to improve the dependability of distributed computing systems by means of fault-tolerance techniques. Within this project, a particular technique, called Fragmentation-Redundancy-Scattering, has been developed in order to tolerate both accidental faults and intrusions.

Many distributed systems have been designed to tolerate accidental faults because distribution enables isolation of elements so that error propagation can be prevented or limited. The same approach can be applied to tolerate, not only accidental faults, but also intentional operational faults, or intrusions. A distributed system is intrusion-tolerant if it is designed so that any intrusion into a part of this system will not endanger confidentiality, integrity and availability. By intrusion, we mean not only computer break-ins by non-registered people, but also attempts by registered users to exceed or abuse their privileges. In particular, possible malice of security administrators is taken into account.

Fragmentation-Redundancy-Scattering (FRS) is a technique which enables to recover erroneous data destroyed or contaminated by accidental faults or by intrusions, while preserving the confidentiality of sensitive data. FRS consists of cutting information into small, non-significant fragments, adding redundancy to these fragments and scattering the fragments through the distributed system, so as to tolerate intrusions into a part of the system with no consequence on data confidentiality and integrity or on system availability.

FRS has been applied to different functions of distributed systems such as persistent file storage, security management and confidential data processing. Current developments include the study of security management of large interconnected distributed systems, access control to objects in an object-oriented distributed system and fragmented object processing. ■

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Distributed Applications on High Speed Networks

by Norma Lijtmaer

Recent developments concerning High Speed Networks with mesh topologies make them increasingly appealing. Furthermore, multiple active, dynamic distributed applications require a dynamic mapping that is strongly related to the structure and the topology of the application.

In High Speed Networks with mesh topologies, stations are interconnected by dedicated, point to point links and have multiple incoming and outgoing links that may exhibit regular patterns. *Flooding techniques* and *routing decisions* are the two basic strategies used to transmit information. The flooding technique is simpler, and ensures that the unit of information reaches its destination with a minimum delay. On the negative side, bandwidth is wasted and network congestion/starvation needs to be prevented. Instead, routing decisions make stations more complex, and buffering requirements become important. However, network bandwidth is used more efficiently. In general, High Speed Networks adopting a mesh topology, whether regular or not, offer high performance throughput, efficient channel utilisation, and low delay. In addition, the proposed access protocols guarantee — or could be modified to guarantee — fairness, distribution, minimum initial knowledge of the topology, easy dynamic configuration and bounded delay properties for supporting real-time constraints.

Distributed application systems built on Wide Area Networks, Metropolitan Networks or High Speed Local Area Networks have intrinsic virtual topologies that are related to the evolution of the applications. Several applications, each with its own different virtual topology, may be present and simultaneously executing on the same network. In fact, the distinctive characteristic of a distributed application is that information processing activities are provided by a set of cooperating, logically separate information processing units or *components*. These discrete components may be located within more than one system and at more than one geographical location, and may evolve in parallel. The structure by which the logically separate components of a distributed application are to be integrated is a *virtual net*. Virtual nets use application-dependent communication structures for connecting the parallel, autonomous tasks of the applications, and for regulating the exchange of data and control among these tasks. They are supported by mechanisms for specifying various aspects of configuration, communication and time constraints.

Eventually, programming and operating system constructs must be provided to allow the infrastructure to map the virtual topology on the logical/physical one. The infrastructure must be able to deal with a heterogeneous environment, with different policies, with application open-endedness and with negotiation mechanisms. Formal models must be adopted to specify the primitive constructs and to prove significant properties. ■

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Pictorial Distributed Systems

by Ovidio Salvetti

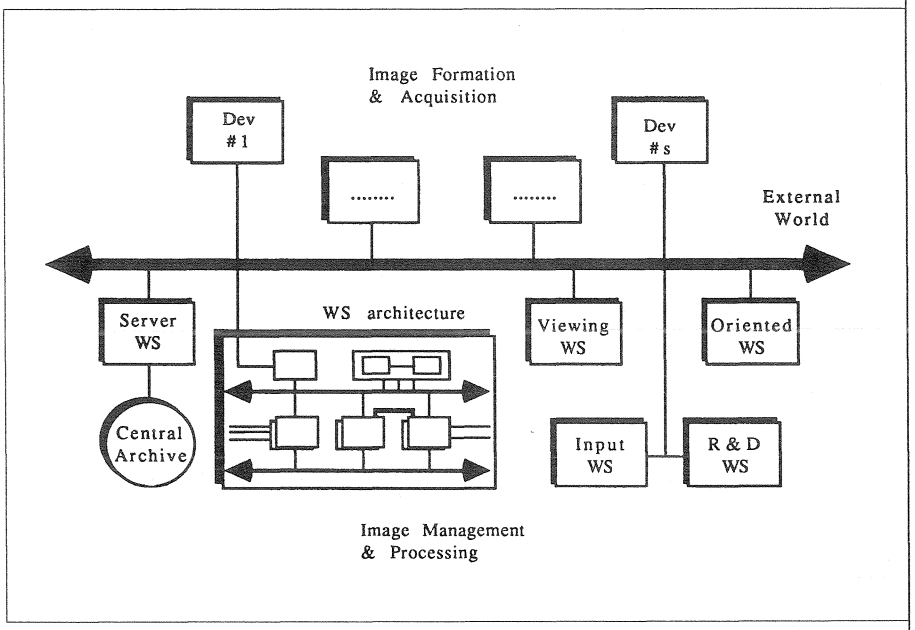
As part of the activities of the Subproject "Dedicated Processors" of the CNR Special Project "Information Systems and Parallel Computing", an image processing workstation, designed for medical and industrial diagnostic purposes, is being implemented at IEI.

The workstation is dedicated to producing and deriving knowledge from digital images and can be connected with other clone workstations in a distributed architecture of high-level specialised components. Models capable of managing system and application dependent features have been developed and standards have been defined for both hardware and software components.

Four fundamental categories of physical and/or logical resources have been studied:
. the *data types* which are dependent on the acquisition, restitution, management and storage specifics;
. the *procedures and processing modules* of the image operating system;
. the *intelligent processes* which represent the system knowledge;
. the *communication models* which standardise the exchange of data and processes.

An image system designed for diagnostic scopes must include:
a) open hw/sw system facilities;
b) signal and image acquisition devices and the relative hardware modules;
c) dedicated workstation and global and local system software functionalities;
d) support for specific methodologies.

The figure shows the hardware architecture of the general system, which is based on a multiprocessor and multibus architecture for signal and image acquisition and parallel computing. Dedicated processors permit the system to offer real-time development simulation and parallelism at global and local levels. The system architecture is the basis on which specialised work stations can be constructed for the creation of a standardised distributed image-based diagnostic system.



The system hardware architecture

The software architecture is based on the following main components:
. a high level man-machine interface which permits time sharing and defines different user work contexts;
. an image processing system (IPM) which includes algorithms and procedures for signal processing at different levels of complexity; an IPM/IPM and IPM/host communication kernel. The station can be specialised to meet the needs of particular applications by integrating system modules appropriately. ■

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Project REFLECS

by Gerard Le Lann

Research & Development activities conducted within Project REFLECS concentrate on those algorithmic issues arising with Distributed Real-Time Fault-Tolerant computing systems. The major output of this project are algorithms and protocols, as well as analytical models and behavioural/performance data.

The notion of distribution used in project REFLECS is that defined in the mid-70's, i.e. control of concurrent asynchronous activities in the absence of global system state. Obviously, we do not equate distribution with networking or openness. It is assumed that processes can exchange messages and that faults can occur at random. We consider crash, omission and timing failures. Under such assumptions, we are interested in proving the existence of specific properties, such as global safety or global liveness, whenever processes conflict with each other at run-time. With respect to real-time issues, the underlying premise of our work is that self-adaptive (or dynamic) solutions raise interesting research challenges and are those needed

to implement future systems. In other words, we do not assume full a priori knowledge of future run-time conditions.

Our work focuses on the following two areas :

- Communication

The channel multi-access problem is solved using contention-based protocols; several classes of such protocols have been devised for "conventional" channel speeds (e.g. Ethernet category), that are probabilistic or deterministic — possibly for wireless networks — as well as for "high-speed" channels (e.g. 1 Gbits/s). We have shown that contention-based protocols are best suited for rigorously satisfying timing constraints whenever systems exhibit some reasonable complexity.

- Computation

Concurrency control and reliable consensus algorithms, based on two different types of architectures, are being investigated: conventional ones and massively parallel architectures. One objective is to gain a better understanding of the possible merits of "optimistic" approaches.

In the area of *real-time*, we are investigating time-dependent scheduling attributes, such as time-value functions (TVF). Our current work can be summarised as follows:

- how to break the complexity (NP) of the scheduling problem; interesting polynomial heuristics based on TVFs have been developed
- how to integrate time-oriented scheduling, fault-tolerance and concurrency control; in other words, what are the appropriate algorithms that, for example, maintain process atomicy and meet process timing requirements.

On specific occasions, e.g. joint experimental work with users/manufacturers, prototypes are developed by Project REFLECS. ■

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Group Orientation in Distributed Systems

by Paulo Veríssimo

Increasing use of distributed systems, with the corresponding decentralisation of activities, stimulates the need for structuring those activities around groups of participants, for reasons of consistency, user-friendliness, performance and dependability. The concept appears intuitively in all flavours of distributed actions: when participants cooperate in an activity (eg. management of a partitioned database, distributed document processing or distributed process control), compete for a given activity (eg. distributed use of a resource), or execute a replicated activity for performance or fault-tolerance reasons (eg. replicated database server, replicated actuator).

Paradigms, algorithms and technologies to assist the solution of these distributed problems have been presented in the recent years (distributed synchronisation, replication and concurrency control, reliable group communication, multicast networking support). Building blocks for group activity have been studied in the past in pioneering projects such as the V-kernel or ISIS, and are currently the subject of great interest, illustrated by projects as the PSYNCH/x-Kernel, DELTA-4, IBM AAS, amongst others.

Encapsulation, modularity and diversity, fault tolerance and timeliness, may be provided by the combined notion of object and group. Different object groups in a system may be concerned with different activities, have different methods and properties, solve different problems in a harmonious way, allow for several domains of consistency and ordering to coexist, provide incremental levels of fault-tolerance, real-time, etc.

A generic systematics of group orientation in distributed systems is yet to be developed. We are currently addressing that problem at INESC, departing from our experience in DELTA-4, an ESPRIT project started 1986 and ended in 1991, where our team, in cooperation with other research teams, addressed the problem of groups in the context of distributed fault-tolerance and real-time.

The notion of group pervades all layers of a distributed architecture, from multicasting communication infrastructures and group communication protocols with diverse order, agreement and synchronism properties, to group management services, such as membership, replication and cooperation management. Measures of the passage of time are also paramount, taking several flavours, depending on the real-time needs, from timers to global time services built on top of approximately synchronised local clocks.

The concepts of group-oriented cooperation and information sharing are extremely relevant, from a number of user viewpoints. Two very diverse application fields illustrate that relevance: computer supported collaborative group working (CSCGW); distributed computer control systems (DCCS).

Computer supported collaborative group working has been a discipline of growing interest, in the measure where widespread, ever-increasing use of communications and distributed systems make its application in a large number of activities possible, both in local and geographically broad areas. Distributed computer control is a very challenging field in fast evolution. The target systems encountered in the process control area are an ideal field to explore the notions of direct distribution, concurrency and groups.

The essentially conceptual work of systematising group oriented programming will be validated by two projects in these two areas currently starting in our group. ■

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The GUIDE Project: a brief overview

by Sacha Krakowiak

GUIDE is a research project jointly conducted by IMAG (universities of Grenoble and CNRS), and Bull, who recently formed a joint research unit called Bull-IMAG/Systemes. GUIDE is also a component of the ESPRIT project COMANDOS (Construction and Management of Distributed Open Systems), whose aim is to develop a general object-oriented platform for distributed applications. Bull is the prime contractor of this project. The objective of GUIDE is to explore distributed computing based on a set of heterogeneous individual workstations interconnected by a high-speed local area network.

Two main application domains are document management and program development. The document management application (cooperative document editor) is developed in project Opera, a joint IMAG-INRIA project.

The initial development involves an Ethernet-based local network interconnecting about 16 workstations (currently Bull DPX-1000, DPX-2, Sun-3, DecStation 3100). Unix™ is being used both as a development system and as a support for an initial implementation.

Project overview

. Object model:
Objects are the vehicle for computation and for data storage. The object model is based on a separate definition of types (interface descriptions) and classes (implementations and instance generators). Several implementations of a type may coexist. Objects are created as instances of classes. Subtyping and subclassing hierarchies are defined, with simple inheritance. Conformity is statically checked; dynamic checking is also provided when necessary. A language has been designed to support this model.

Objects are persistent (they survive to procedure executions) and are named by uniquely defined references. An object may be composed of complex structures (an object can contain references to other objects). These structures may be distributed (although a single object may not).

. Computational model:
Objects are passive. Execution is supported by activities (sequential processes) which execute within jobs. A job provides a virtual addressing space where objects can be dynamically bound. A job can dynamically diffuse to several sites. An activity executes as a sequence of (synchronous) object invocations. Communication between jobs (and between activities within a job) is essentially by means of shared objects. Objects may contain synchronisation conditions to control their concurrent execution. Atomic objects and transactions are supported.

. Object memory:
The object memory is implemented as a two-level store. At the lower level, a Storage Subsystem (SS) is in charge of the long-term storage of persistent objects (there is no "file system"). At the upper level, a Virtual Object Memory (VOM) supports the execution of jobs (i.e. objects bound to jobs for execution are addressed in the VOM). Both VOM and SS are distributed. Objects are located within VOM and SS using their references. Location hints are used to speed up the search. The SS supports multiple copies, and versions.

Current status

By the end of 1991, a first version of the system was developed on top of Unix. It was designed to provide a minimum basis for supporting distributed applications, specified in terms of the model as quickly as possible, and to identify problems raised by the implementation of an Object-Oriented Architecture on top of Unix. A first implementation of the language has also been developed. The target language is C.

The design of a new version, based on the Mach 3.0 microkernel, was completed in 1991. Implementation is planned for 1992. ■

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Formal Specification and Verification of Distributed Systems at CNR

by Tommaso Bolognesi and Alessandro Fantechi

Researchers from CNUCE and IEI have been active over the last few years in the field of formal methods for the specification and verification of concurrent systems, in particular methods based on process algebras and temporal logic. The applications of such techniques to distributed systems have been tried extensively, and special attention has been given to the realm of communication protocols for distributed applications.

Standard Formal Description Techniques (FDTs) have been defined by ISO for the rigorous description of protocols and services developed in the OSI Reference Model. One of these techniques, based on process algebras, is LOTOS which, due to its expressivity and flexibility, can be used in general for the specification and development of reactive, concurrent, embedded, distributed information systems.

The aim of the ESPRIT II LOTO-

SPHERE project (No. 2304) is to define a methodology and to build support tools to favour a widespread use of LOTOS in these fields of application, throughout the whole software life cycle, from specification to implementation and testing.

CNUCE and IEI are two of the sixteen partners participating in this project. Their role has been vital in the definition of Correctness Preserving Transformations between different stages of a LOTOS specification in the software life cycle. They are also active in the design of tools to support the Transformations and tools which integrate behavioural equivalence verification with temporal logic verification.

This work has been carried out in collaboration with the University of Twente, the Polytechnic University of Madrid, INRIA and LAAS-CNRS.

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Parallelising Fortran

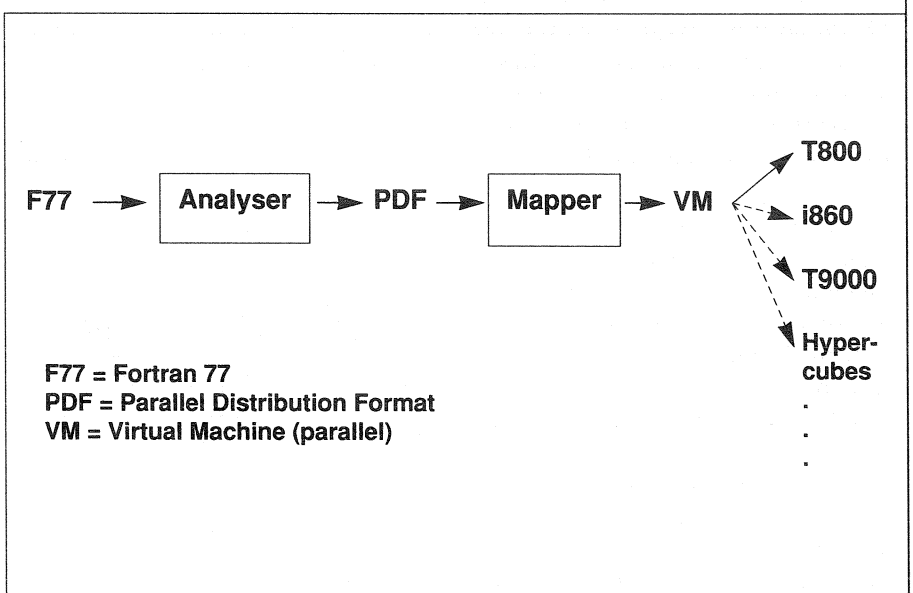
by Chris Wadsworth

Both computer scientists and users have long cherished the goal of a programming language that runs efficiently on all computers. Fortran was the first "high level" language and one of the earliest for which good compilers existed for a standardised language across a wide range of machines. Fortran also now serves as a medium of exchange, and has become the dominant language for scientific and engineering programming.

The advent of commercially-available vector and parallel machines from the mid-1970s onwards posed new challenges for compiler writers to exploit effectively the architectures and capabilities of these machines. Initially non-standard extensions to Fortran, in the form of compiler directives, were a necessary expedient and portability was lost. In the last five years or so research on automatic analysis and transformation techniques has matured rapidly. Good compilers for standard Fortran 77 are now available for vector machines and for parallel machines based on a shared memory architecture.

The BRIM project, named after its partners Brunel, RAL, Intercept, and Meiko, seeks to extend this to parallel machines based on a distributed memory architecture, such as transputer-based systems and hypercubes. A major objective of BRIM is to design and develop techniques for Fortran compilation that are scalable to larger numbers of processors, thus capitalising on the characteristic advantage of distributed memory systems over other parallel machines.

The Figure shows the overall structure of the BRIM compiler. The input is standard Fortran 77. The heart of the design is the use of an intermediate language PDF (Parallel Distribution Format). PDF serves as an interface between the Analyser, which recognises opportunities for parallelism in the source, and the Mapper, which generates code for the target parallel system. For portability the Mapper is designed to produce code for a parallel Virtual Machine capable of efficient realisation across a range of physical machines, including systems using transputers and i860 processors. The initial implementation is planned for T800-transputer systems. The project is on the point of testing its design and techniques on real Fortran programs.



BRIM compiler structure

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Environmental Mathematics - An interdisciplinary project at CWI

by Henk Nieland

Last year CWI decided to stimulate already existing interaction between several of its research groups by structuring part of the research into a number of interdisciplinary projects. One of these, Environmental Mathematics (project leader Jan Verwer), started up its activities in January 1992 with the first of a series of symposia entitled "Topics in Environmental Mathematics".

The subject of the first meeting was "Analytical and Numerical Aspects of Modelling Groundwater Pollution"; it was organized in cooperation with the National Institute of Public Health and Environmental Hygiene (RIVM) and IBM Nederland. The second meeting, envisaged for the second half of 1992, will focus on similar problems for the Atmosphere. The main aims of the project are to develop advanced mathematical methods for the environmental sciences, thus contributing to their strategic and applied multidisciplinary research, and to train young researchers in environmental mathematics.

Environmental research is multidisciplinary, involving scientific disciplines like meteorology, oceanography, hydrology, geology, biology, physics, chemistry and mathematics. Mathematical and computational techniques are essential in several simulation models for environmental problems. Such models occur for example in biosphere dynamics, population dynamics, hydrology, regional air pollution, global energy and climatic change, and the diffusion of toxic chemical compounds. Relevant mathematical and computational disciplines include numerical mathematics (e.g. computational fluid dynamics), image reconstruction, dynamical systems and chaos, statistics, optimal control, biomathematics and large-scale computation on super- and parallel computers.

The research plan for 1992 involves the following topics:

- Adaptive grid software for PDE's
- Numerical simulation (on a CRAY Y-MP) of brine flow for predicting the potential transport of radio-active pollutants
- Population biology of infections
- Theoretic and stochastic system properties of IMAGE (Integrated Model to Assess the Greenhouse Effect), developed at RIVM by J. Rotman
- Numerical analysis of IMAGE
- Removal of sensitivity to the initial state in climate models
- Algorithms for air pollution models, including a massively parallel model on a Connection Machine
- Stochastic modelling of transport problems in soils with non-uniform distributions of plant roots
- Pollution by sediment transport in shallow waters

Most of the projects are to be carried out in close cooperation with external parties. CWI is very much interested in a rapid extension of its research contacts in environmental mathematics. The scale on which several of the phenomena occur make this research a truly international enterprise. ■

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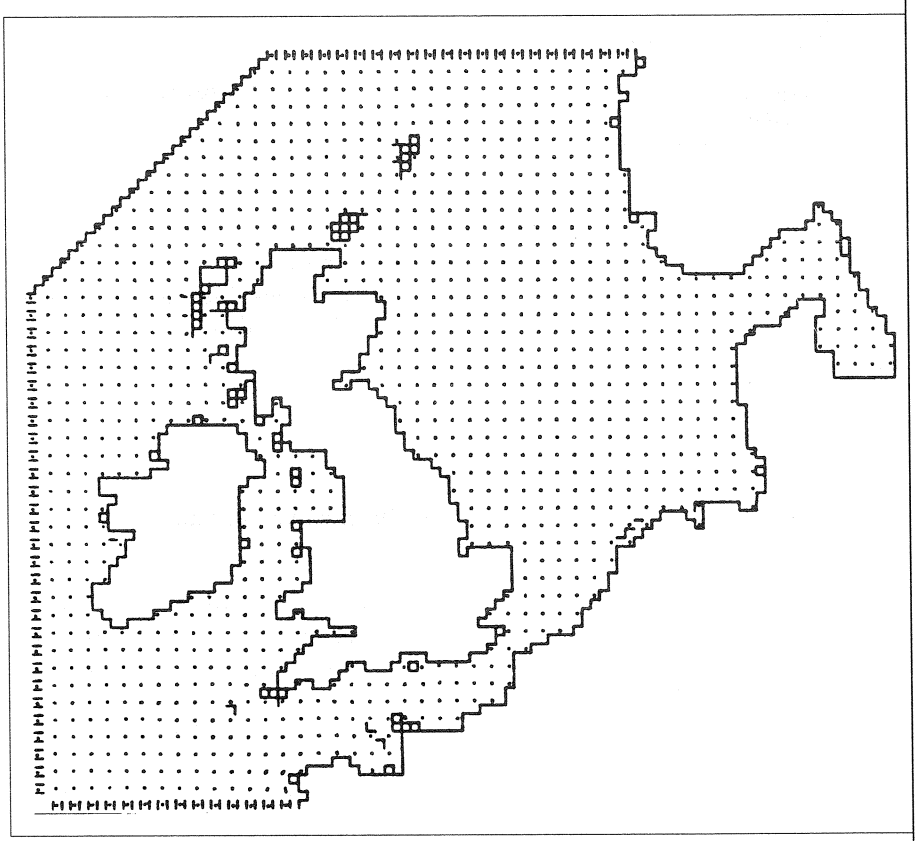

The North West European Continental Shelf is the stage of several large-scale environmental problems, such as water pollution, sediment transport and ecologic changes. Realistic mathematical models, solved numerically on high-speed, massively parallel computers may help in controlling those problems. Based on a 3D shallow-water model, developed at CWI, more detailed studies are envisaged in cooperation with the Tidal Water Division of the Dutch Water Control and Public Works Department. The picture shows part of the computational grid used in the current CWI model for computing tidal waves.

An Equational Reasoning System in Standard ML (MERILL)

by Brian Matthews

As part of the IEATP sponsored project on Equational Reasoning for Lotos Verification, RAL is developing an equational reasoning system (known as MERILL), in conjunction with Glasgow University. This system is inspired and influenced by the ERIL system previously developed at RAL, retaining such features as order-sorted reasoning, configurability, and user interface style, but is written in Standard ML, rather than the original Prolog.

At the current stage of development the system can perform equational reasoning tasks, (rewriting, unification, completion, theorem proving) in a framework of order-sorted semantics. Work is now continuing to extend the underlying logical system to allow reasoning modulo equations as well as modulo sorts, extending the capabilities of the system beyond the original ERIL system. At present, MERILL has a menu driven teletype interface.

Future plans for MERILL include: adding a tactic language to allow the user to set up and run provably correct equational reasoning tasks; the extension for more and more powerful ordering methods; adding forms of inductive inference (structural and completion based) within an order-sorted framework; adding a theory store to allow the proof of theorems over large scale systems; building a window based user-interface, using X-windows, to allow a greater ease of use of the system. Plans for the use of the system include the testing of properties of LOTOS specifications, experiments in parallelisation and the verification of properties and refinement in algebraic specifications.

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Numerical Automatic Quadrature

by Paola Favati

Researchers of the Computational Mathematics Group of IEI-CNR are currently collaborating with researchers of the Universities of Pisa and Trento in the field of numerical automatic quadrature. This research is financed by the CNR Special Project "Innovazione produttiva nelle piccole e medie imprese" with an overall annual involvement of three man years.

The numerical computation of integrals is a practical problem and there is much interest in general methods of computation and in software for numerical integration. An automatic integration program receives the following as input: the extreme of integration interval, the integrand function, and the absolute error tolerance specified by the user; and outputs the estimated error tolerance with the estimated integral value.

A non-adaptive automatic quadrature schemata consists in computing the error estimate and integral value more accurately by applying a family of integration formulas of increasing precision or compounding a fixed formula, until the user request is satisfied or some abnormal termination condition is verified.

The main drawback to non-adaptive quadrature is that the distribution of nodes in the interval is established a priori by the selected formulas. Thus, if a function presents some difficulties at a point (i.e. peaks or singularities), nodes will be added anywhere, whereas they are needed only in the neighbourhood of the difficult point.

This drawback is overcome by using adaptive automatic quadrature, which adds nodes in the neighbourhoods of difficult points. This technique needs a data structure, to store a partition of the integration interval with an error estimate and integral value for any sub-interval, and a local quadrature module, to compute the error estimate and the integral value for the general sub-interval. At any step, the sub-interval with the worst error estimate is bisected and the local quadrature module is applied to both new intervals, until the total error is less than the error specified in input or some abnormal termination condition is verified.

The aim of the research is to develop a global automatic adaptive program which results faster and more reliable than existing ones. A first important result has been achieved by introducing a family of interpolatory formulas with positive weights (called recursive monotone stable formulas (RMS)) that permits the composition without wasting previously computed functional values. Two globally adaptive integrators of QUADPACK: QAG and QAGS, have been improved by substituting the Gauss Kronrod rules in the local quadrature module by RMS ones. Extensive numerical tests have shown that the resulting programs are faster, perform less functional evaluations and are more reliable.

Some additional research is being conducted on local error estimate techniques and testing techniques to evaluate and compare automatic quadrature programs. At present, a theoretical study of the asymptotic behaviour of automatic quadrature programs is under way.

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Formal Modelling of Interactive Graphics Systems

by Giorgio P. Faconti

Research is currently under way at CNUCE in the formal modelling of interactive systems with the aim of developing a theory of interactive graphics systems, and a presentation of the theory in the form of a reference model.

Three specific topics are being addressed:

1.The specification, and the understanding, of the fundamental notion of interactor. A model of interaction is being developed based on a characterisation of the notion of interactor that has already been investigated using several notations and tools such as Extended CSP, Temporal Logic and LOTOS. A methodology is also being described to generate correct specifications of hierarchical interaction devices from high level constructs, implemented through a visual language.

2. The development of a common framework for interaction and graphics systems to be used to incorporate novel modalities. This part of the work is mainly based on the refinement of the Model of User Interface Management Systems (UIMS) set up during the Eurographics Workshop held in Lisbon in June 1990. The mapping between the I/O objects of the Lisbon Model and the characterisation of the notion of interactor has been defined and a methodology for the specification of Transformation Objects is being investigated to ensure system consistency.

3. The definition of a common reference model for graphics and for interactive systems. A Reference Model for Computer Graphics (RMCG) is being standardised within the ISO/IEC Committee responsible for computer graphics (JTC1/SC 24) and has just reached the stage of Draft International Standard. It provides a basic framework and set of concepts within which computer graphics systems and their relationships to other areas can be described. Here, the objective is to investigate in depth the capability of the RMCG to describe the process of interaction and its relationship with UIMS.

These activities have been included in a part of the AMODEUS project (Assaying Means Of Design Expression for Users and Systems), an Esprit Basic Research Action. The partners of CNUCE in the work package on system modelling are SERC/RAL (D.Duce) also an ERCIM partner, the HCI Group of York University (M.Harrison), and the Laboratoire de Genie Informatique of the Université de Grenoble (J.Couteaz). The project takes an interdisciplinary approach to interaction by considering the integration of user's and system's models and by focussing on the following objectives:

- the enhancement of the potential for future Information Technology by contributing to a systematic basis for designing interfaces that will be usable by their intended users for their intended applications
- the providing of the foundations for techniques that will support the effective design of usable interfaces to Information Technology systems.
- the reinforcing of interdisciplinary links by directly addressing the question of how different modelling approaches, drawn from different disciplines such as computer and cognitive sciences, can best be integrated to support interface design.

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Presentation of is-News

by Marlies Ockenfeld

Having enjoyed a strong positive interest, the first prototype of is-News was presented to the public. In the meantime the experimental system was demonstrated to many visitors of the GMD-Institute for Integrated Publication and Information Systems at Darmstadt.

Is-News, an experiment of the institute, is an example of a multimedia information product of the future. The first prototype was realised as a combined effort, with contributions from all the institute's research projects. The current prototype of is-News is a comprehensive hyperdocument in which seven components are integrated. The layout of a printed newspaper was chosen for the overall design of the user interface. So far, the applications available are a pool of articles, which can be searched according to specific user interest, a hypertext article on the Chinese room debate, searching and reading tools for retrieving information from external sources like international bulletin boards or public online data bases, a knowledge-based system for information on conferences, a dictionary, and — to prove multimediality — a pool of video clips, which can be selected by the user according to his interest and then played in a window on the screen in various ways, manipulated using a mouse.

Much interest has been shown in the prototype by experts from publishing houses, journalists, software houses, consultants, and the general public, too. A comprehensive description of the current is-News prototype was published in GMD Spiegel 1/91 (in German). Copies are available from GMD-Institute for Integrated Publication and Information Systems.

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GINA - Generic INteractive Application for Graphic User Interfaces

by Michael Spenke

Graphic interactive user interfaces make life easier for the user, but more difficult for the programmer. This fact has led GMD scientists to develop the "generic interactive application", GINA.

GINA is a runnable program with graphic user interface. It includes no application-specific functions. The object-oriented techniques employed are ideally suited for providing program sections which are identical in various applications in the form of reusable software. New applications are implemented by forming the specified GINA categories and overwriting certain methods. Only those functional elements of an application which are actually new need to be coded.

The standard functions of a typical application are predefined in GINA and are generically inherited. For example, commands for saving and loading documents and a general mechanism for cancelling and repeating commands are already included in GINA itself. This greatly simplifies the programmer's work, while also providing a uniform interface for a whole range of applications.

GINA is based on international standards, in particular the interface elements of OSF/Motif, a set of elementary blocks for graphic-interactive user interfaces. GINA integrates the performance features of the standards and provides them with complementary functionality. The Motif blocks such as "scroll bars", "menus" and "push-buttons" — the so-called widgets — are available as object categories. The GINA "Interface Builder" tool allows window building to be specified by means of simple drawing. The resources of the widgets can be adjusted using interactive boxes.

As shown by the example of a graphic editor, the Motif blocks are not usually sufficient for the implementation of a complete application. Additional interactive techniques, e.g. creating rectangles and manipulating objects with the mouse, are required in the drawing plane. GINA therefore includes predefined categories for programming direct manipulation techniques. By overwriting certain methods, the programmer can, for example, define a specific graphic feedback which will be displayed until the mouse button is released.

GINA exists in versions using the programming languages CommonLisp/CLOS and C++. The Lisp version is freely available, includes comprehensive documentation and is already being used worldwide by a number of leading pilot users. The C++ version can be demonstrated but has not yet been supplied to users. ■

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New Publication on OSF/Motif

Thomas Berlage from the GMD Institute for Applied Information Technology has written an important book for all application designers and developers who want to provide their UNIX programs with a graphical user interface.

The book with the title "OSF/Motif und das X-Window System" describes architecture and functionality of Motif and X and presents many examples of programs and valuable practical hints. The publisher Addison-Wesley has just published the work comprising of more than 400 pages in English, under the title "OSF/Motif - Concepts and Programming". ■

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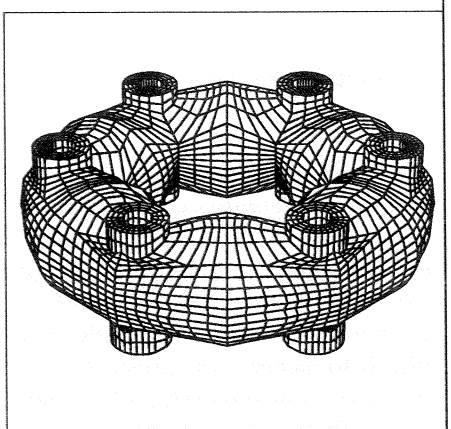
Mesh Generation Techniques

Due to the distinct shortage of suitable texts on mesh generation methods in finite element analysis, Paul-Louis George, a Research Officer at INRIA, has written the book "Automatic Mesh Generation - Application to Finite Element Methods", published by Wiley.



A Junction: mesh of the entire domain after recomposition of sub-meshes.

This book results from research performed in mesh generation by the author over the last few years. Readers are given a detailed survey of existing methods for mesh generation. Structured and unstructured meshes are considered in the different chapters which include numerous figures and application examples.

The book aims to be highly accessible and hope to appeal to students, researchers, as well as engineers working with finite elements.

This book is also available in French, published by Masson. ■

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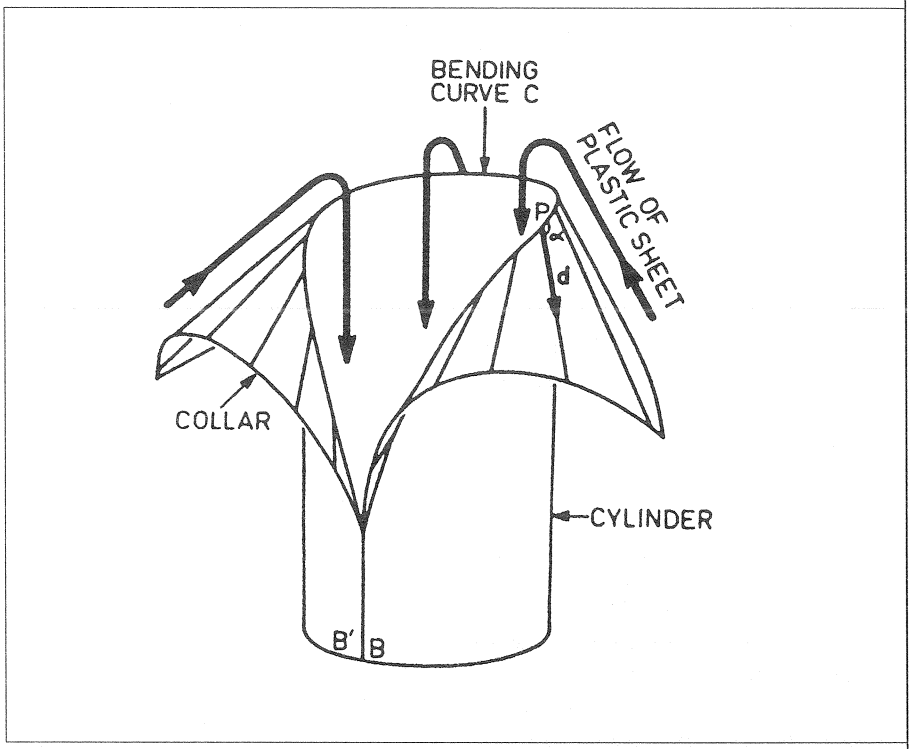
IWDE — Institute for Mathematics Consulting Eindhoven

by Jaap Molenaar



The "collar" forms an essential part of certain packaging machines. IWDE obtained the optimal solution for its design by non-standard techniques from differential geometry.

About three years ago the Faculty of Mathematics and Computing Science of the Eindhoven University of Technology founded the Institute for Mathematics Consulting Eindhoven (IWDE). The underlying idea is to increase the interaction between current research and industrial consulting. IWDE's primary task is the coordination and stimulation of contract research and contract education. The Institute maintains close connections with the University's post-academic two-years training course on mathematics applied to an industrial environment, and is involved in the European Consortium for Mathematics in Industry (ECMI).

IWDE deals with a great variety of mathematical problems in industry, mainly stemming from disciplines other than mathematics. Most problems require derivation and application of non-standard mathematics. As engineering companies are used to apply standard techniques in a restricted context, they usually do not know how to deal with such problems.

After deciding which mathematical techniques to employ in order to solve the problem under consideration, a contract with the company is concluded in which problem definition, mathematical knowledge and tools to be delivered, price, date of deliverance and secrecy agreements are settled. Usually a major part of the available time is spent on software development. Also much care is taken that the solution presented answers the original question and that the client can easily handle this answer in practice.

The modelling of most projects is done by IWDE staff (at present 2.5 positions), after which the projects are run by Faculty staff. Annually about ten problems are handled. Some examples of current or recently finished projects are:

- Analysis of Torsional Vibrations in a Crank Shaft
- Analysis of the Vibration in a Kettle Drum
- Design of an "Optimal Collar", an Essential Part of some Packaging Machines
- Derivation of Algorithms for the Driving Device of a Milling Machine
- Data Reconciliation in a Chemical Plant
- Acoustical Detection of Pollution in Chimneys

IWDE has recently started to organise courses on mathematical subjects relevant to industry, taking examples from real-life problems, where possible. Courses are given by experts from the University or from other ECMI centres. Until now courses were given on:

- Heat and Mass Transfer
(prof. S. McKee, Strathclyde, Scotland)
- Finite Element Methods
(dr. J.K.M. Jansen, Eindhoven)
- Design of Experiments
(dr. J.B. Dijkstra, Eindhoven)
- Inverse Problems
(prof. H. Engl, Linz, Austria)

Courses being prepared at present are:

- Spline Approximations
- Combinatorial Optimisation
- Industrial Noise Reduction
- Statistics in Industry
- Chaos Theory and Time Series Analysis

IWDE, Faculty of Mathematics and Computing Science, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands. ■

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INRIA reinforces cooperation with BULL

by Michel Banâtre

François Lorentz, General Director of BULL, and Alain Bensoussan, President of INRIA, signed an agreement in June 1991 to reinforce cooperation, which has existed for several years. This partnership is based on the conception and realisation of fault tolerant distributed systems, over a four year period.

The Board for Research and Advanced Programming at Bull and the Language and Parallel Systems team at INRIA/IRISA have been cooperating in projects GOTHIC and FTM during the last four years. Project GOTHIC has given researchers at IRISA the opportunity to implement the fault tolerant "stable memory" concept. The FTM (Fault Tolerant Machine) project applies this concept to weakly coupled multi-processor machines.

These studies are pursued, in particular within the framework of the FTM project and the new ESPRIT project, FASST, for strongly coupled systems. ■

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Project SYNCHRONE

by Albert Benveniste

Project SYNCHRONE aims at defining and realising a common basis for synchronous programming tools to lay the foundation for true normalisation. The objective is therefore, by using synchronous programming languages, ESTEREL, LUSTRE and SIGNAL, to realise a basis capable of being integrated into real-time applications development kernels.

Three research teams (INRIA-Rennes, IMAG and INRIA-Sophia) and four software houses (CISI and ILOG for ESTEREL, TNI for SIGNAL and VERILOG for LUSTRE) are involved in this project which is supported by CP2I (Circle for Innovative Projects in Informatics) and for which the first phase is financed by SERICS (Ministry of Industry) and DRET (Ministry of Defence).

Many industries, such as THOMSON, ALCATEL, ALSTHOM and DEC who constitute potential users, have already expressed their interest in this project. ■

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New Emphasis on German-American Cooperation

by Hans Klaus

GMD and the Virginia Center for Innovative Technology (CIT) have recently concluded agreements on scientific exchanges and cooperation in the fields of computer science research and knowledge transfer.

The aim is to exchange GMD scientists with the computer science faculties of universities in Virginia, represented by the CIT. The agreements also provide for information and visitor exchanges. At the same time, a contribution is to be made through the CIT to the Western European Program of the National Science Foundation, with researchers from Virginia being encouraged to submit applications for funding of joint projects with German researchers. GMD is named in the National Science Foundation Program as the official partner for computer science cooperation with Germany.

The CIT was established in 1984 by the state legislature of Virginia with the aim of promoting and implementing applied research in information technology and other high-technology fields through partnerships between universities and industry.

To mark the conclusion of the two-year framework agreement between GMD and CIT, the Governor of Virginia, Lawrence Douglas Wilder, visited GMD on 7 June, 1991, to sign the agreement together with the Director of GMD, Prof. Dr. Gerhard Seegmüller.

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Lawrence Douglas Wilder (left), Governor of Virginia, and Prof. Dr. Gerhard Seegmüller, Director of GMD, signing the agreement (Photo: Münch, GMD)

CWI tightens relations with CSIRO (Australia)

by Adrian Baddeley

A visit to CWI, end of September last year, by Dr. Ron Sandland of Australia's CSIRO (Commonwealth Scientific & Industrial Research Organisation) reinforced CWI's scientific relations with the Division of Mathematics and Statistics of this organisation.

These relations started with the appointment of Prof. Adrian Baddeley — a former CSIRO employee — as the leader of CWI's project on Image Analysis, and were followed by a number of CSIRO researchers visiting CWI. Since 1990, CWI participates with CSIRO in a consultation contract with ACIRL (Australian Coal Industry Research Laboratories). Dr. N.I. Fischer (CSIRO) and Prof. Baddeley are currently planning a pilot research project to analyse spatial patterns of fracture lines in mining areas (with the purpose of increasing safety and profit).

Dr. Sandland, Chief of CSIRO's Division of Mathematics and Statistics, presented his Division's work, which concentrates on computational fluid dynamics and process modelling, statistical process modelling and quality improvement, computer intensive statistical methods, signal and image analysis and software development. He was particularly interested in CWI's research in computational fluid dynamics, operations research, system & control theory, mathematical statistics and image analysis.

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The ICOT Management Committee at GMD

by Dieter Mönch

The Management Committee of the Japanese Institute for New Generation Computer Technology (ICOT) visited GMD on October 16, 1991, headed by Committee Chairman Sukeyoshi Sakai, and accompanied by ICOT's Executive Director Hiroichi Hisoshige and two Department Directors.

The visitors were welcomed by GMD's Board Chairman Prof. Dr. Gerhard Seegmüller, and briefed on recent developments on GMD's research teams, as well as on activities in the five new German Federal States in East Germany.

According to the special interests of the visitors, they were also informed on the procedures for funding and budgeting by Mr. Erich Kammerer, on GMD's industrial relations and technology transfer by Dr. Karlheinz Schunk, and on European Cooperation by Dr. Hans-G. Klaus. Each presentation led to intensive discussions.

ICOT, founded in 1982, is scheduled to finish its operations in early 1992. It is expected that a new institute will be founded in 1992 in relation with a new Japanese long-term R&D program for New Information Processing Technologies (NIPT) which is presently being prepared by the Japanese Government.

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Franco-Israeli Cooperation in Computer Science

by Pierre Népomiastchy

A cooperation, sponsored by the French Ministry of Research and Technology and the Israeli Ministry of Science and Technology, with a total budget of one million US dollars, was initiated in May 1990 with the following projects:

Optical Interconnects for Parallel Systems: P. Chavel (Inst. Optique) - L. Rudolph (Hebrew Univ.)

Specification and Verification of Real Time Systems: J. Sifakis (IMAG) - D. Harel (Weizmann Inst.)

Theoretical and Parallel Algorithms for Early Vision: M. Berthod (INRIA) - S. Peleg (Hebrew Univ.)

Parallelization Aspects of Nonlinear Differential Equations with Applications to Computational Fluid Dynamics: R. Temam (Univ.Paris-Sud) - M. Israeli (Technion Haiffa)

Integrated Distributed Computing: S. Krakowiak (Univ.Grenoble) - A. Barak (Hebrew Univ.)

Algorithm Design and Fault Tolerance in Computer Networks: M. Raynal (IRISA) - S. Zaks (Technion Haifa)

Development of Resource Allocation Strategies for Multicomputers Using Visualisations: B. Plateau (IMAG) & F. Andre (IRISA) - D. Zernik (Technion Haifa)

Dynamically Partitioned Dataflow in a Numerical Environment: P. Berger (ENSEEIHT-Toulouse) - I. Gottlieb (Bar Ilan Univ.)

Concurrence in Algebraic Specifications and Term Rewriting Systems: C. Choppy (Univ.Paris-Sud) - S. Kaplan (Bar-Ilan Univ.)

Analysis of New Schemes for High-Speed Local Area Networks: P. Nain (INRIA) - U. Yechiali (Univ. Tel Aviv)

Structured Design of Highly Parallel Self-Timed Systems: G. Saucier (INPG) - M. Yoeli (Technion Haifa)

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Australian-German Cooperation

by Bernd Krämer

The idea of starting a joint Australian-German research programme with a series of three workshops first arose during a visit to GMD and other German and European research institutes in May 1990 by an Australian delegation on microelectronics and software technology.

A group of six German scientists (five from GMD, one from Dortmund University) took part in Brisbane last year, in the first Australian-German workshop on aspects of software technology. The aim of the workshop was to explore overlapping research interests and draw up a short-term programme for joint research activities.

The highlight of the cooperation will be the presentation of the results at the "14th International Conference on Software Engineering" in Melbourne in May 1992.

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CALL FOR PAPERS

Third Eurographics Workshop on Visualisation in Scientific Computing

Viareggio, Italy, April 27-29, 1992

by Patrizia Palamidese

The workshop will focus on methodologies and technologies to handle visual information of natural phenomena generated by computer models or acquired by sampling devices; it aims at encouraging advances and promote discussion among visualisation researchers and users. The application domain ranges from geo-science, to fluid dynamics, physics, molecular modelling, and mathematics.

Suggested topics :

- multidimensional visualisation: scalar and vector fields, data structures and data management, volume visualisation, iconic visualisation;
- data interpretation: AI-based visualisation, object oriented systems, time dependent visualisation, mapping techniques;
- visualisation environment: distributed visualisation, application builders, real time visualisation, remote visualisation, multimedia environments for science;
- communication techniques: man computer interactions, interprocesses communications, intelligent interfaces;
- reference models and standards;
- applications and case studies.

Contributions:
The workshop will be limited to about 40 participants to encourage discussion. Selection will take place on the basis of full technical papers (10-20 pages). Participation may in some cases be possible through the submission of a position paper (2-4 pages) describing relevant on-going work.

Organisation:
The Workshop is organised by CNUCE-CNR and co-chaired by M.Grave (ONERA) and P. Palamidese (CNUCE).

Programme Committee:
L.A. Carpenter (UK), J.D. Cunha (P), J. Gallop (UK), M. Goebel (G), M. Grave (F), G. Grinstein (USA), L. Moltedo (I), P. Palamidese (I), F. Post (NL), R.M. Spitaleri (I), C. Vandoni (CH), P. Zanarini (I).

Deadlines:
1 February 1992 — Deadline for papers
28 March 1992 — Notification of acceptance and invitation

■

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email: patrizia@icnucevm.cnuce.cnr.it

CALL FOR PAPERS

Fifth International Workshop on Persistent Object Systems: Design, Implementation, and Use

San Miniato, Italy, 1-4 Sep. 1992

by Antonio Albano

The theme of the workshop will be the design, implementation and use of persistent object systems. The workshop will be held in a former Capuchin monastery, located in the countryside near Pisa. It will have an informal atmosphere with plenty of time for discussion, and the exchange of ideas and experiences.

Suggested topics:
Submissions are solicited in the following areas:

- Large scale persistent systems
- Persitent Object Stores
- Methodologies for persistent programming
- Architectures for supporting persistence
- Type systems and persistence
- Concurrency, persistence and transactions
- Tools for the management of persistent systems
- Compilers for languages supporting persistence
- Persistent and database programming languages
- Applications of persistent object systems

Contributions:
Four copies of the complete paper, in English, no longer than 20 pages and typed double spaced, should be sent to Ron Morrison by 3 April 1992. For full instructions on format of manuscripts and any other information, please contact either of the co-chairs: Antonio Albano (University of Pisa) or Ron Morrison (University of St Andrews).

Deadlines:
3 April 1992 — Deadline for papers
1 June 1992 — Acceptance notification
1 July 1992 — Camera-ready papers due

■

Please contact: Antonio Albano - University of Pisa
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email: pos5@cs.st-and.ac.uk

CALL FOR PAPERS

ESORICS-92

European Symposium on Research in Computer Security

Toulouse, France, Nov. 23-25, 1992

by Yves Deswarte

The aim of this symposium is to further the progress of research in computer security by bringing together researchers in this area, by promoting the exchange of ideas with system developers and by encouraging links with researchers in areas related to computer science, information theory and artificial intelligence.

Suggested topics:

- Theoretical Foundations of Security
- security models, contribution of models for knowledge representation
- contribution of formal logic and information theory
- formal development techniques
- Secure Computer Systems
- operating system security, network security
- security management
- virus and worms
- contribution of artificial intelligence
- contribution of new architectures and new technologies
- Applications Requesting Security
- data bases, knowledge bases, transaction systems
- process control, real time
- distributed applications
- Cryptography
- applications
- validation of protocols
- authentication: protocols, key management, processes
- Security Verification and Evaluation-
- formal methods
- measure and evaluation of risks
- measure and evaluation of security
- criteria
- Software Development Environments for Security
- Operation of Secure Systems
- management
- intrusion detection

This list is not exhaustive. Research papers, position papers and panel proposals will be welcomed.

Contributions:
Five copies of papers or panel proposals should be submitted to the program chair by April 3, 1992 at the following address:

Jean-Jacques Quisquater
AFCET - ESORICS-92
156, boulevard Pereire
75017 Paris
France

The texts must be submitted in French or in English. Papers should be limited to 6000 words, full page figures being counted as 300 words. Each paper must include a short abstract and a list of keywords indicating subject classification. Papers will be refereed and the final choice will be made by the Program Committee. Notification of acceptance will be sent by June 15, 1992, and camera-ready copy will be due on September 1, 1992.

Panel proposals should include title, proposed chair, tentative panelists, a 2 or 3 paragraph description of the subject, format of the presentation, and rationale for the panel.

Deadlines:
3 April 1992 — Submission deadline
15 June 1992 — Acceptance notification
1 September 1992 — Camera-ready copy due

■

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COURSE

1992 Multigrid Course at GMD

Bonn, June 22 - 26, 1992.

by Barbara Steckel & Wolfgang Joppich

A multigrid course will be given at GMD in Sankt Augustin near Bonn on June 22 - 26, 1992. The principal lecturer is Professor Achi Brandt from the Weizmann Institute, Rehovot, Israel, one of the pioneers of multigrid. The other lecturers are members of the GMD multigrid research group. The topics of this course will cover the basic principles of multigrid, recent developments and applications.

The main scope of the course is to provide an understanding of multigrid. The visitor will, at the end of the course, be able to write a multigrid program for model problems. Additionally, the course will supply with an overview of multigrid application and recent research activities. The course is especially designed for all those which have to solve partial differential equations in practice.

Multigrid, or more general multilevel computational methods have evolved into an independent discipline by itself, interacting with numerous engineering application areas and impacting fundamental developments in several sciences. The recent past shows an increase in the development of multilevel solvers for various areas, including: aerodynamics, atmospheric and oceanic research, structural mechanics, robotics, quantum mechanics, astrophysics, condensed matter, VLSI design, and tomography.

This enormous spectrum was opened by the following facts: The typical multilevel algorithm uses local processing on each scale of the problem, with inter-scale interactions. As a result, fine scales

can be employed very sparingly, and sometimes only in special or representatively small regions.

For scalar linear elliptic model problems the efficiency of multigrid algorithms was established at the very beginning of multigrid research. These methods turned out to be the most efficient techniques for solving elliptic partial differential equations. The theory states that a multigrid solution is generally obtained in a time directly proportional to the number of unknowns on serial computers. As indicated by the above examples, further research and development showed the potential of the multigrid principle which allows the application of multigrid algorithms and multigrid ideas to highly complex problems. The inherent locality of the multigrid components allows a very efficient parallelisation with nearly optimal speed up. Recent research activities have verified this for a wide class of parallel machines. ■

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CALL FOR PAPERS

GIS - From Space to Territory: Theories and Methods of Spatio-Temporal Reasoning

Pisa, Italy, Sep. 21-23, 1992

by Irene Campari and Andrew Frank

In recent years Geographic Information Systems (GISs) have evolved significantly, changing from refined cartographic processing tools to a set of scientific methodologies for the representation and analysis of spatial knowledge. Progress made in the spatial and cognitive sciences as well as the advancement of computer science, artificial intelligence, and database theory has led to some emerging theoretical developments in GIS. This conference is dedicated to spatial and temporal reasoning in geographic (or large scale) space, one of the core issues in GIS science.

Conference Themes and Scopes
The conference will concentrate on the following themes:

- Modeling of Spatial and Geographic Knowledge
- Formal Methods for Representing and Reasoning with Spatial Concepts
- Formal and Natural Languages for Describing Geographic Space
- Modeling of Environmental Psychology
- Human-Computer Interaction with Spatial and Temporal Data
- Interaction between Geographic Theories and GIS Methodologies
- Cultural Aspects of the Spatial and Temporal Cognition of Places.

The Conference will be sponsored by the CEC, Pisa University, U.S. National Center for Geographic Information and Analysis, IRPET, AICA, CISPEL, and CNUCE and IEI. Official languages will be English and Italian.

Notes for Authors
Full papers in English should be submitted by 3 March 1992 to either I. Campari or A. Frank. Authors will be notified of acceptance by 1 May 1992. Camera-ready copy will be due by 1 June 1992.

The first page of the paper should contain the title, authors' names, affiliations full addresses, fax and telephone numbers and e-mail addresses. It should also include an abstract. The total length should be approximately 18 pages double spaced (less than 6000 words) including figures and bibliography. ■

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SYMPOSIUM

Transputer Applications – Progress & Prospects

Reading, UK, March 30-31, 1992

by Susan Hilton

A 2-day Symposium will be held at the University of Reading, March 30-31, 1992 to mark the completion of an Initiative in the Engineering Applications of Transputers. This Initiative was coordinated by RAL and sponsored jointly by the UK Science and Engineering Research Council and the UK Department of Trade and Industry.

The programme will look at the achievements of the Initiative, focusing on successful Industrial Applications. It will explore the future prospects for the transputer approach to parallel processing, looking forward to the hardware and software technology of the next generation of transputers as we approach the year 2000. There will be presentations by leading figures from within the industry and an accompanying Exhibition by some of the most well known suppliers of transputer hardware and software.

The cost of the Symposium is heavily subsidised by the Initiative. For ERCIM members the charge is {Editorial Comment: pound sign} 60 per person which includes all fees, lunches, the Symposium Dinner and one night's accommodation.

Further details can be obtained from the contact below. ■

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COURSE

CWI Course on Wavelets

by Henk Nieland, CWI

Over 100 participants, coming from academic circles, large technological institutes and the industrial R&D sector attended the first CWI 4-day course on Wavelets, end-November 1991. After a general introduction to basic concepts and theory, the course focused on applications in image analysis, signal processing, numerical mathematics and fractals. Computer demonstrations and experiments were also included. The course was organised by the CWI Wavelets working group, which aims to study both its fundamental and applied aspects, as well as organise seminars, courses, etc.

Wavelets are special types of functions,used as basic building blocks to describe general functions, similar to the sine- and cosine-functions used in Fourier analysis. Wavelets are mathematically more complicated than those simple functions, but they are far more flexible. A complete set of wavelets is formed from a 'mother wavelet' by dilatation and translation. In most applications the mother wavelet is translated by integers and dilated by powers of 2, in which case a "father wavelet" also plays a prominent role. Generally speaking, a mother wavelet is a function oscillating within a certain interval and equal to zero elsewhere. Wavelets are used as a kind of "mathematical microscope" to analyse details of a given function (signal) on any desired scale.

Wavelets were invented about ten years ago by the French physicist Jean Morlet while trying to improve existing methods of analysing seismic signals in connection with oil exploration. Although by now the possible advantages of wavelet analysis are clear, the method is still too young to be widely applied. The most promising areas are image compression and the fast numerical treatment of (integral) operators. Wavelets now form a prominent topic at several conferences in (applied) mathematics. ■

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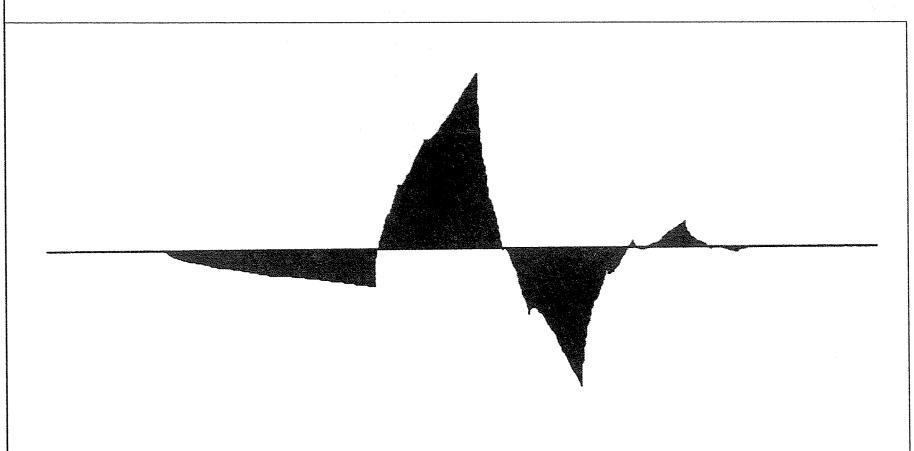

Daubechies mother wavelet D_4 with compact support. This wavelet can be applied in the field of data reduction. Noteworthy is its fractal-like shape.

SYMPOSIUM

German Know-How for Japanese Research Programme

by Wolfgang Giloi

The "NIPT '91 Symposium", the event launching the NIPT research programme, was held in Tokyo last year, with a large number of international delegates in attendance. NIPT stands for New Information Processing Technology Program, a ten-year research programme on the development of the massive-parallel computers of the future, which is to receive over DM 500 million in funding from the Japanese Ministry of International Trade and Industry (MITI).

Six specialist lectures, of which three were given by Japanese delegates and three by invited foreign researchers, provided the setting for presentation of the research programme at the two-day symposium. The foreign speakers invited were Prof. Michael A. Arbib, University of Southern California, Dr. Alan Huang, AT & T Bell Laboratories, and the head of the GMD Research Center for Innovative Computer Systems and Technology, Prof. Wolfgang K. Giloi, whose new concepts for programming models for massive-parallel systems are regarded by the Japanese as an important contribution to the project. MITI has invited GMD's Berlin Research Center to participate in the NIPT program. ■

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PEOPLE

Prof. Dr. Dionysios Tsichritzis (Photo: Münch, GMD)

GMD — **Prof. Dr. Dionysios Tsichritzis**, Centre Universitaire d'Informatique of the University of Geneva, was appointed chairman of the executive board of GMD. Tsichritzis (48) entered office on October 1, 1991. Before teaching at the University of Geneva, he worked for various international research institutions, e.g. as a professor at the universities of Toronto, Crete and Berlin. As author of well-known works of fundamental importance, Tsichritzis has built up an outstanding reputation throughout the international computer science community. Since 1989 he has been a member of the scientific advisory committee of GMD. Tsichritzis succeeds **Prof. Dr. Gerhard Seegmüller** who will return to his chair at the University of Munich. ■

CWI — **Dr. Adrian Baddeley**, leader of CWI's research group on Image Analysis, has been appointed part-time professor at the University of Leiden in Applied Mathematics. ■

GMD — **Prof. Dr. Norbert Szyperski**, Chairman of the Supervisory Board of GMD, gave up this post for health reasons at the end of his three-year term in April 1991. Prof. Szyperski has occupied various posts and fulfiled varying roles at GMD over a period of twelve years and was Director of GMD from May 1981 to April 1986. He has been succeeded as Chairman of the Supervisory Board by Undersecretary of State Dr. Werner Gries, Head of Department 4 (Information and Production Technology; Employment Conditions; New Technologies) of the Federal Ministry of Research and Technology. ■

GMD — **Prof. Dr. Gerhard Goos**, scientific-technical member of the GMD Board, gave up this position in June 1991 in order to resume more intensive scientific activities at the University of Karlsruhe. Prof. Goos had been a member of the Board since 1986. From July 1983 to June 1986, he was a member of the collective management of the GMD Institute for Systems Engineering. Simultaneously, he was Head of the GMD Research Unit for Program Structures in Karlsruhe. ■

ERCIM NEWS

European Research Consortium for Informatics and Mathematics

ERCIM

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