

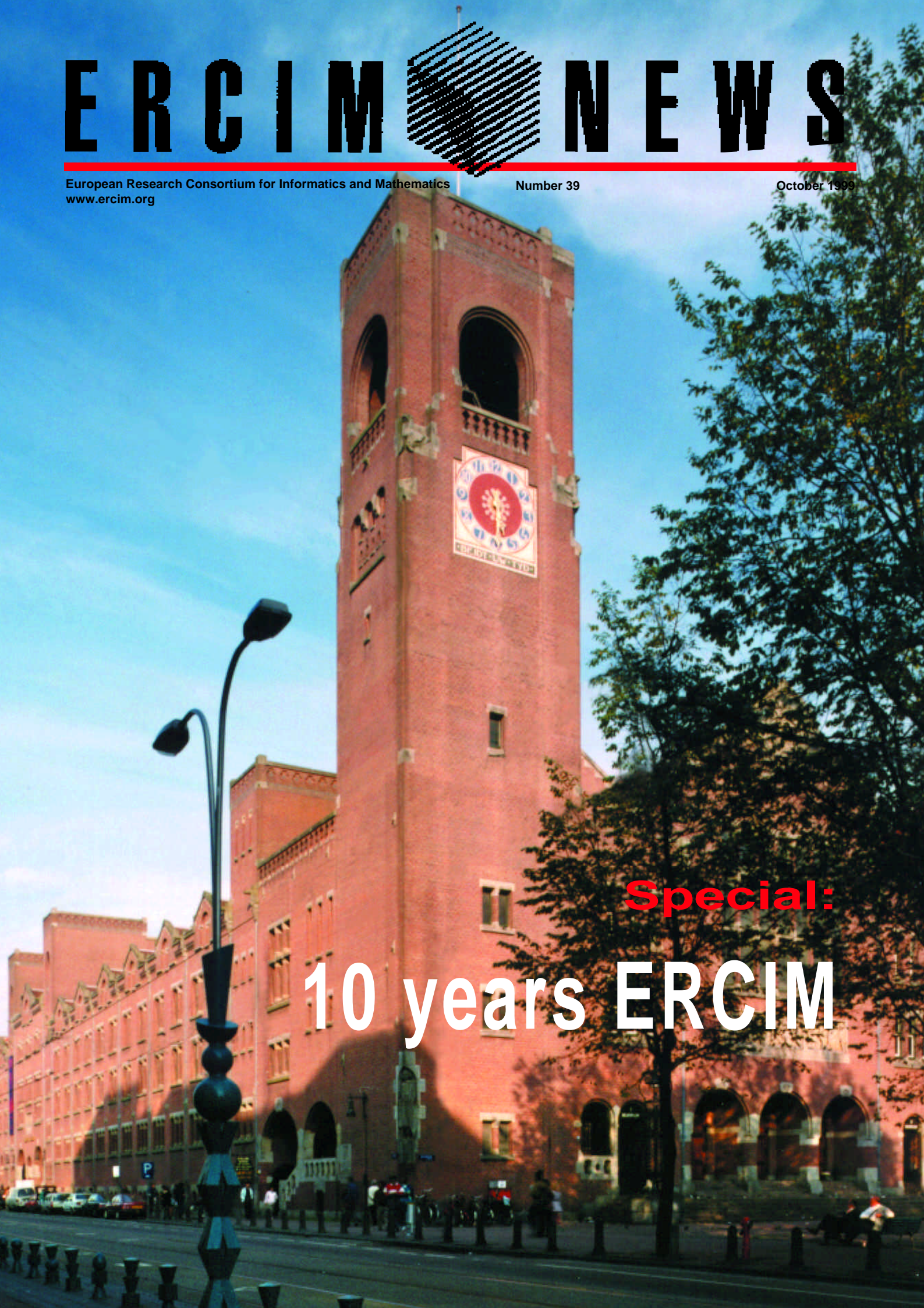
# ERCIM NEWS



European Research Consortium for Informatics and Mathematics  
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Number 39

October 1999



**Special:**

**10 years ERCIM**

ERCIM – The European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in the areas of information technology and applied mathematics. 14 national European research organizations are currently members of ERCIM.

ERCIM News is the in-house magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. ERCIM News has a circulation of 7,000 copies.

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# ERCIM: the Challenge of the Next Century

Gerard van Oortmerssen, President of ERCIM



**At the turn of the century ERCIM is celebrating its 10th anniversary and on this occasion it is appropriate to look back at the developments in our field, and look ahead, to determine the challenges that lie ahead of us.**

I think it is a privilege to live in this unique period, in which a digital revolution that pervades all areas of our existence is taking place. It started only 50 years ago, with the development of electronic computers. As the name suggests, they were designed to help us perform difficult or tedious computations. Gradually, the functionality increased, and computers now enhance various functions of the human brain: reasoning, perception, memory, etc. The combination with modern communication technology and internet gave a new impulse to the digital revolution, creating a world encompassing noosphere. It is truly amazing to watch the world wide web, cellular telephones, notebook computers and personal digital assistants conquer the world in just a few years.

It is tempting to make predictions about where this will lead to in a few more years, but technology forecasts are usually falsified by history. In 1943, Thomas Watson, chairman of IBM, said: "I think there is a world market for maybe five computers", and in 1981 Bill Gates stated: "640 K ought to be enough for anybody". Therefore, I will not even attempt to make this kind of forecast. Technological development will continue, but the final result is not only determined by researchers and developers, but also by the market, the people that use the technology. They will decide whether they want to use a single hand-held device that combines the functionality of a computer, an organiser, cellular phone, internet access, camera, and A/V remote control, or prefer separate devices which can mutually communicate. Naturally, the potential of new technology appeals to users. But choices that users make depend also on other, sometimes non-rational factors: ease of use, and confidence. The further development of electronic commerce, for instance, will very much depend on the perceived privacy

and security of payments. One trend is clear, however: most human-built products will possess embedded intelligence as well as the ability to communicate with other systems. Differentiation and integration increase at the same time: billions of distributed digital computers are integrated in a single communication network.

## What are the Trends in Information and Communication Technology Research?

During the first decades of the digital revolution, development was mainly driven by mono-disciplinary research in mathematics, logic and theoretical computer science. With the increase of complexity, the need for multi-disciplinary research has increased. A proper design of user interfaces requires co-operation with psychologists. Development of intelligent search engines requires co-operation of computer scientists with linguists and cognition scientists. Also, I am convinced that the life sciences will prove to be very important for further developments in our field – new developments in ICT may be inspired by principles of biological evolution.

Another trend that is evident among member institutes of ERCIM is the enhanced interaction between research and society. On the one hand this is a result of pressure from society to generate economic activity. This has led to increased co-operation with industry, and to the stimulation of start-up companies. On the other hand, the deployment of new technology creates new problems that have to be solved. The most illustrative example at this moment is the millennium bug.

Last but not least, internationalisation. Country boundaries are becoming less and less important. Transnational co-operation has been an important trend in business during recent decades. The world is truly becoming a global village. In Europe, co-operation among researchers as well as with industry, has been stimulated by the Framework programmes of the European Union.

ERCIM was founded with the objective of enhancing European co-operation among researchers in the fields of information technology and applied mathematics. During the 10 years of its existence, ERCIM has evolved into an effective network organisation which comprises an important portion of the European research community in ICT. Important activities are the ERCIM Working Groups, an overview of which you can find in this issue of ERCIM News, and the contracts that ERCIM carries out for the European Union and the World Bank. For the coming years, I see three important challenges for ERCIM. First, further develop ERCIM as a network organisation. This will of course mean extension of ERCIM with new member organisations in Europe. But ERCIM wants to be an open network, and therefore this also means increased co-operation with researchers from non-member organisations, and co-operation with research organisations outside Europe. Second, strengthen the role of ERCIM as point of contact and contract partner for the European Commission, other non-governmental organisations and multinational companies. And finally, increase the self-organising capacity of the European research infrastructure. The digital revolution brings the need for a strong, effective and efficient research infrastructure, which contributes to economic growth and well being of Europe. This requires the development of joint objectives, exploitation of existing strengths and joint actions aiming at minimising weaknesses. Over the last ten years, ERCIM has greatly enhanced communication and co-operation between its members. As a matter of course, this leads to co-ordination. Not as a top-down mechanism, but as a self-organising system. ERCIM is ready to meet the challenges of the next century, for the benefit of its members and of society. ■

**ERCIM 10<sup>th</sup> ANNIVERSARY EVENTS**



**The Beurs van Berlage in Amsterdam**

The ERCIM 10th Anniversary events consist of a number of meetings, coinciding with the ERCIM Fall Meetings. On the next pages details are given about the celebration events.

The site of the events is the historic Beurs van Berlage, Amsterdam, Damrak 243, the former Amsterdam Stock Exchange. This internationally renowned monument was built by H.P. Berlage from 1898-1903, and is one of the Netherlands' finest examples of modern architecture. The Beurs is conveniently located in the heart of old Amsterdam.

We look forward to meeting you there.

Up-to-date information on the events can be found at:

<http://www.ercim.org/10years/>

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## ERCIM – a Virtual Laboratory for IT Research in Europe

**4 November 1999**

The Internal Event on Thursday 4 November is targeted at ERCIM scientific and administrative staff. It consists of a mixture of some 20 presentations by ERCIM researchers and invited speakers about research related issues and state-of-the-art presentations, covering a variety of research areas. The internal event is set up to be an excellent occasion to meet other ERCIM researchers and to get acquainted with what is going on in other ERCIM institutes. All ERCIM personnel are invited to attend this event.

### Preliminary Schedule

<b>09.00</b>	<b>Registration, Welcome Coffee</b>	
<b>09.30</b>	Dennis Tsichritzis, GMD: The Changing Art of Research	
<b>10.00</b>	Bernard Lang, INRIA: Open Source Software	
<b>10.30</b>	Stelios Orphanoudakis, FORTH: Information Society Technologies in Healthcare	
<b>11.00</b>	<b>Break</b>	
<b>11.30</b>	Krzysztof Apt, CWI: Constraint Programming, or at the Crossroads of Mathematics and Computer Science	
<b>12.00</b>	Jan van Schuppen, CWI: Control and System Theory	Jan Friso Groote, CWI: On the Reliability of Software
<b>12.30</b>	Keith Jeffery, CLRC: Current Trends in Database Research	Health and Information Technology State of the Art
<b>13.00</b>	<b>Lunch</b>	
<b>14.00</b>	Tamas Roska, SZTAKI: Analogic Cellular Array Computing – A new Bridge between Computer Science, Computer Engineering, and Mathematics	Stuart Robinson, CLRC: W3C State of the Art
<b>14.30</b>	Pentti Kanerva, SICS: Stochastic Pattern Computing: A New Computing Paradigm for Artificial Intelligence	Aarno Lehtola, VTT: Engineering Multilingual Services on the World Wide Web
<b>15.00</b>	Yves Robert, Ecole Normale Supérieure Lyon/INRIA: Algorithms and Tools for (distributed) Heterogeneous Computing	Constantine Stephanidis, FORTH: Designing for "All" in the Information Society
<b>15.30</b>	<b>Break</b>	
<b>16.00</b>	Dominique Pignon, Ecole Normale Supérieure: Perspectives of Development of Virtual Reality and its use in Scientific and Technical Information, Museums and Education in Europe	Jussi Karlgren, SICS: Non-topical Factors in Information Access
<b>16.30</b>	Peter Kacsuk, SZTAKI: Metacomputing	Laurent Kott, INRIA: INRIA's Spin-off policy
<b>17.00</b>	Kristina Höök, SICS: Social Navigation and Unorthodox Views on Usability	Environmental Modelling State of the Art
<b>17.30</b>	<b>Drinks</b>	
<b>19.00</b>	<b>Evening Programme</b>	

**ERCIM 10<sup>th</sup> ANNIVERSARY EVENTS**

**Symposium: ERCIM  
Leveraging World  
Class R&D for  
Business and Society**

**5 November 1999**

Leaders from the fields of Information and Communication Technologies, Manufacturing, and Information Content will give their vision on the future of European R&D. The role of Europe in the future World Wide Web will be discussed with major players of the World Wide Web Consortium.

**Programme**

<b>09.30</b>	Coffee
<b>10.30</b>	Gerard van Oortmerssen, President of ERCIM: The Challenge of the Next Century
<b>11.00</b>	Heikki Hämmäinen, Vice President Nokia Networks: Towards the Mobile Information Society
<b>11.30</b>	Alexander Rinnooy Kan, BoD ING: Technology and its Impact on the Financial Services Industry
<b>12.00</b>	Lunch
<b>13.30</b>	Roger Needham, Director of Microsoft Research Europe: Microsoft Research – What and Why
<b>14.00</b>	Gottfried Dutiné, Director of Alcatel/SEL Germany: When Telecom and Internet converge
<b>14.30</b>	Jacques Louis Lions, Institut de France, Chairman of Comité 2000: The Future of Scientific Computation
<b>15.00</b>	Break
<b>15.30</b>	'Discussion on the future of the Web and Europe's role with Tim Berners-Lee (W3C) and Jeff Abramatic (W3C).
<b>16.30</b>	Drinks



**Gottfried Dutiné, Director of Alcatel/SEL Germany:  
'When Telecom and Internet Converge'**

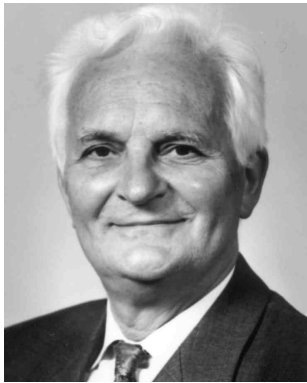
Gottfried Dutiné (1952) has a background in communications technology and received his PhD in that area from the University of Darmstadt. He joined Rockwell-Collins in 1979 where he moved up to the position of Director of Engineering. He then joined Motorola to become Group Director of Product Operations in the US, to be followed by several positions at subsidiaries of Robert Bosch GmbH. Currently he is chairman of the management board of Alcatel SEL AG, Area President Alcatel Central and Eastern Europe and Managing Director of Alcatel Germany.



**Heikki Hämmäinen, Vice President Nokia Networks:  
'Towards the Mobile Information Society'**

Heikki Hämmäinen (1958) gained his Master of Science degree in Computer Science in 1984 from the Helsinki University of Technology and PhD from the same university in 1991. He started his industrial career in 1991 at the Nokia Research Center as Group manager for advanced communication applications. In 1994 he became Head of the Laboratory for Communication Systems of Nokia. His current position is Vice President of Nokia Networks, responsible for Systems Development within the Network Systems Division of Nokia.

### ERCIM 10<sup>th</sup> ANNIVERSARY EVENTS



**Jacques-Louis Lions, Institut de France:  
'The Future of Scientific Computation'**

Professor at the 'Collège de France' since 1973 and ex-President of the Academy of Science, Jacques-Louis Lions graduated from Ecole Normale Supérieure in 1947. A mathematician specialised in system control and analysis, his work focuses on computer science and digital processing applied, in particular, to aerospace, energy, production, information and the environment. He taught as a Professor in Nancy and Paris. He was President of INRIA from 1980 to 1984 before being nominated President of CNES from 1984 to 1992. Jacques-Louis Lions, high scientific and space consultant for Dassault-Aviation, is president of a number of Scientific Councils. He is a member of many foreign and international academies. Award winner at the Academy of Science, he has received many prizes including the Japan award and the Harvey prize from Technion, Haifa.



**Roger Needham, Director of Microsoft Research Europe:  
'Microsoft Research – What and Why'**

Roger Needham has been in computing at Cambridge since 1956 where he graduated in 1961. In 1962 he joined the Computer Laboratory, then called the Mathematical Laboratory, and has been on the faculty since 1963. He took a leading role in Cambridge projects. He has also worked at intervals on a variety of topics in security, (his main current research interest) being particularly known for work with Schroeder on authentication protocols (1978) and with Burrows and Abadi on formalism for reasoning about them (1989). He was Head of the Computer Laboratory from 1980 to 1995, was made Professor in 1981, elected to the Royal Society in 1985, and to the Royal Academy of Engineering in 1993. He is a member of the Technology Foresight Panel and became Pro Vice-Chancellor of the University of Cambridge in January 1996. He became Director of Microsoft Research Limited in 1997.



**Gerard van Oortmerssen, President of ERCIM:  
'The Challenge of the Next Century'**

Gerard van Oortmerssen started his studies in Maritime Technology at the Technical University of Delft. After completing his masters thesis, he began his working career as a researcher at the Maritime Research Institute (MARIN), where he was later appointed Head of Research and Development. In 1976 he completed his PhD thesis at the University of Delft on computer simulations in hydrodynamics. As a researcher he (co-) authored 45 scientific publications. In 1991, he moved from MARIN to CWI as Managing Director. In 1994 he was appointed General Director of CWI. In 1998 he was appointed President of ERCIM. He is advisor for several start-up companies in the ICT field.



**Alexander Rinnooy Kan, BoD ING Bank:  
'Technology and its Impact on the Financial Services Industry'**

Alexander Rinnooy Kan started his career in mathematics and was a full professor of operations research at the University of Rotterdam in the early eighties. He then moved on to the directorship of the Econometric Institute and subsequently became Rector of the Erasmus University of Rotterdam. In 1991 he joined the national employers association VNO-NCW as chairman. Since 1996 he is a member of the Executive Board of the ING Group and heads the Executive Committee, responsible for ING's asset management.

ERCIM 10<sup>th</sup> ANNIVERSARY EVENTS

Demonstrations

4 and 5 November 1999

In conjunction with the presentations, demonstrations of current research will be given:

**AQUARELLE** – Sharing cultural information is the heart of the Aquarelle



vision. Aquarelle provides the users with facilities to produce multimedia folders conforming to the SGML and XML standards, as well as tools for searching information and browsing into the folders available on a network of servers over the Internet. Aquarelle also supports querying multiple museum database systems. The system conforms to a Z39.50 application profile defined in co-operation with the Consortium for the Computer Interchange of Museum Information (CIMI). Information at: <http://aqua.inria.fr/>

**PERSONA** – Tools for Social Navigation: Within the PERSONA project, four systems have been designed and implemented to deal with the problem of navigation through information space. One is the Agnet & Frida system, two characters that sit below the web browser and comment, ironically, their contents as the user browses the web. Another is the Social Navigator, a developers' set of tools that allows adding various social navigation possibilities to net-based applications. A third is the on-line store, EFOL, which incorporates social navigation into the domain of shopping for food. Finally, the Navigational Instrument is a computer-based method for evaluating applications early on in the design process. Information at: <http://www.sics.se/humle/projects/persona/web/>

**CY CAB** – Self-service vehicles for the cities of tomorrow. This new public



transportation system is based on a fleet of small electric vehicles specifically designed for zones with limited access to regular automobiles. CyCab is entirely under computer control and can be driven manually with a joystick, or can be driven automatically under various modes. It is being developed by INRIA with the assistance of EDF, RATP and Andruet S.A. Information at: <http://www-lara.inria.fr/cycaba/>

**W3C** – The World Wide Web Consortium, W3C, an industry consortium of over 350 organisations, jointly run at the W3C hosts MIT (USA), INRIA (Europe) and Keio University (Asia), was created to enhance the interoperability and promote the evolution of the World Wide Web. To enhance the communication between W3C and the Web community, W3C-Leverage Action opened six European W3C national offices, all located at ERCIM member institutes (RAL, GMD, SICS, FORTH, CWI, CNR) as the first point of contact between the Consortium and local W3C members, and also the general public, with an ongoing responsibility to organise local events. Information: <http://www.w3.org/>

**Virtual Reality for Scientific Visualization** – Scientific visualization is the use of computer graphics to create visual images that aid the understanding of complex, often massive, numerical representations of scientific concepts or results. Scientific insight into complex phenomena depends in part on our ability to develop meaningful three-dimensional displays. Virtual environments are interactive, head coupled computer displays that give the scientist the illusion of immersing into a

virtual world. The goal of our research is to construct virtual worlds in the hope that the scientist can get a better understanding of the problem under study. In this demonstration, we will show three examples of scientific virtual worlds. These examples stem from: computational fluid dynamics, cell biology, and the exploration of large data repositories on the Internet. Information at: <http://www.cwi.nl/~wimc/spotnoise.html>

**IMU – Integrated Publishing in Multimedia Networks** – VTT, together



with Finnish universities has developed a new type of publication system for TV-programs and newspaper articles. The integrated publication IMU includes features both from newspapers and TV. The publication is delivered using fast networks like bidirectional cable TV network. By combining the contents of databases from several newspaper houses and TV companies a continuously updated and personalized WWW-multimedia publication is created. The users read the publication from Internet on their PC with normal WWW-browsers. Information at: <http://www.vtt.fi/imu/>.

**THE SNAKE** – a robot for difficult inspection tasks. Movements in areas that



are difficult to reach require unconventional robots with usually complex kinematics. As an example of such an unconventional robot, a snake-like robot has been built by GMD's Biomimetic Autonomous Robots team. The goal of this development is to imitate the movement of a biological snake as closely as possible. The movement of a real snake is very flexible as it can be adapted to various

## ERCIM 10<sup>th</sup> ANNIVERSARY EVENTS

environments. Snakes are able to move on rough surfaces, they cross obstacles, and they can creep into areas that are very difficult to reach with any other kind of movement. This means that a snake-like robot with such properties would be an ideal inspection system (e.g. for tight tubes). Information at:  
<http://ais.gmd.de/BAR/snake2.html>

**ERCIM Technical Reference Digital Library (ETRD)** – a digital collection of the technical documentation produced by ERCIM scientists. The system enables the ERCIM scientists to make their research results immediately available world-wide and provides them with appropriate on-line facilities to access the technical documentation of others working in the same field. The intention is also to make the ERCIM digital collections available as testbeds for the validation of research in the DL domain. Information at:  
<http://www.iei.pi.cnr.it/DELOS/EDL/edl.htm>

**VEP – Visual Enabling for Precision Surgery** – a computer-based three-dimensional (3D) image guidance system for neurosurgical operations, supported by an interventional magnetic resonance imaging (MRI) system. Interventional MRI systems can generate intraoperative MR images which give important feedback for the precise positioning of surgical devices. One specific intervention technique considered within this project is laser-induced interstitial thermotherapy (LITT) where an optical fiber is implanted

within a brain tumor to be coagulated by laser energy. Technically the system will be realised as an augmented reality system combining various types of medical and synthetic images. The surgeon will experience the environment as a kind of interactive graphical 3D scene showing all relevant data for the intended intervention. Information at:  
<http://fit.gmd.de/hci/projects/vep/vep.html>

**MUSIC LAB of CNUCE-CNR** – The keywords characterising the activity of the Computer Music laboratory of CNUCE/CNR, Pisa, are man-machine interaction and real time gesture control. The computer interacts with the artist to produce music in many different ways. In order to achieve this, a special language called Real-Time Concurrent Pascal Music has been implemented. Using this language, a musical performance can be defined in terms of many procedures running simultaneously and interacting with the composition program during execution. Information at:  
<http://spcons.cnuce.cnr.it/music/cmd.html>



**The AVANTI Web Browser:** The AVANTI web browser has been developed in the framework of the AVANTI project that aimed to address the interaction

requirements of disabled individuals using Web-based multimedia applications and services. The resulting unified interface of the browser is a single artefact, in which adaptability and adaptivity techniques are employed, in order to meet the requirements of potentially all users. In the demonstration version, three user categories are supported: able bodied, blind and motor impaired. Information at:  
[http://www.ics.forth.gr/proj/at-hci/html/tools\\_avanti.html](http://www.ics.forth.gr/proj/at-hci/html/tools_avanti.html)

**DialWeb** – The Internet is increasingly used for distributing information and services via the World Wide Web. While information on the Internet today is typically presented via graphical browsers on fixed computers with large screens, telephony, especially mobile telephony, potentially offers more ubiquitous access via a new generation of browsers, including micro graphical browsers and voice browsers. The DialWeb project implements an information service (a music and concert event guide) which can be accessed through a telephone-based voice browser as well as through a conventional graphical browser. The project aims to develop guidelines for designing web services with multiple media interfaces, by evaluating how users interact with the concert guide service.

**A real-time, intelligent advisory system** – A new SCADA system was introduced in the 120/400kV Substation of the Paks Nuclear Power Plant. A real-time, intelligent advisory system was developed and embedded into the SCADA system to increase the reliability and safety of energy supply. The main functions of the system help in maintenance design, in management of alarm situations, in fast analysis of malfunctions and in fast recovery, in designing switching sequences, etc. These functions assist the operator in faster and more effective reactions, supports the management and the plant engineers to better understand and evaluate the whole system, and to improve planning. Information at:  
<http://www.sztaki.hu/sztaki/projects/html/g2paks.html>

## Prospective Reports

On the occasion of its 10th anniversary, ERCIM wishes to contribute to the development of a prospective vision on the future of Information and Communication Science and Technology research and related fields in Europe within a five-year framework. Following a call which was open to any European computer scientist or applied mathematician, ERCIM has supported the following reports:

- Algorithms and Tools for (Distributed) Heterogeneous Computing, by Yves Robert, CNRS, LIP, Ecole Normale Supérieure de Lyon/INRIA
- Designing for 'All' in the Information Society: Challenges Towards Universal Access in the Information Age, by Constantine Stephanidis, ICS-FORTH
- Network-based Distributed Computing (Metacomputing), by Péter Kacsuk and Ferenc Vajda, SZTAKI
- Perspectives for Development of Virtual Reality and its Use in Scientific and Technical Information, Museums and Education in Europe, by Dominique Pignon, Ecole Normale Supérieure.

The full reports are available on the ERCIM website at <http://www.ercim.org/>



# ERCIM – History, Overview and Outlook

by Eckart Bierdümpe

The increasing integration of Europe was the main driving force behind the foundation of ERCIM. In 1988, it became clear that action was necessary in view of the challenges and opportunities of the Single European Act. It was foreseen that development at governmental level would have a major impact on research management, strategies and structures in many fields of science. Thus, three national research institutions working in the fields of informatics and applied mathematics, CWI, GMD and INRIA, decided to unite forces in order to actively participate in and influence this process. They were convinced that, by combining their efforts and complementing each other's fields of research, they would improve their ability to satisfy the demands of the changing environment while, at the same time, enhancing their contribution to the research community and to Europe as a whole. Therefore, on 13 April 1989, the boards of CWI, INRIA and GMD signed an agreement defining the aims of a co-operation for strengthening research and development in the fields of informatics, information technology and applied mathematics. This signalled the birth of ERCIM, the European Research Consortium for Informatics and Mathematics.

ERCIM's policy of openness towards new members from other countries received a strong response and consequently the Consortium has grown considerably over the years (see Figure 1) In 1990 Rutherford Appleton Laboratory, UK, - today a part of CLRC joined ERCIM. In 1991 INESC from Portugal and CNR from Italy followed. 1992 SINTEF from Norway, FORTH from Greece and SICS from Sweden became new members. In 1993, AEDIMA from Spain and VTT from Finland joined, and in 1994 SZTAKI from Hungary and SARIT (at that time called SGFI) from Switzerland. In 1995, it was decided to call a momentary halt and to achieve consolidation as ERCIM

had been growing too fast. In fact, in 1996 ERCIM lost one member, the Spanish consortium AEDIMA which had consisted of too many affiliates and was consequently too loosely knit left ERCIM and was dissolved. On the other hand, in the same year, CRCIM from the Czech Republic and DANIT from Denmark were accepted by the Consortium. Due to domestic problems and a consequent restructuring, INESC left in 1998, while SRCIM joined as representative for Slovakia. Interest in joining ERCIM has been announced by Ireland and Austria and discussions are currently going on with representatives of research groups in Portugal and Spain. After the rapid increase in membership during the first

years, the policy is now to accept new members only moderately (a maximum of 2 new members per year), in order to ensure a better integration.

## Structure

ERCIM opted to constitute an EEIG (European Economic Interest Grouping), a legal institution promoted by the European Union. This was not an easy task as nobody had any experience in doing this. In some countries, the formalities were discussed with the respective Ministry of Finance, while in the UK even a formal ratification by parliament was necessary. Overall, it took longer than expected to establish the

Research institution	Country	Staff (fte)	Member since
CLRC Central Laboratory of the Research Council	United Kingdom	290	1990
CNR Consiglio Nazionale delle Recherche	Italy	800*	1991
CRCIM Czech Research Consortium for Informatics and Mathematics	Czech Republic	250	1996
CWI Centrum for Wiskunde en Informatica	Netherlands	210	1989 (Founder)
DANIT Danish Consortium for Information Technology	Denmark	80	1996
FORTH Foundation of Research and Technology – Hellas (Institute of Computer Science)	Greece	160	1992
GMD Forschungszentrum Informationstechnik GmbH	Germany	1250	1989 (Founder)
INRIA Institut National de Recherche en Informatique et en Automatique	France	2100	1989 (Founder)
SARIT Swiss Association for Research in Information Technology	Switzerland	800*	1994
SICS Swedish Institute of Computer Science	Sweden	80	1992
SINTEF Stiftelsen for Industriell og Teknisk Forskning ved Norges Tekniske Hogskole (SINTEF Telecom and Informatics)	Norway	350	1992
SRCIM Slovak Research Consortium for Informatics and Mathematics	Slovakia	180*	1998
SZTAKI Magyar Tudományos Akadémia - Számítástechnikai és Automatizálási Kutató Intézete	Hungary	350	1994
VTT Technical Research Centre of Finland (VTT Information Technology)	Finland	200	1993
<b>Total</b>	<b>14 countries</b>	<b>7100</b>	

Figure 1: Current members of ERCIM (\*estimation of staff in areas relevant to ERCIM).

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EEIG, but this was finally achieved in 1992. Some problems and disadvantages still exist: members from Hungary, the Czech Republic and Slovakia, and also from Norway and Switzerland cannot become members of the EEIG as their countries do not belong to the European Union.

ERCIM members discuss scientific and technical questions, prepare material for the Board of Directors and carry out its decisions as well as taking decisions on the every day business of ERCIM.

- **ERCIM Office:** The EEIG was registered in Paris as INRIA volunteered to host the ERCIM office. A team of 5 people is now running the office, and

of studies for the European Commission, e.g. on the Internet in the Mediterranean region, on Tunisian research in information technology, on Centres of Excellence in High Performance Computing in southern Mediterranean countries and on EU-China industrial co-operation in High-Performance Computing and Networking. ERCIM is currently evaluating proposals in the framework of the World Bank's InfoDev programme, aimed at improving conditions in developing countries with the help of IT. Furthermore, ERCIM is preparing an action to raise awareness among Latin American scientists and technologists of the opportunities related to the IST programme of the EU in the context of the 5th Framework programme.

### The ERCIM Fellowship Programme

The ERCIM Fellowship Programme was launched in 1990 to enable young scientists from around the world to perform research at ERCIM institutes. Applications are solicited twice a year with a deadline of 30 November and 31 May. The ERCIM Fellowship programme focuses on topics of interest identified by the ERCIM working groups. Ideally, a fellow will work for a total of 18 months in two ERCIM institutes, thus contributing not only to the work done locally, but also to cohesion between ERCIM partners and to the cross-fertilisation and co-operation between research groups working in similar areas in different laboratories. The fellowship scheme also helps young scientists to become involved in one of the ERCIM working group initiatives, to improve their knowledge of European research structures and networks and to familiarise them with working conditions in leading European research institutions.

### Working Groups

The purpose of an ERCIM working group is to build and maintain a network of ERCIM researchers in a particular scientific field. The working groups are also the focus of internal mobility within ERCIM (stay and work in another ERCIM institute for 1 to 6 months) and fellows under the ERCIM fellowship programme are mainly chosen under the auspicious of the co-operation in the working groups.

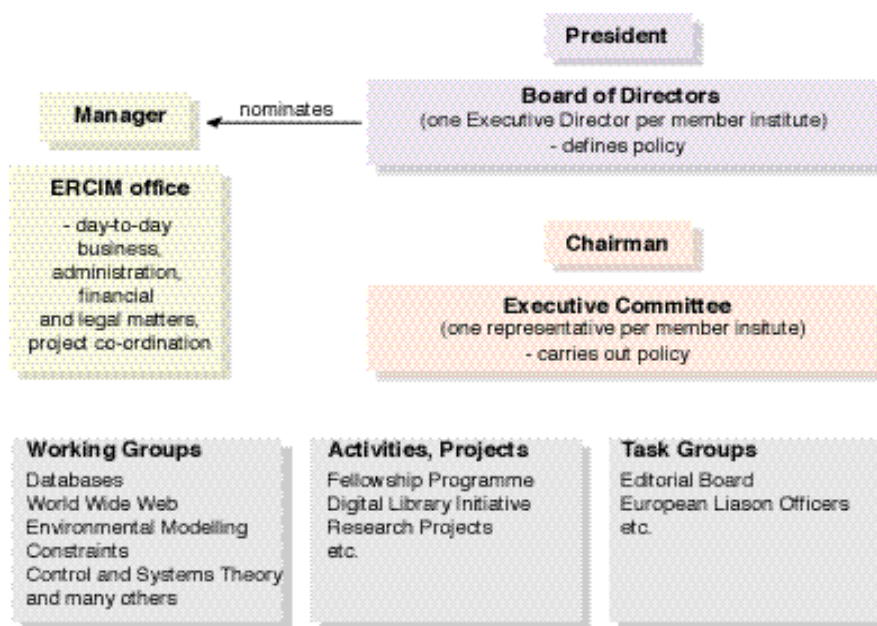


Figure 2: Structure of ERCIM.

Due to the decision to form an EEIG, some modifications in the structure of ERCIM were necessary (see Figure 2):

- **Board of Directors:** The Board of Directors consists of one Executive Director per member institute. They have to approve the final balance of the previous and the budget for the next financial year. Apart from these formal decisions the Board of Directors also decides on proposals made by the Executive Committee and on the general policy of ERCIM. The Directors elect one of the Board as President for a three-year period (currently Prof. Dr. Gerard van Oortmerssen, CWI), to formally represent ERCIM.
- **Executive Committee:** On the working level, the business of ERCIM is co-ordinated by the Executive Committee (again one representative per member). Its responsibilities include suggestions on the budget, decisions regarding the fellowship programme, working groups, etc. In general it is the committee where

dealing with all administrative issues of ERCIM.

However, ERCIM is defined mainly by its scientific initiatives. In addition to the work of the above-mentioned boards, directed at organising, managing and guiding research, the ERCIM projects, working groups and other activities are of great importance for ERCIM.

### Research Projects

ERCIM participates in a number of research projects as co-ordinator or associated partner. In these projects, several member institutes conduct the scientific activities while ERCIM is responsible for management tasks.

### Other Activities

ERCIM also undertakes studies, evaluations and offers consultancy services. ERCIM has carried out a number

For details on the activities of many of the working groups, see pages 12-29.

### Awards and Sponsorships

ERCIM is also promoting internal as well as external excellence and co-operation:

- **Cor Baayen Award:** This award for the most promising young researcher in computer science and applied mathematics was created in 1995 to honour the first ERCIM President. From this year, the award is open to any young researcher having completed his/her PhD-thesis in one of the fourteen 'ERCIM countries': Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Norway, Slovakia, Sweden, Switzerland, the Netherlands and the UK. The award consists of a cheque of 5.000 Euro together with an award certificate.
- **Working Group Award:** Starting from this year, ERCIM is giving an award of 20,000 Euro to the best working group of the year. This award demonstrates the importance of the working groups to ERCIM.
- **Conference and Workshop/Summer school sponsorship:** ERCIM sponsors up to five high quality internationally recognised conferences and six workshops or summer schools per year in order to demonstrate ERCIM's ties with important events in the area and to support them with up to 2000 Euro. With this financial support, for example an interesting speaker can be invited to the event.

### Review and Outlook

ERCIM today probably looks different from what its founders anticipated 10 years ago. It would go beyond the scope of this article to examine in detail into what has been achieved and what has not been possible for ERCIM to do, but some highlights can be mentioned:

- Representatives of ERCIM are increasingly and explicitly invited to participate in research policy preparing actions (example: shaping of the co-operation in the European research policy with the Mediterranean, preparation of the 5th framework programme.

• many European Commission officers are now aware of the existence of ERCIM and use its expertise. This covers the organisation of conferences (e.g. on the information society in the Mediterranean), studies (e.g. IT research in Tunisia) and also contracts to undertake initiatives for the EC (e.g. the initiative in Latin America mentioned above).

• Jointly organised international symposia and conferences have been held successfully both for ERCIM Institutes and as assignments on behalf of the EC.

• The Fellowship Programme has become an important part of ERCIM, and has contributed to the high awareness of ERCIM in the scientific community, ensuring that highly qualified scientists from all over the world contribute with their knowledge to the progress of research.

• The Cor Baayen Award has received a good response. We hope that opening it up to the whole research community of the ERCIM countries will further improve its visibility and help to identify young, bright European PhD graduates.

• The quarterly 'ERCIM News' has established itself firmly in the community and has become an important organ of ERCIM. An average circulation of 7.000 issues in more than 70 countries on top of the online edition are clear evidence of this.

• The number of ERCIM working groups has mushroomed since its modest beginning. It is a dynamic development with some topics (and thus working groups) phasing out over time, while others with new topics, covering new research areas, are being created. As long as the number of new working groups outnumbers the ones shutting down, we at ERCIM are confident that the working groups will remain the core of ERCIM.

It cannot be denied that with 14 current members and more to come there are problems in achieving consensus on every point, which may well increase as the number increases. The member institutes and consortia can be seen as representative of the IT scenario of their respective country. The diversity of the represented countries and consequently the diversity of opinions means that there is a permanent discussion on the right ongoing

strategy for ERCIM. Of course, there are sometimes tensions between the more application-oriented and basic research-oriented members within ERCIM. But the discussions always aim at the integration and the promotion of mutual goals in the interest of ERCIM.

Nowadays, on one hand ERCIM promotes research while on the other, it is becoming more and more involved in the process of European integration. It is fascinating to experience how some of the problems, but also the advantages of the European Union in the large context of society are duplicate in the smaller context of research and science. On reflection, this is not really surprising. Research as well as science cannot be seen as isolated from the social context. The social environment has an impact on science and research and this at the same time can affect the social environment - especially in the area of information and communication, which are closer to daily life than many other research areas. So after all, ERCIM can be seen as an association with a high social relevance.

Thus, the members of ERCIM not only determine how ERCIM will develop in future, but have their share of responsibility for the process of European integration. ■

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## ERCIM Working Groups

The purpose of an ERCIM working group is to build and maintain a network of ERCIM researchers in a particular scientific field. The working groups are open to anybody affiliated with an ERCIM institute. New working groups can be founded if researchers from at least three different ERCIM members are willing to co-operate. The workshops organised by the working groups are open to any researcher in the specific scientific field. The working groups are also the focus of internal mobility within ERCIM (stay and work in another ERCIM institute from one to six months) and the ERCIM fellowship programme. The Working Groups define the topics of the ERCIM Fellowship programme and the participating research groups have the possibility to host the selected fellows. Furthermore, one of the working groups, the Digital Library initiative has become a network of excellence, supported by the European Commission.

### ERCIM Working Groups:

- Digital Libraries
- Database Research Group
- W4G - World Wide Web
- Control and Systems Theory
- User Interfaces for All
- Formal Methods for Industrial Critical Systems
- Environmental Modelling
- Constraints
- Health and Information Technology
- Fluid Mechanics
- Electronic Commerce
- Programming Language Techniques

### Links:

ERCIM Working Groups:  
<http://www.ercim.org/activities/wg/>

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## The ERCIM Digital Library Initiative

by Carol Peters  
and Costantino Thanos

**The ERCIM Digital Library Initiative began in 1996 with the setting up of the DELOS Digital Library Working Group. The aim was to promote European research into the further development of digital library technologies, to stimulate the efficient and cost-effective implementation of digital library systems, to encourage collaboration between research teams working in the field, and to promote the transfer of knowhow and technology to the relevant application areas. We illustrate the main activities of the ERCIM DLI over the last three years, and discuss the intention to establish a forum for Digital Library activities in the future through the creation of a Network of Excellence.**

Digital libraries represent a new infrastructure and environment that has been created by the integration and use of computing, communications, and digital content on a global scale. However, to explore the full benefits of the digital library (DL), the problem for research and development is not merely how to connect everyone and everything together in the network but rather to achieve an economically feasible capability to digitize massive corpora of information from heterogeneous and distributed sources; then to store, search, process and retrieve relevant information from them in a user friendly way. Several driving technologies are now rendering the creation of such digital libraries practicable, i.e. multimedia information storage, retrieval, filtering, networked database systems, distributed computing, hypermedia, etc. The digital library domain is thus an essentially multidisciplinary area covering a range of research topics including interoperability, metadata, information access, multilinguality, intellectual property rights, economic charging mechanisms, preservation and security issues.

For these reasons, ERCIM identified the digital library sector as being an area of



particular interest to its member institutions and decided to sponsor its own Digital Library Initiative. The aim was to promote European research into the further development of digital library technologies, in particular to stimulate research activities in areas which are relevant for the efficient and cost-effective development of digital library systems, to encourage collaboration between research teams working in the field, and to establish links with on-going DL projects and activities in industry and other public and private institutions.

In order to support these activities, in spring 1996, the DELOS Working Group was launched. Most of the ERCIM institutions are members: CLRC, CNR, CRCIM, CWI, FORTH, GMD, INRIA, SZTAKI, SARIT, SICS, SINTEF; non-ERCIM members are INESC, the University of Michigan, and Elsevier Sciences. DELOS has been funded by ESPRIT Long Term Research (LTR No. 21057) within the Fourth Framework Programme of the Commission of the European Union.

### Main Activities of DELOS

During its three year lifetime, DELOS has undertaken an intense programme aimed at stimulating R&D in the DL area. The main efforts have concentrated on the organization of a series of thematic workshops, the formulation of a collaboration with the US National Research Foundation (NSF), the sponsoring of European Conferences for Research and Advanced Technologies in Digital Libraries, the creation of an ERCIM technical reference digital library service and the development of a test-bed collection for the experimentation of new DL technologies by ERCIM scientists. A publicly accessible Web site has been maintained providing information not only on the DELOS activities but also on DL initiatives and projects throughout the world (<http://iei.pi.cnr.it/DELOS/>).

### Thematic Workshop Series

Since March 1996, the DELOS Working Group has held nine workshops on research issues recognized as being of paramount importance to the DL community. Close ties with scientists of recognized value and with representatives of industry and user communities (from both European and non-European countries) have been established and their contribution has helped to make the workshops a success and has provided a springboard for the exchange of ideas. The following topics have been addressed: metadata and interoperability, multilingual information retrieval, image indexing and retrieval, collaborative filtering, preservation of digital information, electronic commerce, user interfaces, digital libraries and distance learning, audio-visual digital libraries. The Proceedings of the Workshop have been published by ERCIM; they are also available at the DELOS Web site.

### **National Science Foundation - European Union Collaborative Working Groups**

A digital library is the integration of multiple components which do not initially fit together in a seamless fashion for a number of reasons. Firstly, the necessary components come from a background of different communities and, secondly, they should enable new functions which were not considered when the individual single components were first designed and implemented. This means that the realisation of large-scale globally distributed digital libraries depends much on collaborative effort both across disciplines and across geographical boundaries.

DELOS, in collaboration with the US National Research Foundation, thus decided, to set up a group of EU-US working groups with the mandate to jointly explore technical, social and economic issues and plan common research agendas with respect to a set of key DL research areas:

- interoperability between digital library systems
- metadata
- intellectual property rights and economic issues

- resource indexing and discovery in a globally distributed digital library
- multilingual information access.

The groups studied the state-of-the-art and current trends in their area and produced a set of recommendations and priorities for future R&D activities. Each group met



**EU-NSF workshop.**

twice over a two-year period. These meetings served as a basis for the researchers to define critical research questions through which it is hoped that joint research proposals will emerge within the framework of the expected agreement for collaboration on DL issues to be signed by the EC and the NSF. The final reports of the Working Groups have now been released and are posted on the DELOS Web site.

### **European Conferences on Digital Libraries (ECDL)**

These conferences provide an important opportunity for European scientists interested in and/or now working on DL-related research issues to come together, compare and discuss their activities and results with colleagues from outside Europe. Major aims of the conference are to stimulate young scientists to explore new areas of interest in digital library development (through fellowships offered to young researchers) and to establish a forum for discussion of issues particularly relevant for Europe.

So far three very successful conferences have been organised: Pisa 1997; Crete 1998; Paris, 1999. An interesting trend is that, while at the first conference papers submitted mainly focused on research topics of relevance to DL applications, many of the papers submitted for the Paris conference discuss actual on-going DL experiences. This shows how real-world

activities in this area have increased over this short time span.

### **ERCIM Technical Reference Digital Library (ETRD)**

Towards the end of 1997, the decision was taken by the ERCIM DLI to create a digital collection of the technical documentation produced by ERCIM scientists and to provide on-line distributed public access to this collection. This service offers a similar service to that provided in the United States by NCSTRL, the Networked Computer Science Technical Reference Library. The aim is to assist the ERCIM scientists to make their research results immediately available world-wide and provide them with appropriate on-line facilities to access the technical documentation of others working in the same field. The intention is also to make the ERCIM digital collections available as testbeds for the validation of research in the DL domain.

The service runs on an infrastructure based on the DIENST system used by NCSTRL, which has been extended by the addition of new functionalities to meet the needs of the European IT scientific community. These include the adoption of a common metadata description standard, the introduction of common classification schemes and methods to manage them, and the implementation of interfaces for languages other than English. An author interface has been included to facilitate the insertion of new documents by the users themselves.

For more information on the ETRDL project and documentation on the system, see <http://www.iei.pi.cnr.it/DELOS/EDL/edl.htm>.

### **Results**

The ERCIM DLI within the framework of the DELOS DL Working Group has played an important role over the last three years in promoting the creation of a European Digital Library research community. It has provided a forum where a number of communities, i.e., libraries, cultural heritage, electronic publishing, electronic commerce, information infrastructure, software industry, etc. have had the possibility of collaborating

intensively with the DL research world, exchanging new ideas, experiences, and research results. It has succeeded in establishing strong collaborative links with the US DL research community, through the National Scientific Foundation (NSF), as well as with other research teams from countries outside the European Union (Russia, Czech Republic, Japan). It has also succeeded in arousing awareness within the European funding agencies of the priority DL research issues and has encouraged the creation and funding of DL projects.

## Future Directions

The efforts of the ERCIM DLI have helped to change the DL scenario in Europe over the last few years. The research community has grown in an impressive way and in many application areas there is an increasing awareness that the building of very large heterogeneous digital information repositories, interconnected and accessible through global information infrastructures, requires R&D in the digital library domain. We have, thus, an application and industrial context that favours scientific and technological developments in this area. We feel that it is very important to maintain this momentum. It is thus our intention to continue and extend the activities conducted by DELOS through the creation of a Network of Excellence for Digital Libraries.

This Network should play a key role in the evolving DL scenario. It can promote an international agenda for future research activities in the DL domain which takes into account the most recent developments in the field. It can constitute a point of reference for all the DL projects funded by the 5th Framework programme of the European Commission by facilitating the exchange of experiences, the testing of technologies, and the evaluation of models, techniques and approaches. It will involve the application community in the technological advances, and study and test appropriate models to facilitate industrial exploitation. It will also create a dense network of relations with other international DL communities.

In order to achieve these objectives, the Network intends to:

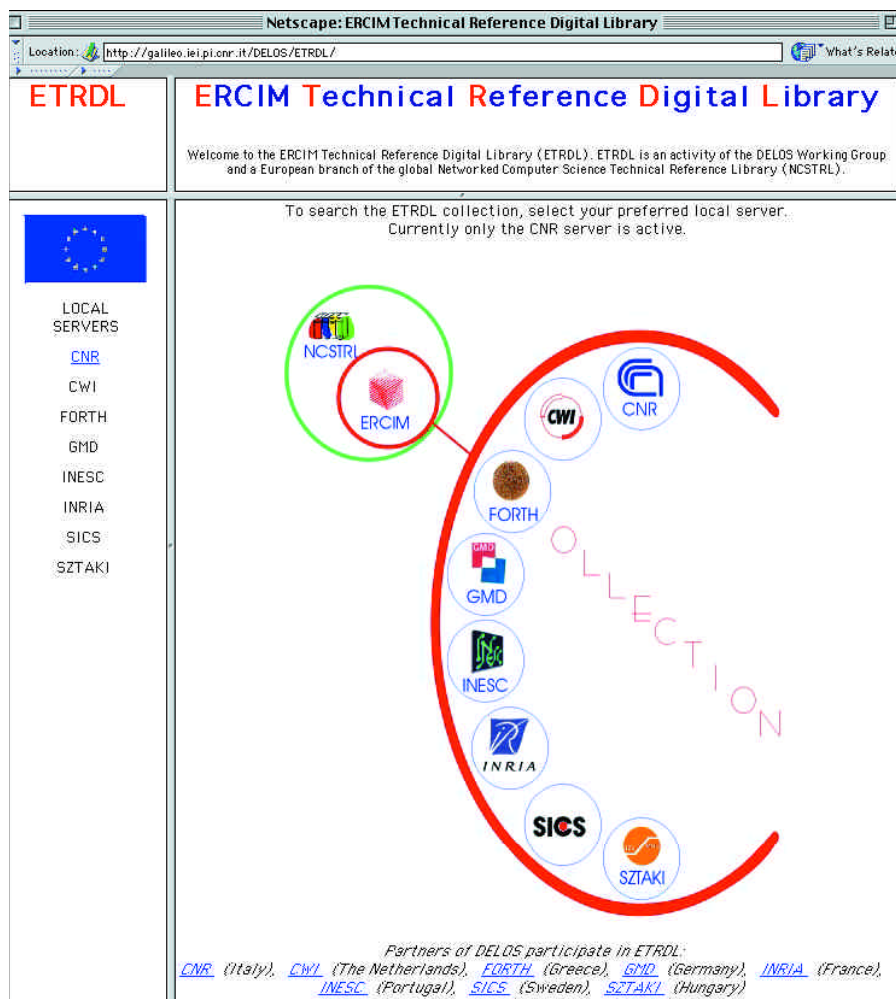


Figure 1: Web interface of the ERCIM Technical Reference Digital Library.

- Create a Digital Library Research Forum aimed at the advancement of research in the digital library domain through the organization of a thematic workshop series, European conferences, and an international research exchange programme.
- Stimulate the Development of Large-Scale Testbeds as experience has shown that progress on new digital library technologies depends on the availability of suitable testbeds (of images, video segments, maps, journal articles, scientific technical reports, etc.). The aim is to accelerate and enhance research in digital libraries and related areas by a number of collections available for research purposes.
- Organize Specific Advanced Education and Technology Transfer Actions through the promotion of summer schools, curriculum revision activities, and specific technology transfer actions in selected application domains.
- Create a Standardization Forum. A number of emerging Web standards will provide much of the basic architecture for digital libraries (RDF, Dublin Core, INDECS, DIENST protocols, UNICODE, XML, Z39.50, etc.). Many of these standards have just begun to move from research to deployment. The Network of Excellence will promote the constitution of working groups with the responsibility of (i) examining a specific cluster of relevant standards; (ii) effecting the transfer of research results into implementation while providing researchers with feedback on practical problems of deployment; and (iii) disseminating results in the form of workshop proceedings and reports, Web-based observatories, etc.
- Create a Cross-Language System Evaluation Forum. The volumes of information available over the global networks in languages other than English is currently increasing much faster than for English. Systems are needed to

access and manipulate this information. However, the implementation of multilingual interfaces and Cross-Language Information Retrieval (CLIR) systems implies the need for suitable methodologies and tools for the evaluation of multilingual system performance. In collaboration with NIST (US National Institute for Standards), the Network of Excellence will establish a forum for the study and discussion of multiple language information access technologies and for cross-language system evaluation.

- Coordinate International Cooperation in the DL Domain. The Network of Excellence will seek to establish collaborative actions with other research communities. In particular, the profitable cooperation with the US established by the DELOS WG will be extended under the NSF International DL programme and the expected cooperation agreement on DLs between the NSF and the IST programme of the European Commission; cooperations with Eastern European countries, South America and Japan will be stipulated in the context of specific agreements for cooperation between the EU and these countries.

#### Links:

**DELOS public website:**  
<http://iei.pi.cnr.it/DELOS/>  
**ERCIM Technical Reference Digital Library:** <http://www.iei.pi.cnr.it/DELOS/EDL/edl.htm>

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## User Interfaces for All

by Constantine Stephanidis

**This ERCIM Working Group was initiated in 1995 against the background of European R&D activities which had analysed the requirements, identified the viability, and demonstrated the feasibility of constructing ‘user interfaces for all’, i.e., interfaces which address the individual user requirements of potentially all users.**

It has been successfully argued that alternative, technologically more powerful and methodologically more systematic approaches are needed to tackle the problems of accessibility and quality of interaction for all potential users in the emerging Information Society. The challenge of this ERCIM Working Group is to plan a path that, apart from meeting certain technical objectives, will bring closer together researchers and teams working in the different ERCIM organisations (but also organisations beyond ERCIM or the European boundaries), who share common interests and aspirations, and would like to contribute to the endeavours towards making the emerging Information Society equitably accessible and usable by a diverse user population with different abilities, skills, requirements and preferences.

The proliferation of computer-based systems and applications in every walk of life and the anticipated widespread use of emerging telematic services has introduced new dimensions to the issue of human-machine interaction, necessitating the design of high quality user interfaces accessible and usable by a diverse user population. This user population at large, includes people with different cultural, educational, training and employment background, novice and experienced computer users, the very young and the elderly and people with different types of disabilities. Thus, it has become increasingly important to design human-machine interfaces, which not only support more efficient and effective user interaction, but also address the individual end user needs and expectations, while

exhibiting a wide range of ‘intelligent’ and ‘co-operative’ behaviour.

The field of HCI is particularly important to the issue of accessibility of Information Society Technologies by the broadest possible user population, as citizens in the Information Society experience technology through their contact with the user interface of interactive products, applications and telematic services. In the past, accessibility was primarily concerned with the selection of suitable equipment to enable alternative computer access, for people with disabilities. As a result, it was mainly considered as an afterthought and reflected a reactive approach, whereby Assistive Technology solutions addressed problems introduced by a previous generation of technology. This reactive approach entails primarily adaptations, which facilitate access to the interface via suitable mechanisms, (e.g., filtering), dedicated interaction techniques (e.g., scanning) and specialised input/output devices (e.g., Braille displays, switches, eye-gaze systems). Typically, the result of adaptations includes the reconfiguration of the physical layer of interaction, and when necessary, the translation of the visual interface manifestation to an alternative modality. For example, access to a Graphical User Interface by a blind user requires “filtering” of the contents of the screen, using appropriate software (e.g., screen reader), so as to present them in an alternative modality (e.g., tactile, audio). Despite the short term benefits that such a posteriori adaptations may bring about, there are serious shortcomings which render this approach inadequate in the long run; the programming-intensive approach towards accessibility increases the cost of implementing and maintaining accessible software, while rapid technological progress may render adaptations harder to implement, or obsolete by the time they are delivered.

The principle of Universal Access, which is gaining increased attention and support in recent years, articulates a new notion of providing access to all users. Along these lines the concept of User Interfaces for All has been introduced to convey a proactive approach to ensuring accessibility and high-quality interaction in human-machine communication, specialising and applying the principles

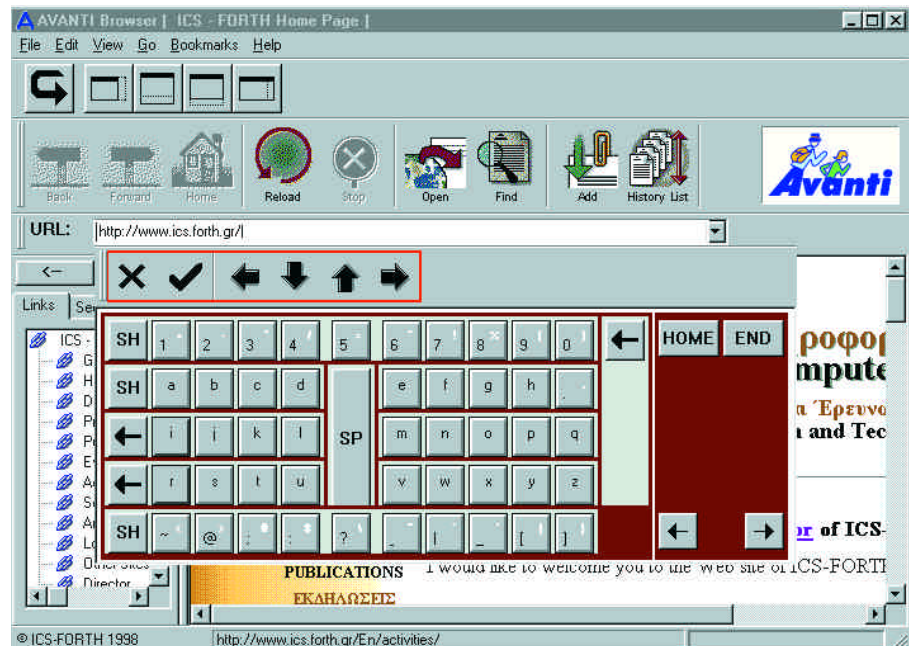
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of Design for All (or Universal Design) in the field of Human-Computer Interaction. The driving force behind the concept of User Interfaces for All has been the establishment of the theoretical grounds and the development of technological solutions that will facilitate the construction of user interfaces of services and applications, which are inherently accessible and usable by all potential user categories.

In this direction, the ERCIM Working Group on User Interfaces for All has initiated activities aiming to consolidate current practice and experience in the area of universal design. In the short- to medium-term, work can be directed towards the identification of key accessibility criteria or requirements to be met by products and services. These activities can be consolidated into an appropriate form that would guide subsequent efforts by both industry and academia, towards information products and services accessible and usable by the broadest possible end-user population. Furthermore, such activities can help industry to gain a renewed focus on the issue of universal design, and facilitate justification for the costs and benefits of alternative technologies. Additionally, they can stimulate new developments, and establish the ground whereby universal design informs and improves practice.

In this context, emerging technological advances can be exploited to design systems and tools which refine and extend the current state of the art in interface design, and support the development of user-tailored and (technological) platform-independent interfaces. This implies the development of user interfaces which can utilise the broad range of lexical interaction technologies and benefit from user-adaptability at design time and / or system supported adaptation at run-time (i.e., adaptive behaviour) according to the particular end-user abilities, requirements and preferences.

Given the trend towards interaction-intensive paradigms for human-computer interaction, future developments in user interface technology are expected to offer more opportunities and more empowering solutions. The introduction of 3D graphics, 3D audio technology, frame-



**Instance of the AVANTI Web browser automatically adapted for single switch-based use by motor-impaired individuals. Adaptations visible in this figure include:**

- (a) a window manipulation toolbar enabling users to minimise, maximise, restore, move and resize the window;**
- (b) on-screen keyboard for text input; and,**
- (c) the scanning highlighter, part of the automatically activated scanning interaction technique.**

works supporting large-scale collaboration and communication between users, interaction techniques based on alternative types of input (e.g., kinaesthetic), as well as issues related to ergonomics and human factors evaluation, can significantly contribute to the enhancement of the current state of the art in user interfaces. The interfaces of the future have the potential to provide the user with a virtual space, which will enable more flexible and natural communication with the computing environment or with other users, providing input and perceiving feedback by utilising proportionally all the available senses and communication channels, while optimising human and system resources. Meeting such a goal, however, requires considerable knowledge and understanding of user abilities and requirements, as well as of user tasks and the overall context of use. Furthermore, expertise in methods for describing and integrating this knowledge in the user interface design process is also necessary (user modelling, for instance, can play a crucial role in this respect).

An example of a successful case in developing a user interface that follows the concepts and principles of User

Interfaces for All, is the AVANTI Web Browser (see figure), which provides accessibility and high quality interaction to different user groups, including people with disabilities. The distinctive characteristic of the AVANTI Web Browser is its capability to tailor itself to the abilities, skills, requirements and preferences of individual users, the different contexts of use, and the changing characteristics of run-time interaction between the user and the system, employing adaptability and adaptivity techniques. The AVANTI Web browser was developed in the context of the ACTS-AVANTI AC042 project co-funded by the European Commission. The partners in this project's consortium were: ALCATEL Italia - Siette division (Italy) - Prime contractor; IROE-CNR (Italy); ICS-FORTH (Greece); GMD (Germany); VTT (Finland); University of Sienna (Italy); TECO Systems (Italy); STUDIO ADR (Italy); MA Systems and Control (UK).

This ERCIM Working Group has held a Workshop on the topic of User Interfaces for All each year since its establishment in 1995. Four workshops have been organised to date (the electronic



proceedings for all four workshops are available from <http://www.ics.forth.gr/ercim-wg-ui4all/>: 1st ERCIM Workshop on "User Interfaces for All", Heraklion, Crete, Greece, 30-31 October 1995; 2nd ERCIM Workshop on "User Interfaces for All", Prague, Czech Republic, 7-8 November 1996; 3rd ERCIM Workshop on "User Interfaces for All", Obernai, France, 3-4 November 1997; and, 4th ERCIM Workshop on "User Interfaces for All" Stockholm, Sweden, 19-21 October 1998. The workshops have attracted an international audience of researchers and practitioners sharing the vision of an inclusive Information Society and offering alternative perspectives into the issues involved and the possible approaches that can be taken to address them. The 5th ERCIM Workshop on "User Interfaces for All" is scheduled to take place in Dagstuhl (more information available from <http://fit.gmd.de/5-UI4ALL-Workshop/call.html>), Germany, 28 November - 1 December 1999.

#### Links:

##### UI4A web site:

<http://www.ics.forth.gr/ercim-wg-ui4all/>

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## Environmental Modelling

by Achim Sydow

**The purpose of the ERCIM Working Group Environmental Modelling is to build and maintain a network of ERCIM researchers in the field of environmental modelling and simulation. The working group is open to anybody affiliated with an ERCIM institute and dealing with environmental research. Since its establishment in 1995, the working group has undertaken a variety of activities in order to promote the cooperation and joint research activities of groups working in the field of environmental modelling and simulation.**

The research subject of the Working Group are environmental systems consisting of geophysical and geochemical elements, abiotic factor complexes (atmosphere, hydrosphere, pedosphere) and biotic elements (growth processes, population dynamics) which represent real complex systems. Information technology has succeeded in developing adequate tools for modelling, simulation, planning and decision support for environmental protection. As a result, education aimed toward transmitting an understanding of environmental systems is nowadays unthinkable without the use of computer techniques.

Considerable progress has been reached in a number of different research areas:

- in theoretical areas, the use of High Performance Computing simulation has brought spectacular results in systems dynamics (evolution strategies, logistic growth, chaos research)
- in climate research, the long term analysis of global change
- in economics and ecology, the considerations of sustainable development
- in mathematics, the development of powerful algorithms for integration and decomposition methods for parallelisation.

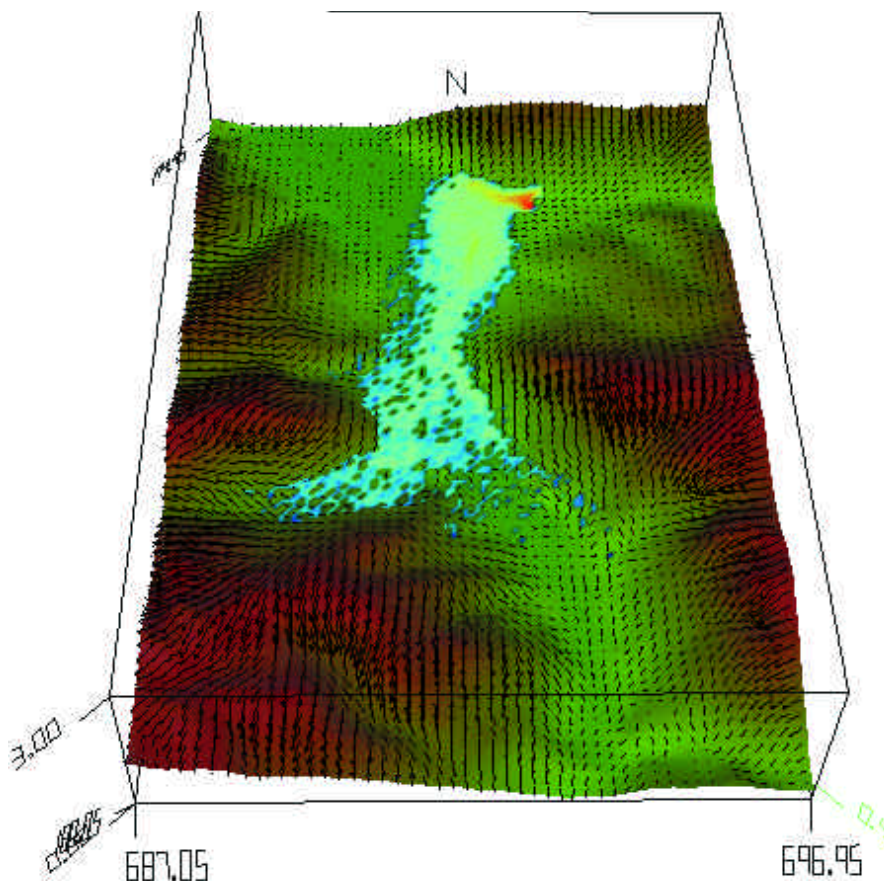
Interdisciplinary cooperation has benefited from computer networking. Parallel computation greatly assists in the efficient analysis of large scale and complex environmental systems. Weather and ozone forecasts are based on parallel computation. Visualisation techniques allow comprehensive overviews and thus assist decision support. Simulation gives numerical insight into the behaviour of complex environmental systems. Intelligent information technologies (neuronal nets, evolution strategies, expert systems) support modelling should relevant background structures from the natural sciences be unavailable. These information technologies can also assist data mining. Algorithms for optimisation and poly-optimisation provide a helpful aid for dealing with conflict situations which can evolve between the areas of ecology, economics and the needs of society.

#### The DECAIR Project

To date, the ERCIM Working Group Environmental Modelling has carried out five workshops. The sixth workshop is already in its preparation phase. Moreover the Working Group has submitted three joint project proposals. The joint project DECAIR (Development of an Earth Observation Data Converter with Application to Air Quality Forecast) is funded within the Environment and Climate Programme of the European Commission.

The DECAIR project aims to encourage the use of Earth Observation (EO) data as input data to atmospheric and air quality models, in order to achieve better simulation and forecast results. It is intended to develop a demonstrator used in a pre-operational context on two application sites: the urban areas of Berlin and Madrid. The specification of the demonstrator is performed by the customers in terms of data constraints (resolution, accuracy, freshness) and data access.

The demonstrator consists of the integration of different modules, some being already developed and tested by the members of the consortium. This integration process is the key aspect of the system and is flexible enough to take into



attention. Such a framework should allow the coupling of different environmental models for defined application problems using the so-called model-bus concept with a generic communication interface.

To date, members from eleven research teams of ERCIM institutions in eight European countries are collaborating within the Working Group. Based on an evaluation of the ERCIM Working Groups' achievements during 1998, the ERCIM Executive Committee selected the ERCIM Working Group Environmental Modelling as one of the winners of the ERCIM Working Group Award for 1998.

#### Links:

ERCIM Working Group Environmental Modelling: <http://www.first.gmd.de/applications/em.html>

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## Constraint Programming

by Krzysztof R. Apt

**The central notion in the area of constraint programming is a constraint satisfaction problem (CSP). A CSP consists of a finite set of constraints, which are simply relations over some domains. The task of constraint programming consists of formulating the initial problem as a CSP and of solving it by means of general or domain specific methods. 'Solving' can mean finding a solution, all solutions or the best solution with respect to some quality measure.**

The general methods are usually concerned with techniques of reducing the search space and with specific search methods. The main idea is to reduce a given CSP to another one that is equivalent (i.e., has the same set of solutions) but is easier to solve. This process is called constraint propagation and the algorithms that achieve such a reduction are called constraint propagation algorithms. So

### Simulated dispersion of Chlorine after an accidental release in the Swiss Reuss Valley.

account customers needs all along the development and exploitation stages, and to manage the risks of failure. The genericity is also an important matter: the system must be easily adapted to incorporate new converted EO data, and to be used for other simulation purposes. As DECAIR's objectives are concentrated on EO data conversion into air quality models data, this problem is addressed through the collaboration with existing European Commission projects, especially within the Telematics Programme.

An applicant has been accepted for the first ERCIM Fellowship within the framework of the Working Group Environmental Modelling. He had started his fellowship at the Working Group member team of INRIA Roquencourt on June 1998 and from March 1999 he has continued his fellowship at the GMD Institute for Computer Architecture and Software Technology in Berlin.

The fifth workshop of the Working Group Environmental Modelling, dedicated to

Information Systems for Environmental Modelling, was held on 3-4 June, 1999. It was organized by INRIA and hosted in Palais des Congrès, Versailles, France. The workshop attracted some 20 participants from six countries. The lectures and discussions focused on applications of information system technology for air quality monitoring, coastal zone management, hydrology and climate. The sixth workshop is planned for March 2000 and will be organised by Rutherford Appleton Laboratory, United Kingdom. The sixth workshop will deal with problems of data management related to environmental modelling such as data mining, data access through the Internet, coupling of models and data bases, updating of model calculation during run-time, etc.

In the near future, the initialisation of a new joint project will play a major role in the Working Group. First discussions about a new project took place at the fifth workshop in Versailles. The idea of developing a simulation framework for environmental applications received main

these algorithms reduce the search space and consequently attempt to limit the combinatorial explosion. Which type of constraint propagation is used depends on the initial choice of constraints and domains and on the applications. In practice several different constraint propagation algorithms were proposed.

In contrast, the domain specific methods are usually provided in the form of special purpose algorithms or specialised packages, usually called constraint solvers. Typical examples of constraint solvers are:

- a program that solves systems of linear equations
- a package for linear programming
- an implementation of the unification algorithm, a cornerstone of automated theorem proving.

This distinction between the general and domain specific methods is crucial and one needs to keep it in mind when studying constraint programming so that one does not apply general methods when efficient special purpose techniques are available. This distinction naturally calls for systems for constraint programming in which both the general and the domain specific methods are available. The former are usually present in the form of a built-in constraint propagation for a selected type of constraints and of specific constructs that support search, while the latter are often present in the form of various built-ins that allow one to call directly specific constraint solvers.

Problems that can be solved in a natural way by means of constraint programming are usually those for which efficient algorithms are lacking (for example computationally intractable problems) or for which formalization in terms of laws (for example electrical engineering problems) leads to a more flexible style of programming in which the dependencies between the relevant variables can be expressed in the most general form.

In fact, many computational problems are not precisely defined or their precise specification may depend on such factors as the time limit required for the generation of a solution. When solving such problems one usually needs to proceed by several iterations. Modelling

these problems by means of constraints can be often beneficial. Indeed, the appropriate modification of the program can then be often taken care of by modification of some constraints or by altering an appropriate fixed program component, for example the one that defines the adopted search method.

An additional aspect brought in by constraint programming is that modelling by means of constraints leads to a representation by means of relations. In a number of circumstances this representation allows us to use the same program for different purposes. This can be useful in several cases, for instance when trying to figure out which input led to a given output. In conventional programming languages relations have to be converted first to functions and this possibility is then lost.

The use of relations as a basis for problem formulation bears some resemblance to database systems, for instance relational databases. The difference is that in database systems such relations (tables) are usually explicitly given and the task consists of efficiently querying them, while in constraint programming these relations (for instance equations) are given implicitly and the task consists of solving them.

We can summarize the above mentioned characteristics of constraint programming as follows:

- the programming process consists of two phases: a generation of a problem representation as a CSP, and a solution of it; in practice, both phases can consist of several smaller steps and can be interleaved
- the representation of a problem by means of constraints is very flexible because the constraints can be added, removed or modified
- the use of relations to represent constraints blurs the difference between input and output. This makes it possible to use the same program for a number of purposes.

The ERCIM Working Group on Constraints was founded in the fall of 1996 in order to facilitate the dissemination of knowledge in the area of Constraint Programming between the ERCIM

researchers. In the meantime it comprises 14 ERCIM institutes. This shows substantial interest in this field.

The research within the group led to a number of scientific collaborations among members of different institutes and to a couple of joint research initiatives. So far three scientific meetings took place. The fourth one will take place this October on Cyprus. In April this year the group shared with two other ERCIM Working Groups the ERCIM award.

In the field of Constraint Programming techniques from Artificial Intelligence, Operations Research and Mathematical Logic are often combined. This leads to exciting new challenges. In particular, an ongoing research challenge consists in finding efficient constraint propagation algorithms that are tailored to specific constraints (such as the ones used for representing scheduling problems). On the programming side there is a continuing need to design and implement better constraint programming languages and environments. On the applications side one keeps finding new applications for this style of programming. Interesting recent examples include computer music and virtual reality applications. ■

#### Links:

**Working Group on Constraints:**  
<http://www.cwi.nl/projects/ercim-wg.html>

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# Research in Control and System Theory

by Jan H. van Schuppen

**Current and recent research in control and system theory are briefly discussed as well as the role of the ERCIM Working Group Control and System Theory in ERCIM.**

Where does an ordinary citizen encounter control? Control is experienced in processing of telephone calls, in car steering, in modern forms of information and control of motorways, in stabilization control of air planes, in orbit control of satellites for hand held phones and tv channels, etc. Almost all engineering products operate properly only because control is used to safeguard their proper operation and to optimize their performance. In the last two decades motivating control problems have arisen in control of high-performance communication networks, of motorway traffic, in air traffic control, of chemical plants, and in finance and insurance to name only a few areas. Control and system theory are highly relevant to the functioning of the Western industrialized societies.

At about half of the ERCIM institutes research in this research area is carried out in designated research groups while at other institutes control is sometimes integrated in research of computer science.

## Problems of Control and System Theory

What is control? Engineering systems require command signals such that controlled variables remain at a specified setpoint say. This function is called control. Control is also the name for a research area in which the design of controllers is studied at the engineering level and in which synthesis of controllers is studied at a theoretical level. System theory is the research area in which study is made of mathematical models for control and signal processing. Besides engineering, mathematics and computer science are the main academic disciplines used in control and system theory.

A system is a mathematical model of an engineering phenomenon that involves an input signal, an output signal, and a state function. The input can be commanded by a controller. The output refers to that part of the state function that can be observed and as such is available to the controller. At any time the current state and the current input value determine the dynamics of the state and the current output value. Systems are usually classified according to the spaces involved and to the equations that specify the dynamics. Thus there are linear, bilinear, polynomial, and stochastic systems depending on the character of the transition map.

Control is based on the principle of feedback. In the closed-loop system the output of the system is used by the controller to determine the input to the system. The control problem for a system is then to synthesize a controller such that the closed-loop system meets the control objectives. General control objectives include: stability of the state function, optimization of performance, robustness with respect to noise signals and poorly modeled dynamics, and avoidance of unsafe states. The engineering constraint of a controller that can be implemented with finite memory is essential.

Control and signal processing require mathematical models in the form of a system with finite memory. Consider a map from input signals to output signals. A realization is a system in a prespecified class such that the associated map from inputs to outputs associated with the system equals a considered map. The realization problem is to establish conditions for the existence of a realization. Furthermore, it also includes the classification of all such realizations. The system identification problem for a pair of observed input-output signals is to determine a system such that the input-output signals approximate the specified input-output signals.

## Current and Recent Research

There is a large body of literature on control of linear systems. In the last decades much attention has been given to robust control of linear systems. Currently there is attention for control of systems

with saturations and with space constraints such as linear systems for artificial neural nets. Motivated by coding theory, linear systems on groups are receiving renewed interests. Primarily motivated by mechanics, control of nonlinear systems has developed within a differential geometric framework. Other engineering areas lead to bilinear systems and to polynomial systems. Control of stochastic systems has led to a body of results for filtering and stochastic control. Optimal stochastic control with an exponential type cost function has led to results on robust control and to interpretations of large deviations. Problems of detection and failure diagnosis for stochastic systems and for discrete event systems motivated by engineering problems have led to theory and algorithms that are applied in wide ranging fields.

Realization theory has started with the work of R.E. Kalman for linear finite-dimensional systems. Since then it has been generalized to other classes of systems and from input-output maps to input-output trajectories. The behavioral approach to realization theory concerns the distinction of observed signals into input and output signals. Stochastic realization theory has been developed for Gaussian systems and finite-stochastic systems. For system identification of linear systems and of Gaussian systems there is a well developed theory for single-input-single-output systems. For multi-input-multi-output systems algorithms based on stochastic realization theory and on the singular value decomposition of numerical linear algebra are quite effective. The approximation problem of system identification takes inspiration from stochastic complexity theory which in turn is based on Kolmogorov complexity. Adaptive control of linear and Gaussian systems is well developed for single-input/single-output systems but there remain difficult conceptual problems for the multi-input/multi-output case. The interaction of control, state estimation, and parameter estimation needs more fundamental thinking.

Motivated by the use of computers for control, there has been developed a control and system theory for discrete-event systems. Modeling formalisms used include automata, Petri nets, process

algebras, and linear systems over the  $(\max,+)$ -algebra. This research benefits from interaction with theoretical computer science. Results concern control synthesis, hierarchical control, and failure diagnosis. Applications have been made in control of communication networks, manufacturing, chemical process control, road traffic, and air traffic control. Research for the class of hybrid systems is primarily motivated by the use of computers for control of engineering systems. The interaction between the discrete and the continuous dynamics is in some models so tight that these must be treated jointly.

**ERCIM Working Group Control and System Theory**

During a workshop at SZTAKI in Budapest, Hungary in November 1995 the participants decided that it was advantageous to their contacts to constitute an ERCIM working group. The organizational structure consists of teams at several of the ERCIM institutes and of a Steering Committee. The activities of the working group consist of bi-annual workshops, contacts about the ERCIM Fellowship Programme, and informal contacts on research. The achievements are the increased contacts between the teams on ERCIM matters and on research. Five of the nine teams of the ERCIM Working Group also participated in a series of EU sponsored research projects in system identification.

A list of the teams with their Steering Committee members follows:

- CNR - LADSEB Systems Theory Group in Padova, Italy (Andrea Gombani)
- CRCIM Institute for Information Theory and Automation (UTIA) in Prague, Czech Republic (Vladimir Kucera)
- CWI Research Group System and Control Theory in Amsterdam, The Netherlands (Jan H. van Schuppen)
- INRIA Research Group Meta2, Rocquencourt, France (Jean-Pierre Quadrat)
- INRIA Research Group MIAOU, Sophia Antipolis, France (Laurent Baratchart).
- INRIA Research Group on Signals, Models, and Algorithms, Rennes, France (Francois Le Gland).

**Control of motorway traffic**

The traffic intensities in motorway networks in European countries is so high that traffic queues are a daily phenomenon. Governments now promote the use of control measures to alleviate the most recurrent congestion. Control measures currently used or planned include: warning upstream traffic about traffic queues, ramp metering (access control on on-ramps), dynamic adjustable speed limits, information provision about the state of the network, routing control, and dynamic lane control. Routing control has been investigated at CWI as part of a European project in cooperation with road agencies, research institutes, and universities. Design of routing control requires fundamental thinking about the interaction of prediction and control. The appropriate formulation in terms of control theory is that of a dynamic game with the Nash equilibrium concept. Because of the complexity of the problem, approximations of the control law must be considered. A control algorithm for routing control has been formulated and evaluated by simulation at CWI. Actual implementation requires further development by the national road agency.



**Dynamic Route Information Board (DRIP) around the city of Rotterdam.**

- INRIA Research Group CONGE, INRIA Lorraine, Metz, France (Abderrahman Iggidr).
- SICS Division of Optimization and Systems Theory, Royal Institute of Technology, Stockholm, Sweden (Anders Lindquist).
- SZTAKI Systems and Control Laboratory, Budapest, Hungary (László Gerencsér).

**Research Perspectives**

Research in linear systems is likely to focus attention on systems with space constraints and on systems in algebraic structures. Research in positive linear

systems is expected to receive relatively more attention. It is motivated by modeling in biology, environmental modeling, and economics. Control and system theory of nonlinear systems will develop further with differential geometry and algebra. The class of polynomial systems is likely to develop with computer algebra packages. Control and filtering of stochastic systems is expected to grow in hidden Markov models and for stochastic systems with exponential families of probability distributions. Adaptive stochastic control needs further conceptual progress. Applications of stochastic control are likely to occur in mathematical finance and in communication networks. Control of discrete-event systems is likely

to progress in hierarchical and decentralized control so as to deal with complexity issues. Control of hybrid systems is expected to develop the interaction between the discrete and the continuous dynamics.

There is likely to be increased efforts in the development of software tools more so than in the past, not only for numerical computations but also for computer algebra or symbolic computations for linear systems, for control of discrete-event systems, and for hybrid systems.

The ERCIM Working Group will be most effective if the research leaders can have regular in-depth discussions on future research directions of their teams.

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## Working Group Fluid Mechanics

by Ullrich Becker-Lemgau

The ERCIM-Working Group on Fluid Mechanics was established in 1998. So far five ERCIM institutes participate in the working group:

- CWI, Computational Fluid Dynamics Group
- FORTH, Institute of Applied and Computational Mathematics
- GMD, Institute for Algorithms and Scientific Computing
- INRIA, research team M3M - Multi-Models and Numerical Methods
- SZTAKI

Two main research areas in the context of Computational Fluid Dynamics (CDF) were chosen to build the focus of the working group:

- Multidisciplinary Applications (coupling) and
- Shallow water equations (numeric, solver, applications).

As a first action a workshop will be proposed for the ERCIM 10th Anniversary Event, held in Amsterdam.

### Relevance of the Topic

Fluid mechanics has always belonged to the dominating application disciplines in high performance computing. Many fluid mechanics problems of high economic importance cannot be solved experimentally at all or only at a considerable amount of cost and time. The only suitable way of solving these problems is by computation. This has been recognized long ago by the fluid mechanics community. Correspondingly, this application field has always had a strong influence on the progress in developing numerical algorithms and new computer architectures.

Significant progress in this field has been achieved worldwide during the past years. Parallel application codes and innovative algorithmic approaches have been developed, which offer the possibility to further reduce the computing times for such computations. Due to this progress the numerical simulation of multidisciplinary problems has become possible.

### Objectives of the Working Group

Extremely high demands on designing accurate prototypes for example in the fields of medical research, aircraft construction, shipbuilding and automotive industries require multidisciplinary simulations. For instance heart valves, airfoils or power plants are exposed to powerful loads in their daily use due to the interactions between fluid and structure. This class of coupled applications opens a new dimension in scientific computing and engineering.

Many complex physical phenomena can be regarded as coupled problems. These are posed as a combination of at least two problems described by systems of partial differential equations. The computation of each single system is usually performed on different, connected domains, possibly with grids of different structures. Therefore, such phenomena are mainly simulated separately using different highly specialized codes.

After dramatic progress both in parallel software and parallel hardware technology, coupled simulations are close at hand. One approach is to solve the governing equations within one code. However, a drawback of this approach is that a completely new code has to be written. The time needed to develop such a code from scratch will be very large since the years of experience in all involved disciplines are not directly reused. Therefore the possibility of running loosely coupled problems using a coupling interface is a practical solution.

Such a coupling interface is already available: the Mesh based Parallel Code Coupling Interface MpCCI, which was developed by GMD-Institute for Algorithms and Scientific Computing during the last three years. MpCCI enables a loose coupling between existing and validated parallel simulation codes based on the Message Passing Interface (MPI) standard.

One of the main objectives of this working group will be research in the area of multidisciplinary applications. Possible topics will be numerics, algorithms, interpolation or industrial applications. MpCCI can be used as a tool or framework for joint projects with the ERCIM partners.

**Links:**

Fluid Mechanics Working Group:  
<http://www.gmd.de/SCAI/scicomp/ERCIM/fluid-dynamics/>

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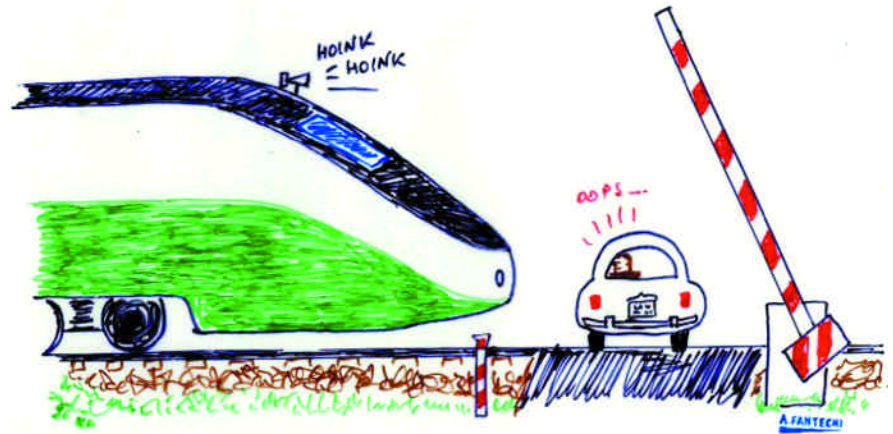
# Towards Reliable Computer Systems?

by Diego Latella, Stefania Gnesi and Hubert Garavel

Nowadays, society is highly dependent on computer systems and there is no doubt that in the near future complex, multimedia, computer-based systems will increasingly permeate our society and our activities, including the most critical ones. There is therefore a strongly felt need for higher quality computer systems, both from the reliability and from the performance perspectives.

The use of formal methods for the specification and verification of properties of systems is one methodological improvement of the system production process, which, together with other techniques, can make it possible to reach high quality standards. The study of formal methods for the specification, design, and analysis of distributed systems has been an important research topic over the past decade. Initially, the research in this area has concentrated on the dynamic, functional aspects of such systems, like their observable behaviour, control flow, and synchronization as properties in relative time. More recently, formal methods for the representation and analysis of functional properties in combination with quantitative aspects of system behaviour have come into focus. They allow for the specification of the delay of activities (or, actions) or the probability of actual occurrence of actions.

There is growing awareness of the importance of formal support for system development. This has reached the point that several regulatory and standards organizations are investigating ways to certify systems, in particular critical systems, and formal methods are beginning to play a major role in such activities. A direct implication of such a trend is that in the near future the use of formal methods will be part of the standard, or at least certified, development process in the computer industry. This is true in particular for those industries developing complex systems – such as



**Applications within the railway industry are complex and safety critical. Formal methods technologies have the potential to increase their quality.**

multimedia and telecommunications –and safety critical systems.

In order to be more directly applicable, formal specification and verification techniques and tools must reach a high level of usability in the near future. These were the underlying motivations which led to the setting up, in March 1996, of the ERCIM Working Group on Formal Methods for Industrial Critical Systems (FMICS).

The main objectives of the Working Group are:

- to bring together scientists mainly, but not only, from institutions within ERCIM, who are active in the field of formal methods and are willing to exchange their experience in the industrial usage of such methods
- to coordinate efforts in the transfer of the formal methods technology and knowledge to the industry
- to promote research and development for the improvement of formal methods and tools with respect to their usage in industry.

The above objectives have been pursued by means of a series of workshops and publications, by initiation of joint projects between ERCIM sites and by the ERCIM Fellowship Programme. Since 1996, four international workshops have been held (Oxford, 1996; Cesena, 1997; Amsterdam, 1998; and Trento, 1999). Additionally, four special issues in international scientific journals have been published. As regards industrial collaborations, the members of the Working Group are

particularly active. Examples of industrial applications are:

- verification of a surge storm barrier control system for Rotterdam
- verification of railway interlocking systems
- verification and test generation for high-end multiprocessor architectures
- specification and test generation for a telecom Corba platform
- automatic test generation for OSEK protocols in automotive systems
- interoperability testing of ISDN networks
- verification of telecom programs written in Erlang
- performance evaluation of an Internet audio tool
- proof-carrying code for Java Virtual Machines focusing on confidentiality properties of mobile code
- secure micro-payment on the Web only to mention a few.

From 1996 to 1999, the Working Group has been founded and coordinated by Diego Latella (CNUCE-CNR, Italy) and Stefania Gnesi (IEI-CNR, Italy). Since July 1999, the Working Group coordinator is Hubert Garavel from INRIA Rhone-Alpes.

**Links:**

**FMICS Web site:**  
<http://www.inrialpes.fr/vasy/fmics>

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# What's Next in Database?

by Keith G Jeffery

**This short paper attempts to encapsulate the thinking that has been going on in the ERCIM Database Research Group over the last 8 years. Of course, the members of the group are internationally known researchers and participants in communities covering their own special areas of interest, and so the group acts as a focus integrating many aspects of database (or more generally information intensive systems)**

The predominant technology today is relational. Founded on theoretical work by Ted Codd and others in the late sixties, the technology took 15 years to mature to market acceptability. However, much data processing still uses earlier hierarchic and network-structured (CODASYL) database systems and even file systems. Relational databases have several advantages:

- they are founded on solid theoretical principles
- they utilise predicate queries as opposed to navigational (what I want, not how to get it)
- there is a standard query language so interoperation is assisted;
- they are easy to use and a solid basis for advanced application (business or technical) systems

### The Factors

The major factors requiring a move forward from a relational basis are: Expressivity, Representativity, Distribution, Interoperability, and in a wider context (dealt with under 'Current Hot Topics' below): WWW-database integration, Metadata, Data Warehousing and Data Mining.

**Expressivity** – This is the feature that allows an end-user to communicate effectively with the information system. 'Where can I buy inexpensive but good coffee downtown?' is the user expression - this is a long way syntactically and semantically above anything SQL

(Structured Query Language) can express. Similarly, expressions involving the temporal dimension are handled poorly.

**Representativity** – This feature concerns the ability of the system to represent data structures and content adequately. Relational systems originally handled poorly data types such as text strings, multimedia content (e.g. images) and more complex data structures – the partitioning across relations (tables) is awkward for query and user-comprehension and has performance implications because of excessive joins. Relational systems - despite having a type date / time - represented inadequately temporal information, especially concerning temporally-defined versions of information.

**Distribution** – Distributed database technology has been researched for over 30 years. The move from mainframe and dumb terminals to client-server computing allowed a client to access multiple information servers and various proprietary and standard protocols emerged. Distributing a centrally designed, homogeneous database system for performance or in order to concentrate data processing close to the users is a well-known and understood technology, although some other non-functional aspects of the system design are less well understood. Relational theory, with horizontal and vertical partitioning of the database, provides a solid underpinning. However, replication for performance and synchronisation of updates across networks poses availability and performance problems not yet solved adequately.

**Interoperability** – A major requirement studied since the seventies is the need to interoperate information systems. The user at a client workstation requires apparently homogeneous access to heterogeneous, distributed information servers. The heterogeneity occurs in hardware / software platform, names of attributes, types of attributes, character set or medium of representation, language of representation, media types used, storage architecture, access architecture, data structure, query language, availability of information on precision, accuracy, domain limits and the semantics of the

data. Techniques of data exchange and data access have been developed, but much more needs to be done. The ubiquity of WWW has highlighted the need - user access to WWW information sources usually requires a multi-step process utilising the intelligence of the end-user to navigate and to resolve heterogeneity.

### The Solutions Emerging

**Expressivity** – Advanced user interfaces with graphical representations (draw what you mean by downtown) and advanced interaction based on user models, domain ontologies and dialogue models- utilising logic programming technology - are a topic of active research with products emerging. In the temporal dimension the latest SQL standard incorporates much of the R&D work over the past decade on temporal data handling.

**Representativity** – The object-oriented paradigm was intended to address the representativity issue. The use of object classes with inheritance of properties and the tight binding to methods that were class-specific allowed a direct connection between conceptual level modelling of an information system and the implementation. Versioning was included rather naturally, and complex data types were handles as specific classes - with associated methods. However, pure object-oriented systems – despite the excellence of some of them such as O2 developed at INRIA – have been less successful than expected due partly to performance problems. Furthermore, the tight binding of data and program (method) is in direct opposition to the trend of the last 30 or more years to separate them to allow maximal flexibility and re-use.

**Distribution** – Advanced R&D work on transactions, locking and commit over the last 15 years has produced excellent products. However, there are still some remaining problems of integrity especially with large multimedia objects when a 'check-out, check-in' transaction style with reconciliation of any synchronous updates is required to avoid lengthy 'hangs' while another user is updating. Such technology also requires version handling; this is particularly difficult with



an object instance that has many sub-object instances of different versions. Typical application areas are CAD (Computer-Aided Design), office systems and multimedia editing.

There are no tools yet developed that distribute a database system reliably taking into account all the factors, such as network bandwidth, network reliability, performance, security, availability, privacy, client geographic location, server geographic location, time zone of location. A skilled analyst is still required for this task - largely because many of the values of the factors are uncertain or unavailable.

**Interoperability** – The solution of the interoperability problems will almost certainly always involve the end-user providing additional guidance to the information system. However, modern R&D has provided increasingly sophisticated solutions allowing schema reconciliation so that data structures and attribute names in two different database schemas can be matched and the match proposed to the end-user for verification or correction. Machine translation is overcoming some of the language problems and there is intense R&D in this area.

The problems concerning information about the data - such as accuracy and precision - are starting to be resolved by the use of metadata (data about data). Early attempts in the database community to standardise so-called data dictionaries through the IRDS standard were not universally successful. However, with the overpowering need caused by WWW there is renewed interest in this area and from W3C the RDF (Resource Description Framework) coded in XML (eXtensible Markup Language) has emerged as a widely-used metadata standard. However, much more work is required to agree definitions for particular application areas and to provide the tools to automate the interoperation process further.

### Current Hot Topics

In addition to R&D on the topics discussed above - bringing in the integration of database technology with object-orientation, logic programming, functional

programming, artificial intelligence, multimedia and other areas of computer science and engineering – there are a few areas of work which are current and of wider applicability. They commonly draw on recent advances in the topics discussed above.

**WWW-Database Integration** – From early days in the WWW concept, the idea of using WWW to provide browser client access to pre-existing database-based information servers has been attractive. Work in the first half of the nineties provided the CGI (Common Gateway Interface) and several organisations (including some of the ERCIM institutes) developed 'Dataweb Technology' as it was named at CLRC. Significant ongoing R&D is attacking issues of performance and standards to avoid lock-in to proprietary solutions. Also some groups are working on techniques and tools analysing the structure and content of websites to provide a database-style conceptual model to assist uniform querying across database-based and non-database-based web servers.

The great advantage of Dataweb Technology is that the data content and structure is maintained independently of its access (through WWW forms as query templates) and presentation (through HTML (HyperText Markup Language) or XML with associated presentation control using CSS (Cascading Style Sheets) or XSL (eXtensible Stylesheet Language) respectively).

The integration has also encouraged the emergence of a different architecture; between client and server a mid-layer is inserted for the application server. It despatches Java applets to the client browser workstation and servlets to the information server(s) so providing a thread of control for the particular transaction in the application.

The integration has to span database-based websites, information retrieval-based websites, conventional 'document' websites and websites with high multimedia content. This is a great challenge and increasingly attention is turning to the use of metadata to describe websites and intelligent assists to the client browser query process.

**Metadata** – Metadata is arguably the key facility for interoperability and intelligently-assisted user access to global information resources. Metadata can be used by intelligent agents to expedite search and retrieval, handle security and privacy issues and re-route network traffic improving availability. Metadata can be used to provide query assistance to the end user, in order to achieve the ultimate goal 'get me what I mean, not what I say'.

Metadata has been used especially in the scientific / technical community for many years. The library community has large metadata collections in computerised catalogue systems. Catalogues of engineering parts or technical products are stored as metadata. Building upon the concepts of a database schema, data exchange in the seventies and even earlier utilised additional data describing the data being exchanges to allow automated processing at the receiving server and better interpretation of the results by the end-user. The business community, working from a basis of rigid standardisation for data exchange, has come to utilise metadata.

The explosion of demand for universal information access caused by WWW has really highlighted the need for metadata. The web-indexing engines (such as Alta Vista, Excite, HotBot, Yahoo, Lycos) build metadata databases to describe succinctly and with uniformity heterogeneous information servers. However, use of specialised metadata servers for specific application domains - utilising advanced database techniques with knowledge-based systems and a domain ontology to capture, store and provide knowledge about the application domain – is starting to emerge as a powerful way forward.

**Data Warehousing and Data Mining** – The need for readily available management information for business led to data warehousing- essentially storing a restructured and usually summarised copy of the base data in a form suitable for statistical analysis and visualisation. The technology facilitates looking at data on, for example sales, by periods of time, by geographic region or by class of product. The technology features deeper exploration of the data (drill-down) and

higher-level summarisations (roll-up). Long used in the science and technology domain – where data centres for many disciplines exist and are used heavily - data warehousing is having a profound effect on business decision-making.

Data Mining is the technique of finding patterns in data. The data are analysed using special functions to look for correlative patterns; the technique is much more ‘brute force’ than classical multivariate statistics but has produced interesting results in several application domains, both scientific / technical and business. The basic concept that a computer system can detect the pattern (representing a hypothesis) in a mass of data mirrors one technique of human hypothesis creation. However, the performance issues are receiving attention as is the theoretical underpinning of data mining and current R&D includes work on utilising data mining with multivariate statistical analysis results as a ‘guide’, to improve success of the mining techniques.

**The Future**

The rapid advances in database systems (or, more widely, information intensive systems) over the last 30 years or more indicates that the future is an exciting challenge. The usual issues of performance and accuracy will continue alongside issues such as improved representativity, expressibility, universality of access and universality of understanding of the information assisted by metadata and the WWW.

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**Health and Information Technology**

by Vesa Pakarinen

**As the information society is becoming more concrete in EU member states, the challenge is to synchronise the rapid development of information technology with the changing market of health care and medicine itself. The rapid changes that have taken place in the field of informatics, have also an important knock-on effect in the health sector. However, pure technology is not sufficient, the acceptability of healthcare policy makers and end-users is of utmost importance. As citizen’s aspect is becoming more and more crucial, the whole area of health care service providers is migrating to a new position, where qualified, managed and seamless care is the ultimate goal of health care strategy taking into account the general trends like ageing and integration needs of systems.**

The European industry – not having access to adequate and consistent information of the work efforts and of the expertise of R&D in health telematics – is not always able to well understand their requirements, the diversity of needs (driven by organisational and socio-cultural differences).

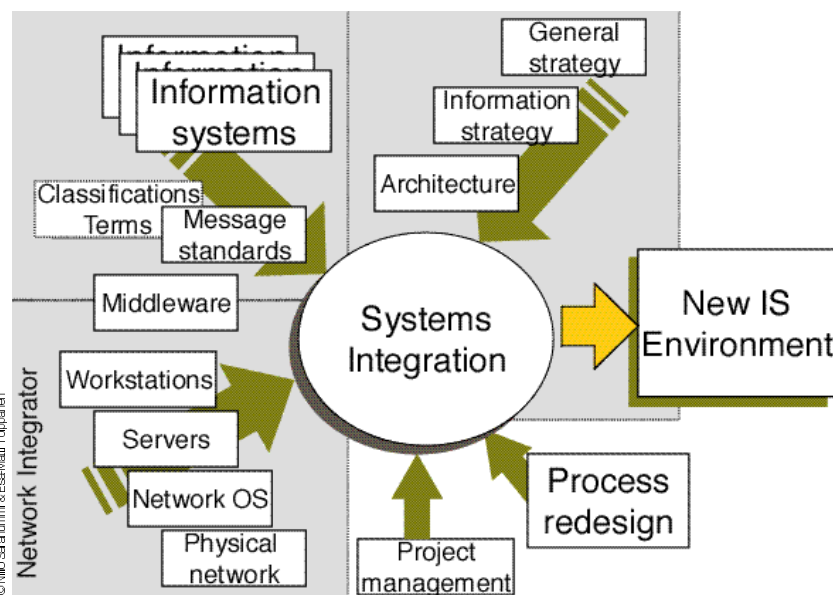
Information technology also plays an important role in solving the structural problems of health care, combined with decision to re-engineering and change management. This also means changes in the economy and functionality of an organisation using information technology and information systems. An information system is always logical and it is impossible to introduce it into a non-logical environment - which is why also the environment has to change. Process management has been brought into health care mainly through the development of information systems.

Also the need to benefit of a knowledge-based health service to citizens and professionals, using available new telematics technologies is growing, due to the development of evidence-based medicine.

**Objectives of the Working Group**

At the end of 1997, the ERCIM Health and Information Technology Working Group was initiated, mainly because many ERCIM-members are working in the field of Health Care (or medicine). The original purpose of the workgroup was to:

- build up an ERCIM network for people and organisations working in the field e.g. by its own www- pages and workshops



Integration aspects of complex systems.

- raise awareness of this WG within ERCIM, the EU Commission and national actors
- prepare joint project proposals among ERCIM-institutes.

In 1998, the Working Group held one meeting in order to find common interest among ERCIM-members for practical projects (see ERCIM News No. 34). A possible co-operation platform was seen in the 5th Framework Programme of European Union. The working group identified some coherence, including keywords like :

- integration of heterogeneous medical information
- technology transfer and societal embedding of innovations in health telematics
- enabling technologies (e.g. XML) in health care
- biosignal interpretation
- assistive technology for citizens with special needs.

As networking tools are improving and the borders of organisations are getting more diffuse, the focal points of the ERCIM-network activities could be:

- enhancement of publicity, data accessibility and information services with regard to social and health information technology and its applications
- implementation of joint R&D projects with several partners at the European, national and regional levels
- intensification of collaboration between ERCIM organisations in order to develop and utilise information technology and telematics
- co-operation with regional and other equivalent centres of excellence.

There are two key possibilities how this Working Group could concentrate to the domain. Another, traditional dimension is to sub-specialise into very deep and narrow know-how in selected areas. Another possibility would be focusing on the integration aspects of complex systems used in health care (see figure). The latter kind of orientation implies co-operation with other ERCIM Working Groups, like user-interfaces and usability in general.

Concerning citizens' aspects, there can be danger that we are entering into a society where citizens loose control of the technology development. It may be that data security and privacy solutions are unreliable, and where governments and corporations can use health databases for their own purposes, even against the interests of the individuals. Already today we can see that inequality between citizens and regions are increasing depending on whether there is a possibility to use information technology or not.

Themes that could be explored in the 5th Framework program:

- personalised user interfaces
- usability
- independent living solutions
- content provision (health information, guidelines etc.)
- integrated solutions for citizen centred wellness & health
- E-Health
- ambient intelligence.

As concrete actions, the working group is planning to have a workshop during ERCIM week in Amsterdam, preliminary date is the 3rd of November 1999. The aim of the workshop is drafting a proposal to the 5th Framework Programme, focusing on the second call of Information Society Technologies Programme (IST, deadline 15th Dec 1999). Preliminary partners and collaborating companies have been identified in active member organisations of ERCIM and preliminary interest is in the Key Actions 1.1-3. Another occasion to finalise the proposal could be around IST-99 conference in Helsinki at the end of November 1999. ■

**Links:**

**HIT web pages:** <http://www.vtt.fi/>

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## The World Wide Web Working Group – W4G

by **Stuart K Robinson**

**The World Wide Web Consortium, W3C, an industry consortium of over 350 organisations, jointly run at the W3C hosts MIT (USA), INRIA (Europe) and Keio University (Asia), was created to enhance the interoperability and promote the evolution of the World Wide Web. ‘Leveraging Actions for Software Technologies’, sponsored by the European Esprit programme, were aimed at accelerating the wide adoption of innovative software technologies by European industrial, financial and commercial users. On 24 November 1997 W3C announced the launch of W3C-LA (Leveraging Action), a joint project between INRIA and CLRC-RAL to leverage the Web for European industry. By the end of the project in 1999, European membership of W3C had increased by 38%, faster than in the USA over the same period.**

The core developments of the W3C improve the basic functionality of the Web, increasing its expressive power and its flexibility. During the lifetime of W3C-LA, the Web has undergone fundamental change, going from a system concerned with the world-wide exchange of a particular form of document (expressed by HTML 4.0) to one based around:

- the separation of content from presentation with the introduction of the concept of style sheets, (CSS, <http://www.w3.org/Style/>), which the association of style with tags
- the exchange of user-defined structured data (XML, <http://www.w3.org/XML/>), a special case of which are documents, a special case of which are HTML 4.0 documents.

The Extensible Markup Language (XML) uses the concept of an optional description (a Document Type Definition - DTD) defining the structure of the data and exchanges data marked up using the tagging declared by that DTD. For the particular case of HTML documents, a DTD - XHTML (<http://www.w3.org/MarkUp/>) is

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currently under development. Further DTDs are under development, for example

- for mathematics (MathML – <http://www.w3.org/Math/>)
- synchronised multi-media (SMIL – <http://www.w3.org/AudioVideo/>)
- chemistry (CML – <http://www.venus.co.uk/omf/cml>)
- schematic graphics (SVG – <http://www.w3.org/Graphics/SVG/>).

The shift to XML, allows 'documents' to be exchanged that are compositions of several tagged components from differing DTDs, as all structured data is expressed in the same format. For example, a document can have text using XHTML, with sections using mathematical notation (MathML) embedded within a schematic graphic, all within one uniform framework (one syntax, one parser).

Style sheets (now XSL, <http://www.w3.org/Style/XSL/> with enhanced tag identification) can be applied uniformly to any DTD. Additionally, an API to the abstract syntax of the document has been defined (Document Object Model, DOM <http://www.w3.org/DOM/>), which, coupled with scripting, allows portable, interactive, client-side processing of the transmitted data, reducing server load and Internet traffic.

XML not only provides the basis for user defined data exchange, but additionally provides the framework for the exchange of Web infrastructure data, such as meta-

data (<http://www.w3.org/Metadata/>). Previously, a whole series of unrelated syntaxes and semantics were being developed, resulting in 'browser bloat' and a heavyweight HTML. Such infrastructure mechanisms, for example content selection (<http://www.w3.org/PICS/>) and privacy preferences (<http://www.w3.org/P3P/>), can become particular XML applications. In particular, the introduction of the Resource Description Framework (RDF, <http://www.w3.org/RDF/>) allows the exchange of semantics over the Web as just another XML application. The Resource Description Framework (RDF) integrates a variety of web-based metadata activities including sitemaps, content ratings, stream channel definitions, search engine data collection (web crawling), digital library collections, and distributed authoring.

With this infrastructure in place, and with the energy of commercial interest in digital television (<http://www.w3.org/TV/>), the integration of the Web and television is rapidly approaching. Different standardisation bodies and vendors will make significant efforts over the next year to achieve this, thus enabling applications such as browsing the Web using a television set, or using Web content formats to annotate a television broadcast, making television more interactive. With these innovations, the whole fabric of society changes – entertainment, the democratic process, business and the workplace.

### W3C-Leveraging Action

W3C-LA developed awareness of the W3C and these recent changes, and encouraged industry champions to demonstrate their positive impact on future business. Key initiatives were developed to characterise the business drivers for and the impediments to the uptake of the Web's maturing technology opportunities. The W3C Office initiative, established through W3C-LA, resulted in six European W3C local offices being opened at ERCIM institutions. Later sections below detail the activities of the first and last Offices to open during W3C-LA

### W3C Offices

To enhance the communication between W3C and the Web community, W3C-LA

opened six European W3C national Offices (RAL, GMD, SICS, FORTH, CWI, CNR) as the first point of contact between the Consortium and local W3C members, and also the general public, with an ongoing responsibility to organise local events.

### Symposia and Workshops

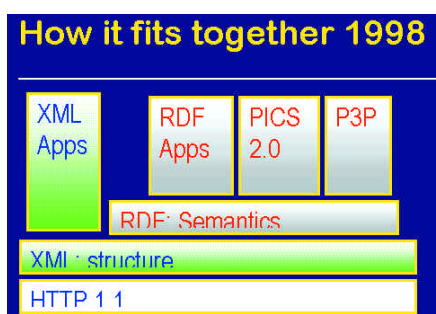
To encourage organisations to start to use the Web as a ubiquitous medium, meetings were held across Europe. The pattern established by CLRC and followed by the other Offices was an initial "management level introduction to W3C, followed by technical workshops and a specific hands-on workshops and finally an industrial champions' day. Additionally a large number of other talks and presentations were given throughout Europe, a monthly Newsletter established and a W3C Office Press Releases distributed.

To exhibit innovative uses of the W3C developments, shrink-wrapped demonstration packages were developed and disseminated throughout Europe at W3C-LA or related events. The demonstrations gradually used more of the results from the W3C-LA technical work-packages as the project progressed and included: HTTP 1.1 Performance, PICS, CSS Validator, MathML and XML, PNG, Scalable Vector Graphics, SMIL, Amaya, RDF and Workflow, XML/XSL and Hyperglossaries and CGM Web Profile.

The Web community uses the Web itself as the primary medium for communication. W3C is no exception. W3C-LA enhanced European access to W3C information by beginning to mirror the INRIA site at the Offices via satellite. This also allowed the establishment of African Offices in Morocco and Tunisia.

### The W3C-Office at Rutherford Appleton Laboratory

The RSA Symposium: Visions of the Web The first office to open was that at RAL. Activities began with a high-profile W3C-LA Symposium at the Royal Society of Arts in London in December 1997 organised jointly by Computer Weekly, DISC and RAL. Some 150 senior executives from leading UK companies heard W3C Chairman Jean-François



**RDF schema can constrain exchanged content and allows the expression of relationships between 'entities' on the Web, for example, CLRC wrote this page, or CNR confirms that CLRC wrote this page. This is the basis for a more general, meaningful, meta-data mechanism and the road to Tim Berners-Lee's 'Web of Trust' (<http://www.w3.org/1998/02/Potential.html>).**

Abramatic open the proceedings by describing the Web as a people-to-people communication medium, a machine-to-people framework for computing knowledge and a machine-to-machine information infrastructure. He was followed by star attraction Tim Berners-Lee, inventor of the Web, and W3C Director, who described his dream of a hypertext system which would be 'personally cool', enable social efficiency and understanding and allow the exploitation of computing power in real life. His vision was for the Web to become a single universal space encompassing PCs to TVs, hypertext, video on demand and RT channels and spanning the personal to the global, the scribbled to the polished. Getting somewhat carried away he even coined a new word 'intercreativity' meaning building things together in the Web. He went on to talk of the importance of the "Web of Trust",



**W3C-LA Symposium at the Royal Society of Arts in London in December 1997.**

the whole security infrastructure from keys and signed documents to personal information, which will allow electronic commerce to take place safely and securely. The afternoon was devoted to the explanation of the work of the W3C covering the User Interface, Architecture, and Technology and Society Domains. These talks were complemented throughout the day by demonstrations that illustrated many of these new developments and how they could impact the Web in the future.

Following the success of the RSA event, the office published a UK W3C monthly newsletter highlighting a current topic, and tracking membership trends and Web

related events. Some 800 organisations asked to receive it and future information about the W3C. The Newsletter was made available to the other European Offices, and is available throughout Europe via the local Offices.

Further 'Open Symposia' describing the recent Web advances took place as further offices opened at SICS, GMD, CWI (March/April 1998), and a tutorial event was held at FORTH in September 1998. These were followed by "Demonstrator Advice Workshops" aimed at potential industrial champions (users of W3C recommendations and W3C-LA demonstrators). The purpose was to explain to potential users the technologies behind the demonstrators, thereby encouraging their take-up. A Technical Workshop, with RAL experts detailing various innovations, was held at RAL on 17th July 1998 and a hands-on SMIL (the most developed demonstrator) workshop, also at RAL.

The Office has its own Web site and all existing (and Future) Newsletters and the slides from many of the events are available through that site. Additionally the RAL W3C Mirror site began operation in February 1999. For more information on the RAL W3C Office see <http://www.w3c.rl.ac.uk>

A second RSA event was run in December 1998 where industrial champions presented use that they were making of the emerging technologies from thereby encouraging its take-up by other users. Jon Bosak of Sun give an excellent talk on XML, highlighting the effect of the XML linking proposals, illustrated by showing the work of a Californian company with its copy in XML and using XSL to style it in different newspaper styles. Chris Lilley of the W3C gave an overview of the SVG activity. Tony Stuart of RivCom gave an entertaining talk on how RivCom are using XML to specify industrial data on a range of projects. Lynn Labieniec from RivCom were also demonstrators along with staff from RAL, INRIA and VHL. Much had already changed in one year!

### **The W3C-Office at CNR**

The Italian W3C Office (e.mail: [w3c-cnr@cnr.it](mailto:w3c-cnr@cnr.it)) organised its opening event

on April 22nd 1999, in Pisa, hosted by CNR. The event was a success, with more than 130 participants and presentations offered by the W3C team. The event also hosted a round table, where convenors expressed their views about the opportunities of Internet applications, and the related difficulties. It was stressed that the use of the Internet by the public at large in Italy is not as widespread as in other countries, but the general feeling was that the size of the market would grow rapidly. From this perspective, the interest showed by the Italian Government in the Information Society appears to emphasise the growth of the use of this technology.

The Ministry of Industry participated in the event and declared that they were very interested in supporting the Office initiative and its activities. As a consequence of the opening event, a web site (<http://w3c.cnr.it>) and a discussion list ([w3c-it@cnr.it](mailto:w3c-it@cnr.it)) have been set up. Details about the event, and full coverage of sessions are available in real video on the site.

After the opening, the Italian W3C Office immediately started to work with the Italian W3C members. A plenary session has already been held and more will be held on a monthly basis. The Italian members appreciate this approach as it allows them be more in contact with the Consortium than merely being present at international events. The Italian Press has already showed high interest in the Office's activities. Many Italian newspapers have already covered Office activities and a more constant and official presence is being planned. After these first months of existence the Office is planning its activities for the near future. First of all a schedule of events for various target audiences will be released in September. The writing of documentation, illustrating the advantages of becoming a W3C member will be the first step in a recruitment campaign. ■

### **Links:**

**W3C:** <http://www.w3.org/>  
**W3C-LA:** <http://www.w3.org/W3C-LA/>

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### ERCIM Projects

ERCIM is participating in research projects of the European Commission (EC) as co-ordinator or associated partner. In these projects several member institutes conduct the research activities while ERCIM is responsible for administrative tasks. ERCIM offers its expertise in the management of international research projects when at least three ERCIM members are involved. ERCIM currently participates in the following projects:

- ESIMEAU – information technologies for the modelling of water resources in semi-arid zones (see page 33)
- THETIS, a data management and data visualization system for supporting coastal zone management for the Mediterranean sea (see article below)
- DECAIR, development of an earth observation data converter with application to air quality forecast, (see page 36)
- SIMES, a research project on multimedia information systems for environmental remote sensing in the sub-Sahara region (see page 35)
- MtoM3D - Made to Measure garments, 2D-3D approach. A project that aims to increase the added value to clothing products made in the Mediterranean area (see page 36)
- DELOS – an ESPRIT Working Group aimed at promoting European research into further development of digital library technologies (see page 12)

Under the Fifth Framework programme of the EC, ERCIM has recently had four new projects accepted:

- ANFAS, a Euro-Chinese research project with the goal to develop a decision support system for prevention and protection against floods using modeling and simulation techniques
- a Network of Excellence for Digital Libraries which will provide the framework for the formulation and activation of an international research agenda in the DL domain; this is a follow-up of the DELOS Working Group
- a feasibility study for C-WEB, a project that aims at designing a generic platform based on open standards to support community-webs; typical target applications are semantic portals and corporate memory systems
- a study to identify the potential research areas, priorities and partners in South America for the Information Society Technologies (IST) programme.

#### Links:

ERCIM projects: <http://www.ercim.org/activity/projects.html>

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## THETIS – A Data Management and Visualization System for the Support of Coastal Zone Management in the Mediterranean Sea

by Catherine Houstis

**The aim of the THETIS project is the design and development of an open federated environmental scientific information system for the support of the interdisciplinary area of Coastal Zone Management. The THETIS system architecture takes advantage of distributed computing infrastructures including Digital Library, Mediation, Graphical Information Systems (GIS) and World Wide Web technology to provide single point access, location,**

### **integration, retrieval, and visualization of distributed geospatial data and programs remotely via a Web browser.**

Scientific repositories have traditionally evolved in isolation. They are essentially legacy systems running in stand-alone mode. There is an increasing need for scientists, engineers, and decision-makers to integrate the wealth of accumulated information. Coastal Zone Management support and, more generally, decision support based on scientific data depends on the dissemination and visualization of information possibly geographically distributed over a number of heterogeneous and autonomous scientific data repositories from a single point of access. In addition, it can be significantly aided by the generation of new information through the remote execution of simulation and data processing models possibly located on legacy systems, on demand.

Coastal Zone Management (CZM) is a methodology for the holistic management of all coastal resources with the ultimate aim of promoting sustainable development of coastal zones. An abundance of

information has been accumulated for CZM. This information is the result of work in several scientific disciplines such as marine biology, oceanography, chemistry, and engineering. It is very diverse in terms of content, resolution or accuracy, storage formats, and the types of repositories that manage it. Typical information used for CZM purposes includes monitored data and images that may be stored in various databases, files, and even spreadsheets. Furthermore, mathematical models exist for simulating physical processes of coastal sea circulation, wave generation, sediment transport, etc. In addition, techniques such as image processing and statistical methods for reformulating, fusing, or extracting information from monitored data are available. Data access may require specialized vendor database tools and integrated access does not exist. In the simplest case data exchange is accomplished through surface mailed diskettes. Moreover, scientific models are often implemented as legacy programs that require specialized hardware and software to execute.

The THETIS system is an Environmental Scientific Information System designed and implemented for managing data for coastal zones in the Mediterranean Sea. The system is accessible through the WWW and provides user access to data, programs and images stored in geographically distributed scientific repositories. The user is able to locate, retrieve and visualize data stored in these repositories from a web browser. In addition, the user can produce data on demand by remotely invoking programs with appropriate data inputs and visualize these data using a GIS based user interface. Search of data/programs is also done via a map. GIS's provide a natural user interface since environment related data have always a geographical attribute. In addition, specialized visualization software is used. The user is capable of storing the results of program invocations back into the system by means of an automatic publication system that is implemented within THETIS. Thus a globally shared digital library of scientific information is formed dynamically regarding the application of interest, i.e., coastal zone management.

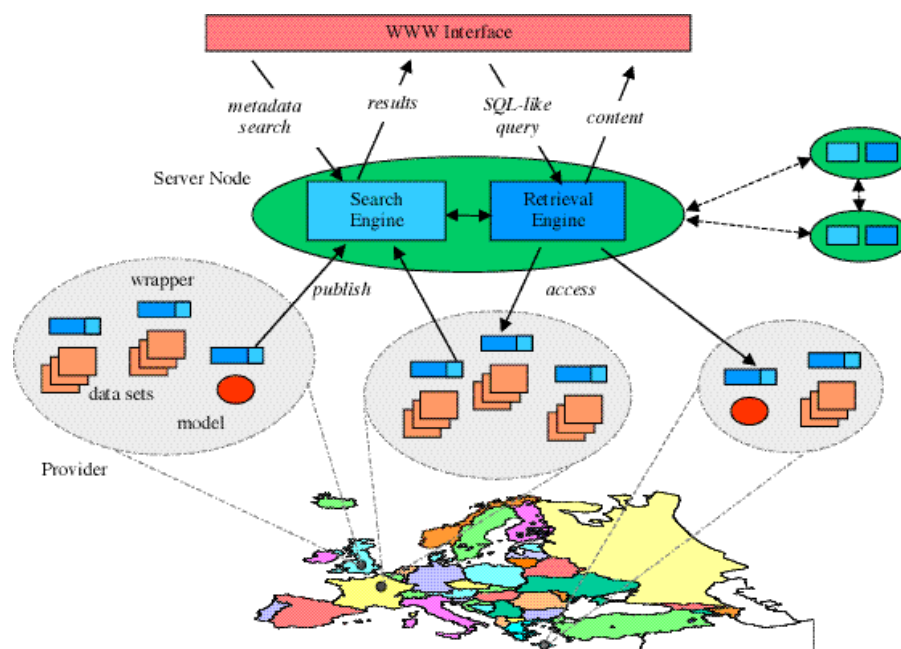
The THETIS system design is based on a number of components, namely, a distributed search engine, a distributed retrieval engine, the system data repositories and the user interface as shown in Figure 1. The search engine implements a distributed search of metadata regarding the system repositories or publishing sites. There are two different types of metadata addressing data and programs. The FGDC standard has been used as the basis for both of these types because of the common geospatial component in environmental data and the thematic information requirements by the standard. Metadata, an electronic form implementing the standard's agreed fields, are completed/edited by repositories publishers (i.e., scientists that make their data/programs/images available to the system) and directly submitted via the web to the THETIS system. The search engine automatically indexes these forms. Moreover, a spider program also automatically retrieves metadata from repositories when the repositories are updated independently and maps them into the systems metadata. Search queries are based on thematic keywords, specific

organization names and/or geographical locations selected graphically on a map (by encircling the area of interest via a mouse) at the user interface. The output of search queries provides metadata information about data, programs and images and a link of their location. The user brows metadata information then selects a link of interest and queries it via the retrieval engine.

The retrieval engine offers two main functionalities. First, it enables the access of data and images that reside in distributed publishing sites through a JDBC interface (other interfaces such as FTP and HTTP are also supported). In accordance with this interface, the retrieval

query locally. This engine maps the user global query into local queries, each for a different query execution engine of some remote publishing site, and a composition query for producing the final result. Client sites communicate with publishing sites via a CORBA communication module. Local queries received by the query execution engine of a publishing site are sent for execution to the appropriate wrappers of the site. The query execution engine has a runtime system to integrate the results of local queries.

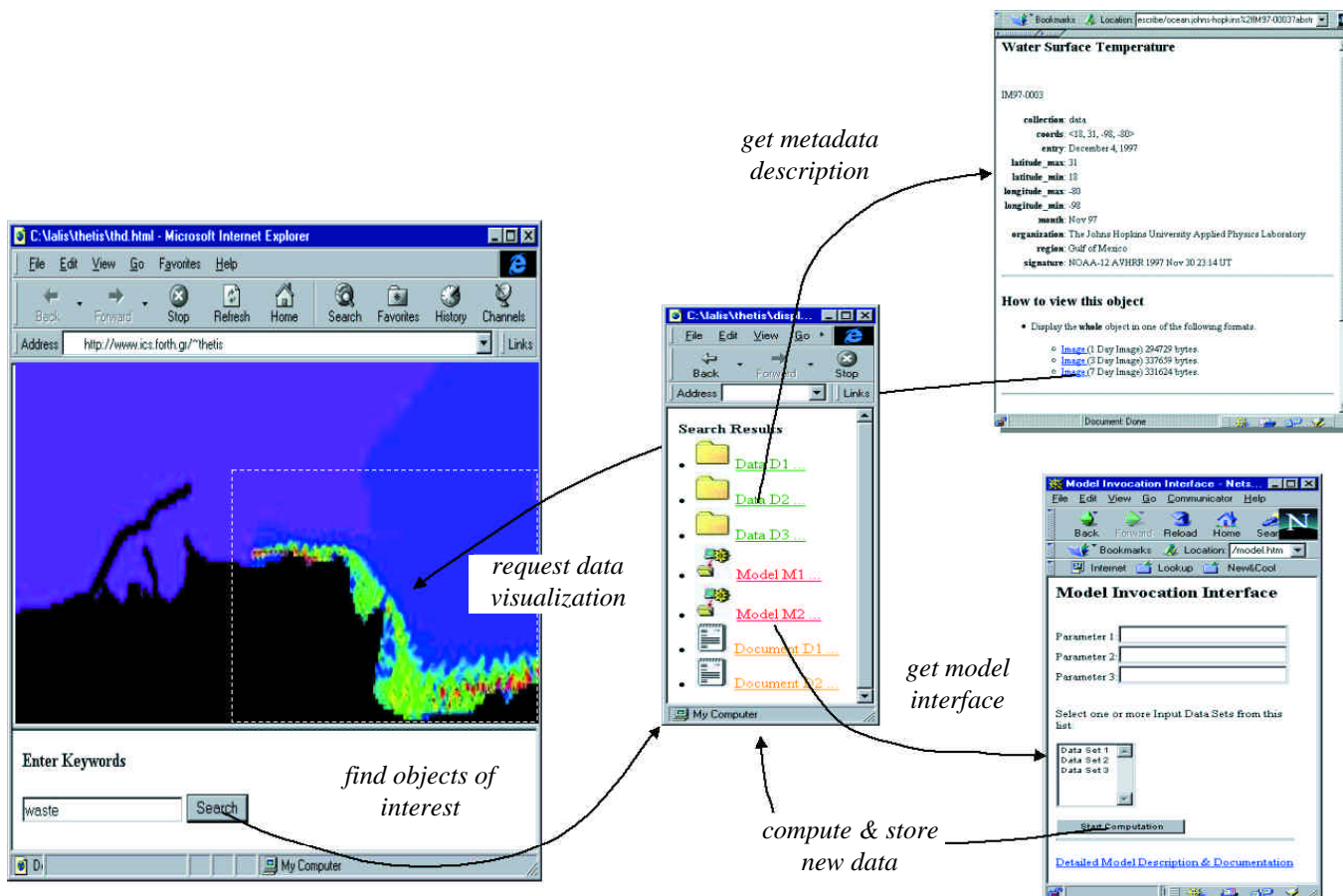
As a second functionality, the retrieval engine enables the invocation of remote program execution with input data arguments that are the result of distributed



**Figure 1: THETIS architecture.**

engine supports a restricted SQL query language to query the data. To support a distributed access to data, data publishers first have to make their data available in the form of relational tables. The data themselves do not have to reside in a relational database though. Instead, a software module, called a data wrapper, takes charge of the dynamic translation of the original data into a relational format when queried. Several data wrappers are available for different kinds of data in the THETIS system. Once data are published via data wrappers, the query execution engine at the client site processes a user

queries. Such invocations are performed via a job execution language. The processing of job execution commands is somehow similar to queries. First, program publishers publish their programs via program wrappers. Then, a client site sends to the publishing site where the program resides a job execution command. At the publishing site, job execution commands are processed asynchronously. A job manager module requests execution of the queries that compute the program inputs, invokes the execution of the program, makes the result



**Figure 2: Thetis user interface.**

available to the client, and also notifies the client of the result.

There are three different application demonstrators integrated from the scientific repositories connected to the system, which we call scenarios of use of the THETIS system, and which support coastal zone management: A Waste Transport scenario for the computation of concentration of effluents based on general circulation data displaying the movement of pollutants, calibrated for the north coast of Heraklion in Crete; A Sea Structure Tracking scenario, which allows for the study of the dynamic of oceans through stepwise satellite image processing from satellite pictures of the Mediterranean Sea; and A Wave Prediction/Hindcasting scenario, which is based on the calculation of wave climate at specified points based on historical wind and wave data, applicable any where in the Mediterranean, provided that local input data are available. The scenarios are implemented interactively with the user. The user is also allowed via the web interface to submit parameters relevant to the programs he/she is remotely

executing, such as grid accuracy, wind direction, etc. These inputs are user dependent and required for the execution of scientific programs. The user interface is shown in Figure 2. It displays an instance of the search and retrieval capabilities of the Waste scenario visualized on a map of the North of Crete. At the user interface the user may visualize the resulting data via a Geographical Information System, VRML and customized visualization tools automatically invoked by the Web browser.

The THETIS project started on 1 July 1998 and will be completed on 31 December 2000. The THETIS consortium includes the research organizations: Institute of Computer Science and Institute of Applied Mathematics, FORTH, University of Crete, Institute of Marine Biology of Crete, INRIA and IMA-CNR, corporations specializing on the management of environmental information: HR-Wallingford (England), and Alcatel Industries (France), and a user group: RECORDMED which consists of delegates of four Marine Research Organizations, namely, ICRAM (Italy),

IEO (Spain), IFREMER (France) and NCMR (Greece). The project coordinator is ERCIM. The project leader is ICS-FORTH.

**Links:**

**THETIS web site:** <http://www.ics.forth.gr/pleiades/THETIS/thetis.html>  
**Demo server:** <http://kos.ics.forth.gr:8000/CoordsIndex.html>  
**Visualization in THETIS:**  
<http://thetis.ima.ge.cnr.it/~thetis/wave/wave.htm>

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# ESIMEAU – Information Technologies for Water Resources Management and Modeling in Semi-Arid Areas

by Fadi El Dabaghi

The increasing demand of freshwater associated to the decrease in water resources and the extensive use and pollution are calling for better design and optimal exploitation of hydro-systems. It is universally recognized that water resources problems are complex, characterized by the interaction of several physical phenomena, some of which we can not easily understand. Any effort to develop a solution for these problems, whether it is to preserve water for irrigation, or to manage a watershed, or to build a dam to alleviate flood problems or to oxygenate a lake to eliminate eutrophication problems must be based on an approach that considers all cause and effect relationships and evaluates in a systematic way the various alternatives.

Similarly to other decision support problems that deal with the environment, the appropriate way for doing this is the use of systems theory. That is an approach that accounts for the feedback among the various components of the ecosystem studied and which attempts to express mathematically the interrelationships that exist. Like in any engineering or science topics, when treating problems related to water resources the following has to be considered:

- Partial Differential Equations based governing equations involving parameters and/or coefficients that might be known or need laboratory or in situ experimental information for their evaluation
- phenomena occur in a geometric domain that can be a watershed, a lake, a river, etc

- well posedness is required (boundary and initial conditions are needed)
- Computer code for numerically computing the unknown variables using a numerical method (finite difference, finite element, finite volume based) therefore involving the so-called discretization or meshing of the domain through a pre-processor
- post-processing facilities.

Once a computer model built, one can then proceed to further simulations of scenarios that represent the user's requirement and exploitation. However, the end user has to go through all the process, i.e. data

The main objective of ESIMEAU is to build an infrastructure of an integrated system to be used as a single decision support system for the management of water related issues. Such an open work platform will embody numerical models and simulators operating on spatial geographic databases, as well as data acquisition and data management tools. The direct beneficiaries are spatial planners and decision makers who will find through such a system, efficient operational facilities in the preparation and the installation of planning and/or emergency measures directly related to water – both as a sustainable resource and as a natural hazard – in general, and

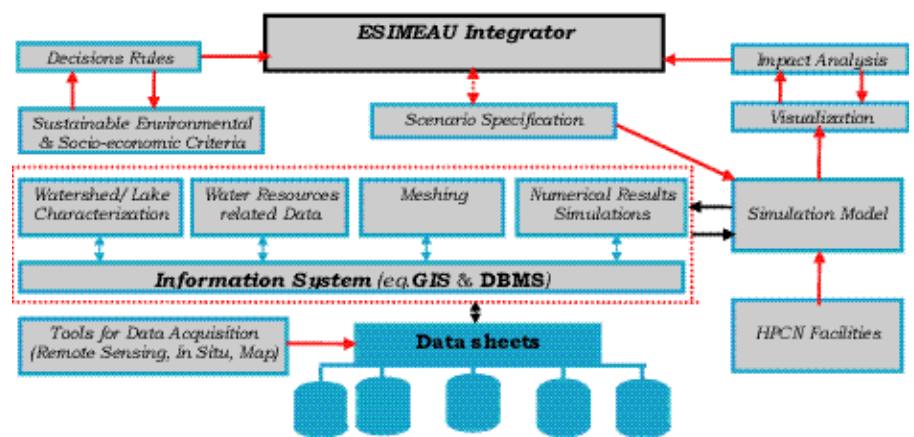


Figure 1: Esimeau Integrator.

analysis and data preparation for a model, domain meshing, computer simulation, post-processing and decisions. This is a bit cumbersome.

## ESIMEAU Objectives

For the sake of illustration, within the ESIMEAU project, only surface water is considered. Important components of this framework are data and models. The data reflect the current and future conditions in the area studied, while the models are mathematical constructs that describe in quantitative terms the relationships that exist in the real world. Although mathematical models for water resources problems have been developed for some time, their use is not widespread, particularly in developing countries, because they are cumbersome to use and difficult to comprehend by people without extensive mathematical and computer background.

specifically for semi-arid areas. The main actions to be addressed are :

- develop or integrate tools for the management, analysis and treatment of heterogeneous data taking into account the semi-arid climate characteristics;
- model and analyse rapid phenomena such as floods and solid transport or slow scale ones such as eutrophication, erosion, climate change and develop appropriate numerical algorithms for a better and realistic simulation reproducing the real physical situation of the phenomena under investigation ;
- integrate these conventionally separately dealt with application domains into a single application through intelligent interfaces within an appropriate and user-friendly framework.

The architecture of the system to be developed will contain:

- general modules such as graphics, data base management systems (DBMS),

## SPECIAL THEME: 10 YEARS ERCIM

geographic information systems (GIS), shells, simulators, etc which will constitute a part of the skeleton of the system

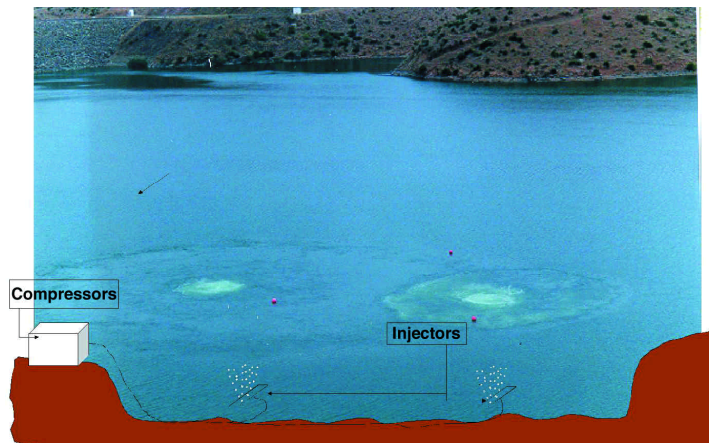
- specific modules taking care of particular physical applications (hydrology, hydraulics/hydrodynamics, eutrophication, etc.) are to be developed separately step by step. Within the framework of the present project, the numerical modules are focused on the mechanical treatment of eutrophication, the flood/release risk management occurring in watersheds will be limited to the state of the art for further numerical modeling.

A dynamic modular approach is adopted in order to integrate the various contributions of the partners in three main levels in an open generic platform characterized as follows:

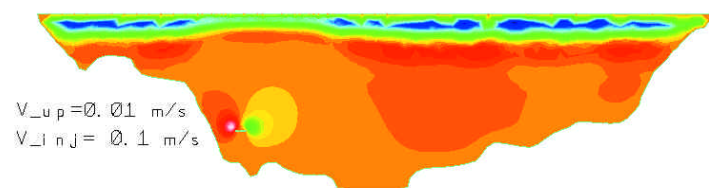
- at the top level, the ESIMEAU integrator which will allow the end user without prior or deep knowledge about computer technology, to access and use within a user-friendly environment all the operational modules, data manipulation, model access, visualization, numerical simulation and post-processing including thematic maps
- at the intermediate level, specific modules for data treatment, and numerical simulation/prediction modules. These modules are developed following the general ESIMEAU architecture (Input / Output), and integrated whenever a task is finished and implemented.
- at the lower level, data access, consultation, modification and visualization interfaces.

For a good coherence, an efficient exchange and a positive collaboration between partners, the philosophy of work will be reinforced by specific Information Technology (IT) knowledge transfer parallel actions towards south partners :

- develop and implement methodologies based on Geographic Information Systems (GIS) for handling datasets for water resources management
- training and dissemination actions on the use of GIS packages such as ARCVIEW, and High Performance Computing (HPCN) as well as on numerical methods and modeling/simulation



**Figure 2:**  
Aeration  
of the  
BouRegreg  
Lake  
in Morocco.



**Figure 3:**  
Streamlines  
in a cross  
section of  
the lake.

- build the integrator WEB site devoted to the project for real time information on the development and progress.

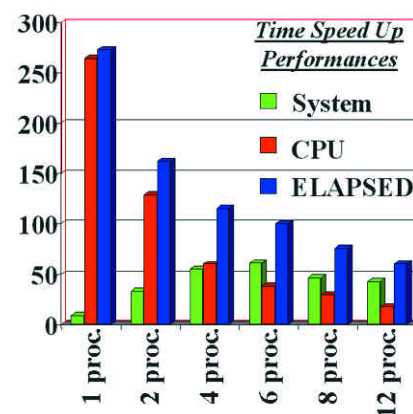
As mentioned above, the water and/or environment national boards and/or specialized companies are the privileged end-users of ESIMEAU. Such a system is of crucial interest to them since it offers an evolutive generic platform based on an open global architecture. It is built with respect to various water issues and linking traditionally water resources aspects related to separate domains, specifically research and IT tools with socio-economic actions.

### CruCID

In addition to ESIMEAU, a demonstration project called CruCID will focused on the use of High Performance Computing and Networking in the modeling and simulation of flood wave propagation. The end users are organisms concerned with flood alert, inundation prevention, watershed planning and environmental impact studies, as well as institutions interested in HPCN platforms and the associated tools. The project will improve the capabilities of partners from developing countries related to the implementation and development of HPCN parallel computing, and its applications to engineering sciences. As for the European partners, CruCID (Flood Modeling using HPCN) will provide an

opportunity to extend their research experience in HPCN techniques, usually devoted to high technology fields such as Computational Fluid Dynamics, to some important new environmental applications such water resources.

The parallel version(s) of the selected software from some available freeware ones, to be implemented within CruCID, will reduce drastically the computational costs and CPU times, which will allow the simulation of large scale problems and consequently provide more reliable results. Such HPCN based software could be the backbone of a flood alert system. The consortium will be opened to water agencies in charge of flood alert and protection.



**Figure 4:** HPCN Performance for one phase flow analysis.

The partners in ESIMEAU and CruCID are: ERCIM; INRIA; IACM-FORTH; IRD-Institut de recherche pour le développement, France; RIKS-Research Institute for Knowledge Systems, The Netherlands; ENP-Ecole Nationale Polytechnique d'Alger, Algeria; ESIB-Ecole Supérieure d'Ingénieurs de Beyrouth, EUCLID, Lebanon; EMI-Ecole Mohammadia d'Ingénieurs, ONEP-Office National de l'Eau Potable, Morocco; CITET-Centre International des Technologies de l'Environnement de Tunis, ENIT-Ecole Nationale d'Ingénieurs de Tunis, Tunisia.

**Links:**

**Esimeau web site:**  
<http://www-esimeau.inria.fr>

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## **SIMES – Environmental Multimedia Information System for Sub-Saharan Africa**

by **Olivier Monga**

**SIMES is a Research and Development project on information systems dedicated to environmental monitoring systems. It aims at providing a multimedia exchange platform for environment researchers and actors, and to facilitate the dissemination of information produced by the environmental monitoring systems.**

SIMES aims at integrating the various tools needed for the acquisition, management, processing and dissemination of full multimedia information related to environment. It is dedicated to environmental monitoring systems dealing particularly with the dynamics of socio-ecosystems, the

exploitation of renewable resources, and the impact of human activities on the environment, with a first area of application in sub-Saharan Africa. It will provide a 'generic information system' in form of a toolbox to be used by these monitoring systems to implement their own information system. The result should facilitate the networking of all information produced by the numerous research operations and development projects in this field.

SIMES is based on the Web and on Corba and will enable the networking of environmental information and the related processing packages, it will also provide a user-friendly Web interface for the navigation among the networked information and processing facilities. All potential users will thus be able, from a simple microcomputer connected to Internet, to access the available environmental information and to run the related available processing packages. The navigation interface will be based



**Fishermen in the inner delta of the Niger river.**

upon the various 'views' relevant for the information structure (eg, geographical co-ordinates, chronology, geographic and thematic thesaurus, semantic fields, taxonomic tree, information format, institutions names, etc.).

The system specification documents are available at <http://www.ercim.org/simes>, and an interface prototype is available for a pilot monitoring system in Mali.

SIMES will provide a set of integrated tools and a methodology for setting up information systems dedicated to environmental monitoring, including numerous processing packages. Any application aiming at monitoring the

dynamics of socio-ecosystems, particularly related to the exploitation of renewable resources or to the impact of human activities on environment, should be natural users of SIMES tools and methodology.

SIMES incorporates numerous pilot applications so as to ensure a pertinent focus for the tools selection and development/tuning, as well as to validate these tools. The first and most advanced application is a monitoring system on the fishing activities run in the central delta of the Niger river in Mali (Observatoire de la Pêche dans le Delta Intérieur du Niger). Two other ongoing applications are in Senegal: 'Observatoire environnemental de la vallée du fleuve Sénégal' and the 'Observatoire démographie-santé de Niakhar'.

SIMES uses for data processing the most advanced techniques in image processing, statistics, modelling and artificial intelligence. Especially, recent Computer Vision Tools are used such as image mosaicking and registration. These methods enable to register and match multi sensor images of a same area: satellite images, aerial images. SIMES is run by a consortium of nine institutions: University of Oxford, Vrije Universiteit Brussel, Université de Berne, ERCIM, Ecole Supérieure Polytechnique de Dakar, Université de Dschang, Ecole Supérieure Informatique de Bobo Dioulasso, Institut d'Economie Rurale, CNTIG), lead by INRIA and IRD.

**Links:**

**SIMES:** <http://www.ercim.org/simes>  
**Monitoring system on the fishing activities run in the central delta of the Niger river:** <http://www.orleans.orstom.fr/ext/pechedcn/>

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## **MtoM3D – Made-to-Measure Garments**

by **André Gagalowicz**

**The MtoM3D research project aims to develop the market and the value of the apparel products made in Developing Countries by adapting existing industrial solutions to the plus-size sector, a made-to-measure-based activity. Expert knowledge leads the design of a pattern-alteration system, prototyping and validation being achieved in a 3D simulation of the adapted garment.**

Traditional made-to-measure methods and equipment are analyzed to establish a set of alterations for 2D patterns in order to provide a standard model for a set of plus size mannequins. This set of mannequins represents different conformations of human bodies that belong to the plus size sector. This set of mannequins helps to determine the size of the garment from a standard size chart. The garment patterns from this standard size are altered using a standard apparel grading system. Then, available 3D data of a mannequin are used to develop a realistic simulation software that takes into account fabric parameters describing the fabric mechanical properties of a simulated garment in order to numerically dress it on a simulated 3D mannequin. The simulation of draping effects are controlled by comparison with the draping of a real mannequin. At this stage of the project, we have the digitized 2D patterns for a plus size mannequin and a procedure to simulate how a 3D mannequin wears a garment built for these

patterns. Here, we merge this information to study the simulation of an adaptation of a standard size to a plus size garment. The results are validated by mounting manually the computed altered patterns on the real plus size mannequin which is compared to the 3D computer simulation.

The software will be validated and merged into a unique software package including a set of numerical mannequins for plus size body conformations, a set of alterations and grading capabilities to adapt a standard garment to these plus size standard mannequins, a set of commercial garments compatible with the system and a friendly user interface. The input for the software is a conformation, a size, a type of fabric and a style of cloth chosen. The software delivers a 3D image of a mannequin wearing a garment with the corresponding conformation, size, cloth and type of style.

### **Technology Transfer**

In the textile industry, there are strong relationships between industrial partners from the North and the Countries of the southern mediterranean coast. Half of the industry in Tunisia and Morocco relies on the apparel sector. The new computer assisted expertise being developed through this projet is done by a joint effort of northern and southern academic and industrial partners. The introduction and dissemination of this technology within the apparel industry for the production of made-to-measure garments will strengthen these links and facilitate the co-operation. New markets for plus sizes will benefit to textile industry in developing countries both in the field of garment production as well as in the development of new

technologies. The advantages of simulations of draping or alterations on 3D customer plus-size mannequins will be quickly understood by the clothing industry. It will allow to shorten the cycles for collection design and increase the made-to-measure garment quality. Draping simulation using fabric parameters will facilitate the use of more diverse types of materials for garment production.

The partners of the project are Accesit, Morocco, CAD Modelling srl, Italy; EMI, Morocco; INRIA; IRSIT, Tunisia; Lectra Systèmes, France; Société Moderne de Confection, Tunisia; Styl Plus, France; and ERCIM. MtoM3D is co-financed by the European Commission's INCO-DC programme.

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## **DECAIR – Development of an Earth Observation Data Converter with Application to Air Quality Forecast**

by **Jean-Paul Berroir and Francois Llibat**

**The objectives of the DECAIR project are to provide air pollution models with good quality input data derived from earth observation (EO) satellites data, and to design a system prototype able to provide models with their required data, under specific quality and freshness constraints.**

One of the major objective of the DECAIR project is to investigate the use of remote sensing data to estimate input data for air quality models. According to the nature and usage of the data, different kind of input data are under investigation: data required for documenting the studied area (elevation, land use); meteorological,



**Draping simulation.**

initialisation and emission data, required on a daily basis; finally parameters required by the models for their internal modules, such as surface uptake, energy balance, turbulence, etc. In our investigation we first conduct an analysis of users requirements (authorities, companies in charge of delivering pollution measures, modelers), in order to specify the needs for high quality input data. Then, an analysis of data requirements will be conducted in order to select the appropriate satellite sensors and processing methods to estimate these input data. Finally, a prototype will be built that delivers up-to-date land use data and daily radiation data to models. A sensitivity analysis will be carried out to select critical model parameters, and to investigate remote sensing data analysis methods able to estimate these parameters.

The second major objective is the design of a Data Management System. This system has to be able to access, process and integrate data from various remote data sources like satellites, ground stations, etc., in order to maintain high quality input data for various final users like models users (the scientists designing and running models), companies and authorities at different sites, public). The system architecture is designed to fulfill objectives which are specific to the DECAIR project, i.e. to give the different air pollution models high quality 'EO-processed' input data, and to automatically enforce accuracy and freshness of these data. It is also designed for long term objectives, such as easy adaptation of air quality models to a new application sites.

The architecture is based on modern concepts and techniques already addressed in other projects, for instance in the telematics domain: the Mediator technology will be used to process queries over an integrated logical view of all the data sources. A Monitor is responsible for governing the execution of queries, the call of data processing modules, the loading of the processed data to the DECAIR database and the access to this database by the final users. The design of the DECAIR database will handle the technical constraints related to the large number of image data to be stored and their relation to Graphical Information Systems. Communications between these

components as well as dissemination of results to end users and public authorities will base on WWW technologies.

The DECAIR project is carried out with a strong concern of compatibility with concepts and standards developed by other projects in environmental information systems and telematics technologies. DECAIR involves research teams specialized in air quality modelling: GMD Institute for Computer Architecture and Software Technology and UPM, Spain, environmental information systems: INRIA, CLRC-RAL, FORTH-ICS, satellite image analysis: INRIA and industrial partners BULL and SICE. The applicative objectives of the project are to demonstrate the ability of satellite data to enhance the quality of air quality simulation, and to facilitate the implementation of an air quality model to new sites. The project will be demonstrated in the cities of Berlin and Madrid. It started June 1st, 1999, and its duration is 36 months. The project is administered by ERCIM.

#### Links:

**Decair home page:** <http://www-air.inria.fr/decair>

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### CALL FOR PARTICIPATION

## 12th ERCIM Workshop on Database Research

**Amsterdam, 2-3 November 1999**

This Workshop will address all areas of database research in ERCIM member groups, with the emphasis on current activity. Extended abstracts of presentations should be submitted by email (in Word, RTF or Postscript) to the local organiser, Arno Siebes ([Arno.Siebes@cwi.nl](mailto:Arno.Siebes@cwi.nl)). See the ERCIM web pages for full details.

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## RECOMB'99: Research in Computational Biology

by Mireille Régnier

**RECOMB99, the Third International Conference on Computational Biology, was held in Lyon, from April 11th to April 14th. The two previous conferences were held in the US: Santa Fe in 1997 and New York in 1998. The 4th one is scheduled in April 2000 in Tokyo (Japan).**

Among the 320 people that attended the conference, 183 were European, 111. One should note an increased interest from companies, as we had 70 non-academic attendants.

Program Committee selected 35 papers out of 147 submissions. Among the new subjects discussed at RECOMB99, let us cite the regulation mechanisms in gene expression, and notably metabolic pathways. Protein geometry and drug design were also extensively studied.

Stanislas Ulam Computational Biology Address was given by Piotr Slonimski, Director of French Center for Molecular Genetic at Gif-Yvette. Using software developed by new company Gene-It, P. Slonimski presented unexpected and outstanding results on evolution.

Among other invited conferences, Distinguished New Technologies Lecture was delivered by Ed Southern (Oxford University, England) on Large DNA Microarrays. Finally, Trends in Computational Biology were presented by John Wooley. He pointed out the now unavoidable contribution of computer science for the interpretation and classification of biological data.

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# Security of E-commerce threatened by 512-bit Number Factorization

by Henk Nieland

On August 22, 1999, a team of scientists from six different countries, led by Herman te Riele of CWI, found the prime factors of a 512-bit number, whose size models 95% of the keys used for protection of electronic commerce on the Internet. This result shows, much earlier than expected at the start of E-commerce, that the popular key-size of 512 bits is no longer safe against even a moderately powerful attacker. The amount of money protected by 512-bit keys is immense. Many billions of dollars per day are flowing through financial institutions such as banks and stock exchanges.

The factored key is a model of a so-called 'public key' in the well-known RSA cryptographic system which was designed in the mid-seventies by Rivest, Shamir and Adleman at MIT. At present, this system is used extensively in hardware and software to protect electronic data traffic such as in the international version of the SSL (Security Sockets Layer) Handshake Protocol.

Apart from its practical implications, the factorization is a scientific breakthrough: 25 years ago, 512-bit numbers (about 155 decimals) were thought virtually impossible to factor. However, developments went much faster than foreseen, and at present it is a precarious matter to venture upon quantitative forecasts in this field. When Rivest challenged the world in 1977 to factor RSA-129, a 129 digit number (from a special list), he estimated that on the basis of contemporary computational methods and computer systems this would take about  $10^{16}$  years of computing time. Seventeen years later it took only eight months in a world-wide cooperative effort to do the job. Moreover, one should realize that it always remains possible that a new computational method is invented which



Factoring RSA-512 drew world-wide attention in the media. During the press conference at CWI on 26 August, 1999, from left to right: Eric Verheul (PricewaterhouseCoopers, Utrecht, The Netherlands), Andrew Odlyzko (AT&T Labs-Research, USA), Herman te Riele (CWI), Gerard van Oortmerssen (CWI), Arjen Lenstra (Citibank, New York, USA), Paul Leyland (Microsoft Research, Cambridge, UK).

makes factoring 'easy' (for example quantum computing, if an operative quantum computer will ever be realized).

The factored number, indicated as RSA-155, belongs to a Challenge List issued by the US company RSA Data Security, Inc., which sells licences and products based on the RSA method. Thus the company hopes to remain well-informed about the power of factoring methods. Factoring numbers on this list measures how secure the RSA method actually is. For special numbers, for example of the form  $a^b \pm 1$ , factoring has proceeded to well over two hundred digits. Here too CWI holds the world record: in April 1999 the 211-digit number  $(10^{211} - 1)/9$  was factored, a computational effort comparable to factoring RSA-140.

RSA-155 required a total of 35 years of computing time on some 300 very fast SGI and SUN workstations and Pentium II PCs. Since the computations were performed mainly in parallel, the job took only seven calendar months. Computing time was provided by Citibank (US), CWI (The Netherlands), Ecole Polytechnique (France), Entrust Technologies (Canada), Centre Charles Hermite (France), Lehigh University (US), Microsoft Research (UK), Sun Microsystems (UK), and the University of Sydney (Australia). An essential step in the computation requiring an extreme amount of internal memory,

was carried out at the Amsterdam Academic Computing Centre SARA on its Cray C916 supercomputer in about ten calendar days. Distributed computation projects in which tens of thousands of PCs participate, are already underway. Combined with parallelizing the supercomputer's part in the computation (still being investigated), this warrants the expectation that factoring 512-bit numbers will require only a few days before long. ■

#### Links:

Computational number theory and data security at CWI:  
[http://dbs.cwi.nl:8080/cwwwi/owa/cwwwi.pprint\\_projects?ID=12](http://dbs.cwi.nl:8080/cwwwi/owa/cwwwi.pprint_projects?ID=12)

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## 9th WWW Conference The Web – the Next Generation

Amsterdam, 15-19 May 2000

At the Ninth International World Wide Web Conference (WWW9), leaders from industry, academia, and government will present the latest developments in Web technology, and discuss the issues and challenges facing the Web community as it moves into the 21st Century. The conference will consist of refereed paper sessions, poster sessions, panel sessions, a W3C track, and two specialized tracks: The Web and Industry, and The Web and Society. It will also feature presentations by keynote and invited speakers. The conference will be preceded by a day of tutorials and workshops, and will conclude with a developers' day. WWW9 is sponsored by ERCIM.

The Centre for Mathematics and Computer Science (CWI) is hosting WWW9 and plays a key role in organizing the technical programme. The International World Wide Web Conferences are events of the International World Wide Web Conference Committee (IW3C2), and are managed by Foretec Seminars, Inc. Tutorials and Workshops.

A program of tutorials and workshops will cover topics of current relevance to Web design, services, operation, and use. Subjects will include: XML, SVG, Web security, E-commerce, metadata, mobile use of the Web, and internationalization. These half- and full-day sessions will

feature internationally recognized authorities.

### Developers' Day

This daylong program will be devoted to the interests of Web developers, and will provide in-depth discussions of topics at the forefront of Web technologies.

### Exhibition

The exhibition will be held in a large, modern, hall adjacent to the meeting rooms. Exhibitors will display the latest offerings of Web-related hardware, software, and services. When appropriate, vendors will be presented with an interoperability challenge.

### Important Deadlines

Paper Submission: 22 November 1999  
Author Notification: 1 February 2000  
Final Paper Due: 1 March 2000

Technical papers will be refereed by an International Program Committee, and the Proceedings published by Elsevier Science B.V. Best Paper and Best Presentation awards will be presented at the conference.

Details of the paper submission process can be found on the WWW9 Web Site at [www9.org](http://www9.org). If you wish to be placed on the WWW9 Announcements mailing list, please send an e-mail message to [info@www9.org](mailto:info@www9.org).

### WWW9 Conference Committee

Conference Co-Chairs:

- Ivan Herman, CWI, The Netherlands
- Albert Vezza, CNRI, USA

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