a word
from the president
The year 1997 saw several outstanding achievements for INRIA. For the first time, one of our researchers was elected member of the Academy of Science. The first joint research unit, combining teams from the Henri Poincaré and Nancy II universities and the Institut National Polytechnique de Lorraine, as well as researchers from two organizations-CNRS and INRIA, was founded at Nancy. The creation of "cooperative research initiatives" proved to be a much appreciated means for researchers of INRIA or other organizations to explore new areas of research by combining the contributions of teams from different sites. A certain number of scientific firsts and records were established, such as finding eight prime numbers in arithmetic progression. 1997 was also the first year of the Franco-Chinese joint laboratory created by the Beijing Academy of Science and INRIA. The World Wide Web Consortium met with success and plans to bring together nearly three hundred members from all five continents in the near future. Research results, sometimes of the most fundamental kind, were transferred to applications at an ever-accelerating pace, one example of which is the complete verification of a payment protocol for electronic commerce using the Coq formal proof system. The preparation of projects for new technology companies that INRIA engineers and researchers will be launching at the very beginning of 1998 shows particular promise.

Prime Minister Lionel Jospin's speech at Hourtin placed France resolutely within the dynamic of the information society and cited INRIA as one of the assets of our country in the international scientific and technological competition of today's world. There were numerous requests for INRIA's expertise by local communities or governmental missions concerning the use and expansion of the new technologies. The government gave its authorization to the Institute to create its INRIA-Transfert subsidiary that, along with professional investors, will develop the first start-up fund in France consecrated to information and communication technology. The dominant theme of the thirtieth anniversary of the Institute was prospects for the future. Open House Days drew as many as several thousand visitors to some of our research units. 1997 also saw a sharp increase in the number of employment opportunities for qualified personnel in the area of information technology in France as well as abroad.

Here then are a few examples chosen at random to show how busy 1997 was at INRIA. Activities were carried out in a rich and fruitful environment with a lot at stake scientifically, technologically and socio-economically. It was a year during which all those who participated in the research projects and services of the Institute were very much in demand and they can be justifiably proud of the results.

The annual report offers some of these selected extracts and other information, as a prelude to the year 1998 that also promises to be rich in commitments and opportunities.

Bernard Larrouturou
President of INRIA
contents
The Institut National de Recherche en Informatique et en Automatique celebrated its thirtieth anniversary this year. The Institute was created in 1967. It became a scientific and technological institute operating under the dual authority of the Ministry of research and the Ministry of Industry in 1985. Decree 85-831 of August 2, 1985 on the organization and functions of the institute, defines the following missions:

- to undertake basic and applied research,
- to create experimental systems,
- to organize international scientific exchange,
- to ensure the transfer and dissemination of knowledge and expertise,
- to contribute to the effective implementation of research findings,
- to contribute to cooperative development programs especially through training,
- to carry out scientific evaluations,
- to contribute to standardization

In 1997, there was a budget for 715 positions at INRIA, 327 of which were for research. However, due to a dynamic policy of openness to and cooperation with numerous organizations for research and higher education in France and abroad, INRIA actually had at its disposal slightly more than two thousand personnel within its research units. The budget of the Institute amounted to 540 million francs, excluding taxes, mainly from government subsidies. Approximately one quarter of the budget stemmed from its own resources, coming from research and development contracts.

The scientific teams are organized in research projects that have a strong thematic interest in common and that enjoy a great deal of scientific and financial autonomy. The 73 current research projects are divided amongst the five research units located in the following regions: Île-de-France, Brittany, the French Riviera, Lorraine and Rhône-Alpes:

- **INRIA Rocquencourt** (west of Paris), created in 1967 (23 projects).

- **INRIA Rennes**, created in 1980 (13 projects), linked to CNRS, the University of Rennes I and Insa Rennes within the framework of Irisa.

- **INRIA Sophia Antipolis**, created in 1982 (18 projects)

- **INRIA Lorraine**, created in 1984 (8 projects), linked to CNRS, the Henri Poincaré and Nancy 2 universities, INPL and the University of Metz within the framework of Loria and the Institut Elie Cartan.

- **INRIA Rhône-Alpes**, created in 1993 (14 projects), linked to CNRS, the Joseph Fourier University, INPG and ENS-Lyon.

General headquarters and management services are situated at Rocquencourt, as well as the Development and Industrial Relations Department.
Dedicated to information and communication technology, INRIA organizes its scientific activities around four themes that give a good idea of the precise extent of the research topics.

**Theme 1: Networks and Systems**
This theme is concerned with the future of computer systems in three areas, parallel computing, network design and real-time system programming, as applied, for example, in aeronautics or the multimedia uses of computer networks. In particular, supercomputer architecture, extremely high speed protocol design, distributed computer system programming, telecommunication network modeling and the quantitative evaluation of their performance are studied within this theme.

**Theme 2: Software Engineering and Symbolic Computation**
What is at stake here is the future of software production methods. There are two main orientations: on the one hand, programming in the strict sense, including languages and programming environments with special emphasis on verification methods, and on the other hand, algorithms and their quantitative evaluation with emphasis on cryptography and problems in geometry.

**Theme 3: Man-Machine Interaction, Images, Data, Knowledge**
Work in this domain concerns generic problems encountered in the programming of a large number of future applications. One set of problems includes research on databases, in particular multimedia databases, knowledge bases and cognitive questions relating to computer use such as information, natural language and speech processing. A second set of problems includes computer vision, image analysis and synthesis, image compression, video communication, automatic reading and understanding of written document systems, satellite image processing, virtual and augmented reality, robotic vision and medical imaging, among others.

**Theme 4: Simulation and Optimization of Complex Systems**
This theme pertains to new methods, stimulated by computer developments, for the modeling and resolution of large scale problems coming from physics, biology, economics and engineering. One orientation is toward automatic control, robotics and signal processing with multiple industrial applications. Issues concerning the environment or the medical sector are also of interest. Secondly, modeling and scientific computing are connected with the modeling and simulation of complex phenomena in e.g. physics and chemistry, but also in finance, and the design of novel numerical methods.
INRIA's foremost ambition is to excel in science and to play a major role in technology transfer in its areas of research, computer science, automatic control and scientific computing.

Information and communication technologies are going to be the primary economic sector in the coming years. This is already the case in the United States. These new technologies present a formidable potential for growth and the creation of employment. They are drastically modifying all design and production processes and are transforming the whole service sector. These developments are based on an ongoing technological innovation process that is currently accelerating at full speed. This process of innovation is characterized by an extremely competitive international arena and by direct interaction with scientific developments. Everywhere in the world, private companies are finding strong support from public research institutions: the "virtuous circle" connecting fundamental research with applications is playing its role to the full. There are numerous examples of cross-fertilization.

The disciplines that constitute the foundation of the Institute's four research themes aim at designing, modeling, analyzing, simulating and controlling complex systems. These systems are either artificial systems, such as production, transportation or telecommunication systems, among others, or natural systems in the case of the genome, cognitive processes, the climate, ecosystems, combustion and so on. Fundamental or applied research results and new concepts or methods become, more often than not, basic tools for other scientific disciplines or for numerous technologically innovative sectors. INRIA's initiatives are thus constantly in a dynamic balance between progress in theoretical knowledge and the development of advanced applications. INRIA developed its scientific policy and modified its
organization based on the above principle, as defined in the Strategic Plan of 1994 and the Objectives Contract signed with the Government in 1995.

The general orientations that characterize the Institute's policy are focusing its research expertise on a few research directions identified as major scientific challenges; extending the partnership between INRIA and industrial and tertiary sector companies in information technology and its applications; enhancing cooperation with other research agencies and higher education institutions and consolidating the international presence of French research. More specific objectives falling within this general framework were just defined within the last few months. These objectives state that an exacting and thorough evaluation procedure must be continuously maintained and accompanied by the development of prospective thinking. Simultaneously, financing means must be set up to ensure that researchers can be rapidly mobilized around promising topics. The importance of the effort already initiated for technological transfer must be continued, with particular support for the creation of technology companies. A human resources policy that facilitates personnel mobility must be implemented. Finally, young Ph.D.s trained at INRIA must be offered the best professional opportunities.

The Research Projects

The scientific organization of the Institute is purposefully horizontal. There are no departments or large laboratories but only small teams. INRIA's structuring into research projects facilitates reactivity and interactions with colleagues from other French or foreign institutions and with the application sectors. The fact that there are very few hierarchical levels is good for individual initiative and mobilization around common objectives. On the average, a research project includes some twenty persons. These individuals are either researchers, engineers, technicians and administrators from INRIA, or researchers or professors from other institutions, universities, Grandes Écoles and CNRS.

Each project must achieve precise objectives within a given period of time. Projects are periodically evaluated according to criteria that take into account their scientific results and their international standing, but also the applications they generated. Thus projects do not last forever. When the major objectives are thought to be achieved or must be reconsidered, a project is then either transformed or brought to a halt. During the last three years, 14 projects were terminated and 21 new projects were created.
Evaluation and Prospective

INRIA's objective of achieving scientific excellence at the international research level demands a strong evaluation procedure. Each year, the Evaluation Committee examines two of the nine programs to which the research projects belong. Each program is thus evaluated every four years. A board of ten or so external experts is constituted to evaluate each program. Three of these experts, including one from industry, take charge of the evaluation for each project. After a meeting between the experts, the project researchers, the Institute management and the Evaluation Committee, a synthesis is written and the Committee issues recommendations concerning the general organization of the program and the evolution of each project, whether continuation, redefinition of certain objectives, profound restructuring or termination. The Scientific Board then gives its opinion and the President of the Institute finally makes an explicit decision concerning the continuation or termination of each project evaluated.

There is no compelling reason why the research areas in which the Institute will be involved five or ten years from now should be totally in keeping with the work already done. This is why it became clear that analyzing and planning ahead thoroughly on a regular basis were to identify emerging research topics and the evolution of the needs of the application sector. Such planning can be achieved by relying on the researchers involved but also on the Institute's partners, especially industry and international centers of excellence. There are two main parts, one aimed at the scientific and industrial community at large and at the supervisory authorities, that concerns the general evolution of the field, and the other for more internal use to identify shifts in orientation or new work directions for the program.

Development Initiatives and Cooperative Research Initiatives

The organization of research into research projects is supplemented by two kinds of initiatives: development initiatives and cooperative research initiatives. Approximately 10% of the Institute's budget (excluding salaries and proper funds) are consecrated to these multi-site initiatives, which all rely on the research projects.

Development Initiatives are directed by the Department for Development and Industrial Relations. They correspond to a new form of industrial partnership of a limited duration but of a larger scope than individual collaborations between industry and the research projects. An example of a development initiative is Praxitelé, in partnership with CGFTE, Dassault Électronique, EDF, Inrets and Renault. Praxitelé ended in June 1997 and resulted in an actual experimentation of a new system of individual public transportation. Another example is the partnership established in 1996 between Bull and INRIA within the Dyade GIE (Economic Interest Group). Dyade already counts several achievements in terms of Internet transaction reliability and electronic commerce protocol verification. The role played by INRIA within the World Wide Web Consortium should also be mentioned. Seven development initiatives were launched since 1994 and more than half of the Institute's research projects participated in one of them.

In addition to this, since 1997 INRIA's scientific board has a specific budget at its disposal for cooperative research initiatives. These supplementary financial means are attributed to the teams in order to foster the emergence of new topics. They also contribute to a better collaboration between INRIA's research projects and sites and encourage new scientific partnerships with other organizations. These initiatives are financed for two years. The selection of proposals is done by the Scientific Director, assisted by the Presidents of the Project Committees of the five research units, after an open consultation.
Technology Transfer

It is by now well recognized that the transfer of knowledge and skills cannot only rely on the linear scheme: fundamental research → applied research → development → industry. Economic competitiveness demands that this cycle be shortened and success often resides in taking account of the constraints of the applications as early as possible. A research organization such as INRIA, and especially in this particular field, cannot be content with “placing its results at the disposal of the community.” In order to stay at the leading edge of knowledge, technology transfer must also be placed at the heart of its policy. There is no unique method for succeeding in technology transfer but a whole set of means that can be used according to the situation and the circumstances. Based on its accumulated experience, INRIA favors three principal approaches:

- Transfer by personnel, essentially doctoral candidates and post-docs that are trained within the research projects and are the best “vectors” of the research spirit and technological innovation within companies,
- the creation of dynamic, innovative companies in the information and communication technology sector; INRIA is responsible for the start-up of more than twenty such companies. With the creation of the INRIA Transfert subsidiary beginning in 1998, the Institute is renewing its efforts in this domain. INRIA Transfert will set up assistance and financial support structure for technology company start-up,
- investment in application sectors such as the traditional engineering areas, i.e., aeronautics, aerospace, defense, automobile, chemical industry, energy production, and so on. Other areas are, of course, the field of telecommunications where the potential for development is considerable and which is increasingly based on computer science, but also medicine and health, transportation, environment, commerce and finance. This involves research contracts with companies or communities—several hundred such contracts are currently in progress—as well as long-term partnerships with other research institutions and large industrial conglomerates.

Training Through Research

Training through research of young Ph Ds or post-docs is one of the essential responsibilities of the Institute:

- more than 500 doctoral candidates are currently working in the five research units. INRIA works in close collaboration with the universities and pays keen attention to the quality of the doctoral theses prepared within its teams, and more generally, to the quality of training. Ph Ds from the Institute go into Industry and into university positions in more or less equal numbers.
- around forty young foreign researchers occupy post-doctoral positions at INRIA each year. The post-doc fellowships instituted within the Ercim European consortium make it possible for young Ph Ds to spend nine months in two institutions outside of their country of origin.
- approximately twenty scholarships are awarded to young French Ph Ds to spend a year abroad. Applications come from all of France and the Institute chooses among the applicants, together with the Ministry of Foreign Affairs, the Ministry of Research and CNRS.
- INRIA also finances “industrial post-docs” with corporate support. These positions, which take the form of a real-scale finalization or validation work, increase the chances for a successful technology transfer if the subject of the doctoral dissertation is suitable.

Satellite image segmentation using a Markovian model.
Project PASTIS
National and International Scientific Cooperation

In addition to the numerous scientific exchanges that INRIA researchers maintain as a matter of course with their French and foreign colleagues, the Institute has been pursuing a policy of openness and partnership for several years in order to share its scientific projects, its experience in terms of channeling research results and its international collaboration network with other public research and higher education institutions. A remarkable example of the implementation of this policy was the creation of Lorla (Lorraine Laboratory for Research In Computer Science and its Applications), a joint research unit with CNRS and three universities, in 1997. Furthermore, there currently exist 37 “joint projects.”

On the international level, INRIA maintains regular relations with more than 80 countries. The principal collaborations are in Europe, within the ERCIM network that involves institutions from 14 countries, as well as through European Community projects—currently more than 60 of them, in North America (agreement with the National Science Foundation), in Russia (the Lyapunov Institute, a joint project with Moscow University), in China (the Franco-Chinese laboratory inaugurated in 1997) and with several Mediterranean, African and Southeast Asian countries.

The dynamism of these exchanges is revealed by the ever growing number of foreign visitors who spend some time at INRIA every year: 650 persons corresponding to 270 man/years.

Human Resources Policy

INRIA is a relatively young institution. Within thirty years, it has met with indisputable success. In spite of its small size—slightly over 300 permanent researchers—the institute is renowned in France and throughout the world for the quality of its scientific results, the expertise of the researchers who work or were trained there and for its success in terms of transfer and the creation of companies. In light of the crucial importance of the industrial, economical and social stakes involved in the expansion of information technology, the true wealth of the Institute resides in the men and women who work within its teams. It is this wealth that will help the Institute tackle the scientific challenges of the years to come, side by side with and on the same level as other major research centers in the world. INRIA must thus continue to develop and attract talent through an open but exacting recruitment procedure. The Institute must also manage the career of its researchers, engineers, technicians and administrative personnel at best. In particular, training adapted to changing skills must be made available and individual initiative and creativity must be rewarded. In this respect, new measures were implemented in 1997:

- The instauration of the annual activity interview procedure, that allows room for a more thorough and fruitful dialogue at all levels. Team and personal objectives, the satisfaction of individual aspirations and how to talk through possible difficulties are discussed.

- The creation of a mobility task force to preserve the scientific dynamism of the Institute and to foster technology transfer. In this respect, it is necessary to encourage internal mobility, in terms of functions, themes or location, and also support external mobility projects.

On another level, one of INRIA’s constant concerns is the job market value of its non statutory personnel, even in today’s favorable context in the computer science sector. It is essential, not only for doctoral candidates, but also for collaborators under contract who participate in projects or development initiatives at INRIA, that their stay within the Institute be a definite plus for their subsequent employment prospects.

Image from a behavioral simulation performed with the general purpose animation and simulation platform GASP.
Project SIAMES
(Joint project with CNRS)
Result of a three-dimensional migration computation
Project ESTIME

Creation of video sequences
In a panoramic format from a sequence of images with panoramic motion
Project VISTA
(joint project with CNRS)

New projects created in 1997

ATOLL
Software Tools for Natural Language
INRIA Rocquencourt
Scientific leader: Bernard Lang
bernard.lang@inria.fr

COMORE
Modelling and Control of Renewable Resources
INRIA Sophia Antipolis
Scientific leader: Jean-Luc Gouzé
jean-luc.gouze@inria.fr

ESTIME
Parameter Estimation and Modelling in Heterogeneous Media
INRIA Rocquencourt
Scientific leader: Jérôme Jaffré
julio.jaffre@inria.fr

IS2
Statistical inference for Industry and Health
INRIA Rhône-Alpes
Scientific leader: Gilles Celeux
gilles.celeux@inria.fr

PARAGRAPHE
Parallelism and Graphs
INRIA Rennes
Scientific leader: Philippe Daronneau
philippe.daronneau@inria.fr

VISTA
Spatiotemporal Active Vision
INRIA Rennes
Scientific leader: Patrick Bouthemy
patrick.bouthemy@inria.fr
Nominations, Prizes and Distinctions

Michel Montpetit Prize

The 1997 Michel Montpetit Prize of the Academy of Science was awarded to Michel Sorine, head of project SOSSO (INRIA Rocquencourt), for his contributions to the development of advanced methods in automatic control and their implementation in industrial situations.

Best Paper Award at the 1997 "Automated Software Engineering" Conference

Charles Consel, Professor at the University of Rennes 1, Renaud Marlet and Scott Tihbaut, members of the COMPOSE pre-project (IRISA-INRIA Rennes) obtained the Best Paper Award for their article "Mapping software architectures to efficient implementation via partial evaluation."

INPG 1997 Doctoral Dissertation Prize

Cordélia Schmid, a doctoral candidate from the MOVII project, received the INPG 1997 Doctoral Dissertation Prize for her thesis on "Pairing Images by Greyscale Local Invariants. Applications to Object Base Indexing."

Jury’s Special Prize at the 1997 "Pirelli International Award for the Development of Scientific Culture"

The Jury’s Special Prize went to Frédéric Boussinot, from the École des Mines de Paris and a member of project MEJIE, for a demonstration of icobis programming. This type of programming was developed within the MEJIE project of INRIA Sophia Antipolis. An "icobis" possesses a graphical aspect—an icon- and a behavioural aspect, for example a movie. Following this new approach, programming no longer consists in writing lines of code but resembles more building up "cartoons" within which the components may interact.

CNRS Bronze Medal in Linguistics

The Bronze Medal of CNRS was awarded to Anne Reboul, CNRS Research Officer within the DIALOGUE project at INRIA Lorraine for her work in linguistics. It is the first time that such a distinction in linguistics was awarded to a researcher working in a computer science department.

Academy of Science

Gilles Kahn, the Scientific Director of INRIA, was elected member of the Academy of Science in November 1997, within the division of mathematical and physical sciences and their applications. Gilles Kahn is the first computer scientist to become a member of the Academy of Science.

(1) COMPOSE: joint project with CNRS, (2) MOVII: joint project with CNRS, INPG and ENSAM, (3) MEJIE: joint project with ENSMA-CMA, (4) DIALOGUE: joint project with CNRS, the Henri-Poincaré University, the Nancy 2 University and INPI.
Participation in various national bodies
- Conseil supérieur de la recherche et de la technologie (High Council for Research and Technology):
  - Jean-Pierre Verjus, Professor at the Institut National Polytechnique de Grenoble and Director of the Rhône-Alpes research unit, was appointed at CSRT as representative for the scientific and technical communities of the various research sectors.
- Institut Universitaire de France
  Jean-Paul Haton, Professor at the University of Nancy 1 and head of project SYCO (5) (INRIA Lorraine) was nominated senior member of the Institut Universitaire de France.
- Conseil supérieur des bibliothèques (High Council for Libraries)
  Jean-Claude Le Moal was nominated at the Conseil supérieur des bibliothèques. He is responsible for the Electronic Media Department within INRIA's Scientific Communication and Information Unit (UCsi).

Nominations at INRIA
- Jean-François Abramatic, President of W3C, was appointed Director of Development and Industrial Relations at INRIA on September 1st, 1997.
- Michel Cosnard was appointed Director of the INRIA Lorraine research unit, on September 1st, 1997. He replaced Alain Quéré who had been named Director of CNUSC in Montpellier.

Events
- Creation of Llama, the Franco-Chinese Laboratory for Research in Computer Science, Automatic Control and Applied Mathematics in Beijing within the framework of a collaboration between INRIA and the Chinese Academy of Science (January 1997).
- INRIA became a member of Aupelf-Uref, the French-speaking Agency for Higher Education and Research (October 1997).
- Creation of Loria in Nancy, a joint research unit with CNRS and the three Nancy universities (November 1997).
- First virtual stone of the future "Innovation and Transfer Center" of INRIA Rocquencourt, during the "Science Feast" days (October 1997).
Projects and results

VASY:
detection of a locking risk in Firewire
Firewire is a subset of the IEEE 1394 standards for high-throughput buses to interconnect PCs, television sets, camcorders and so on. The asynchronous mode of firewire was modeled in Lotus and verified using tools from the VASY initiative. This verification exhibited a case of unexpected message reception, which can lead to locking. This actual problem was communicated to the IEEE 1394 consortium.

APACHE:
solving a 430,000 atom model
A model containing a beta-galactosidase protein of 430,000 atoms, from the Brookhaven Protein Data Bank, was solved on the CRAY-T3E using the AO parallel computing platform. The problem was solved in three hours on 256 processors with an 80% processor usage rate. The models that can be found in the literature are only of the order of 30,000 atoms. The molecular dynamics code Takakaw is used by CEA.

IDOPT (a):
using Odyssee in a meteorological model
The IDOPT project, with the support of the Operational Inverse Mode cooperative initiative, was able to develop very rapidly the adjoint code of the Meso-NH meteorological model (CNRM, Météo-France and Laboratoire d’Aérologie de Toulouse, CNRS) using the automatic differentiation software Odyssee developed by project SAFIR of INRIA Sophia Antipolis.

SHERPA:
developing PowerGene
The PowerGene software was used to annotate the complete genome of the B. subtilis bacteria in less than a month. PowerGene was developed within a collaboration of the INRIA Rhône-Alpes research unit, Ifog, the Pasteur Institute and the Biometry Laboratory of the Claude Bernard University in Lyons. In addition to aiding in the choice and chaining of sequence analysis methods, PowerGene also facilitates the analysis of the results through a visualization of physical and genetic maps interface.

DYADE:
certifying CSET
(an electronic commerce protocol)
The Dyade GIE and the CB Bank Card Group got together to propose an Internet payment protocol in 1997. For the first time, a CSET payment protocol was certified using the Cog formal proof system. This gives the protocol an unequivocal level of security. This formal proof technology stems from work undertaken for more than ten years at INRIA and within the Bull group research teams.

PARA, RODIN and CRISTAL:
participating in Ariane 5 software verification
The on-board computer systems and software of Ariane 5, in charge of guiding the Ariane rocket, fulfilled their mission and made launch 502 a success. The whole organization of the software was completely redone. Aerospacetime, INRIA, and several external consultants participated in the launcher’s computer systems overhaul.

ROBOTVIS:
calibration software
Several software packages were patented at APP (Software Protection Agency) by project ROBOTVIS. They all are concerned with camera calibration. D-Cal minimizes the distortion effect. FTCalib extracts intrinsic and extrinsic camera parameters from 2D and 3D data. TotalCalib is an interactive image sequence calibration software. C-Act is an active contour library and M-Par a parametric model extraction and characterization library.

RÉSÉDAS (a):
designing and developing Moderes
In the context of distribution of service management, the RGT (Telecommunication Management Network) is becoming central in day to day network exploitation. New tools are necessary to meet the demands of this situation. Project RÉSÉDAS thus designed and developed the Moderes environment and distributed it on the Internet. Several companies are already using Moderes, such as Nolda in Germany. This environment can be used to develop standardized management models (GDMO and GRM standards) using a set of tools (analyzers, SDL generators, HTML ...). A new version of Moderes developed in Java was published recently.

(a) IDOPT: joint project with CNRS, INPG and UJF
(b) RÉSÉDAS: joint project with CNRS the University of Rennes 1 and Iseo Rennes
CROAP:
formal proof using Coq
The Coq software was developed by project CROAP to provide a working environment for the Coq proving system. The Coq system stems from a collaboration between the project by the same name and the École normale supérieure in Lyons. This system is designed to handle formal mathematical proofs. In addition to the graphic interface, Coq offers proof by mouse selection, structured editing tools and a textual explanation of the proofs. Coq as well as Coq runs on Unix workstations.

WWW:
XML, an editor for documentation on the Web
The new XML standard offers considerable possibilities of association between databases and textual documents. XML can be used to enrich the slightly limited generic HTML tags with specific, user-defined tags.

Industrial Collaborations and Technology Transfer
Commercialization of project EPIDAURE software
The Focus Imaging SA company (formerly known as Focus Medical) just increased its capital significantly to commercialize work in medical imaging carried out in collaboration with project EPIDAURE from INRIA Sophia Antipolis. Analysis and diagnosis products using cardiac volumetric image sequences are proposed. The company hired Jean-Philippe Thirion, a researcher of project Epidaure, as Scientific Director and installed its software development unit at Sophia-Antipolis.

France Telecom uses technico-economic models from random geometry
The network economic evaluation methods based on random geometry developed by France Telecom and project MISTRAL of INRIA Sophia Antipolis were used to evaluate the universal service cost submitted by France Telecom to the Telecommunication Regulation Authority. In particular for the evaluation of the cost of the local loop.

Commercialization of Nuages
The Nuages software of project PRISME for reconstructing 3D models from planar sections, is the object of a commercialization contract and is at the heart of a new real-time endoscopy simulation product constructed by Siemens.

Success of the Cocktail library
The Cocktail software library from project PASTIS, which can be used to analyze multispectral satellite images to monitor the vegetation, for example, has raised the interest of NSF and Alcatel.

Distribution GHS 3D
Enterprise Software Products, Inc., an American publisher of preprocessing tools for scientific computing and CAD, chose the GHS3D software brick for its Femap line of modeling, analysis and data visualization software tools. GHS3D is a tetrahedral mesh generator developed by project Gamma. This is an example of successful transfer of research technology to Industry.

Inauguration of the N3S-Natur consortium
The goal of the N3S-Natur consortium is to develop a code by the same name capable of covering most of the industrial needs in complex aerodynamics. One of the characteristics of this code is its ability to take into account complex, possibly moving, geometries, due to the fact that the code is able to compute on tetrahedral, unstructured meshes that evolve with time. Current applications are turbines, aircraft turbo-reactors and piston engines. École centrale de Lyon, Électricité de France, INRIA, Météo-France, Renault, Simulog and Sncema participate in this consortium. All are co-developers, co-owners and users of the code. A first version, N3S-Natur 1.1, is on Simulog’s product list.

INRIA participates in the ProHiPC Technology Transfer Node
This transfer node is financed within the HPCN (High Performance Computing and Networking) European program. The twenty some TTNs created in Europe aim at making HPCN technology better known in the corporate world. ProHiPC is coordinated by the École normale supérieure de Lyon with the participation of Matra, Simulog and INRIA. It provides a good opportunity for INRIA projects to transfer their skills to small and medium-sized companies that have an interest in the applications of parallel computing in their area. INRIA projects CAPS, OMEGA, ORION and REMAP are already involved in ProHiPC.
industrial relations
and development initiatives

In addition to research, INRIA's goal is the transfer of results to industry. There are three levels of initiatives:
- signing contracts and agreements with industry;
- implementing development initiatives;
- creating and developing technology companies.
Furthermore, wide-ranging and permanent contacts are established. This is particularly the case during the INRIA-industry meetings, which are useful to help industry better anticipate the technological orientations of their future products and to help scientists better comprehend the needs of the market.

Contracts and industrial partnerships

At the end of 1997, the number of current contracts was 300, 140 of which had been signed during the year. These contracts were of several types: research or consultancy contracts, license agreements as well as know-how transfer contracts. They were generally concluded directly by the research projects and concern large corporations, as well as small and medium-sized companies. Some of these contracts were signed within the framework of the 120 European projects in which INRIA participates. The technology and expertise transfers thus produced generated an innovative industrial fabric covering all the techniques involved. They led to the commercialization of thirty some products in varied areas.

The partnerships established by the Institute were designed to contribute to the solution of problems in information technology posed by industry or administrative services. These partnerships help INRIA to achieve or reinforce prominent worldwide positions in strategic research sectors. The partnerships sometimes take the form of framework agreements. This is the case with Alcatel, Bull (Dyade GIE), Berlioz, Rank Xerox, Renault and Thomson-CSF, in particular.
Development initiatives

Development initiatives offer another means of fostering technology transfer. They are programs for a specific duration—generally three to five years—that are pursued in collaboration with one or several leading firms or users in information technology. They have a significant budget. Industrialists benefit from development initiatives by improving their technological capital and by gaining an opening to new opportunities. Development initiatives also constitute an efficient means for INRIA to channel its results and discover new research directions. The quality of participants and funding from external partners provide a good indicator of the actual impact of the Institute. Most development initiatives usually involve several INRIA projects. They present an opportunity for coordination, or even cross-fertilization, between the research projects and the technology companies.

Development initiatives that reached their conclusion in 1997:

Praxitelé

Praxitelé was launched in 1993 in collaboration with CGEA, Renault, EDF, Dassault Electronique, Soebe, GTI, Inrets and the École des mines de Paris. Its purpose was to demonstrate the feasibility and socioeconomic interest of a new public transportation system based on electrical self-service individual vehicles through an actual on-site experimentation. In October 1997, the initiative resulted in the installation of the first operational system of this type worldwide at Saint-Quentin-en-Yvelines.

In addition to this operation conducted with traditional cars (electrical Clio), INRIA also conducted research on new concepts for urban vehicles making use of computer resources and robotics. This research led to the presentation of the "CyCab" in June 1997. CyCab is an entirely new vehicle allowing for secure driving and automated driving in trains.

By coordinating the research work of 14 INRIA projects, the Praxitelé initiative placed the Institute on the leading edge of "Intelligent transportation.

http://www-rocq.inria.fr/praxitelé/

Prévisia

Prévisia was created from a common interest shared by four partners, BNP, EDF, France Telecom (CNET) and INRIA, for the evolution of information systems toward shared architectures. In April 1994, the four partners regrouped within a GIE to realize a set of services that valorized this type of architecture. The project was structured around five modules. Three of the modules concerned service development:

- a directory based on X.500 technology (Axia),
- a workflow service based on object messaging (Cldria),
- a transactional service based on the X/Open and OMG standards (Tosia).

The remaining two modules concerned the global architectural design and the construction and exploitation of the platform. Prévisia came to its end in April 1997. It led to the announcement by Nexor of a product stemming from the EIS (Enterprise Information System) scheme federator developments.

Significant advances in standardization were also achieved.

Ongoing Development Initiatives

Dyade

Information and communication technology is evolving to supply new services to an increasing number of users through a worldwide information highway network.

To accompany this evolution, Bull and INRIA launched a strategic partnership in April 1996—the Dyade GIE. Its objective is to invent and exploit new technological routes that will meet needs in information and intermedia tion systems. These routes revolve essentially around Internet/intranet infrastructures and their applications. In order to master the complexity of these new systems and to guarantee the quality of service demanded by the users, the primary task to be undertaken concerns infrastructure
robustness and software component quality.
Cooperation between Bull and INRIA teams is organized
around initiatives with a precise and limited goal.
Each initiative must demonstrate its industrial interest within
one to two years.
In 1997 the Dyade GIE announced the following results:
• the development of jingle, a videoconferencing
and cooperative work software for PCs, within the Visioconf
initiative. The initiative was transferred to Bull and the software
will hit the market in 1998
• the co-realization of a prototype "JavaCard", a smart card
supporting Java, and of a prototype "JavaTerminal" (secure API
for smart card and payment terminal drivers) in the framework of
a partnership with CRP.
• a demonstration of the Aquarelle access server, following the
development of two components for project Aquarelle, see
Médiaculture below.
http://www.dyade.fr

Médiaculture
The goal of Médiaculture is to design a distributed information
system on cultural heritage. Médiaculture brings together the
work of more than twenty partners – INRIA projects, technolo-
gy companies, users, research organizations and industry.
Most of the work is performed within project Aquarelle, which
is financed by the Telematics Applications program of the
European Union. Following a feasibility study and preliminary
work in 1994–1995, the first prototype demonstrations and
evaluations were performed in 1996–1997.

The main technical objectives are as follows:
• developing a search system to locate available documen-
tation,
• supplying hypertext and query navigation tools to access
documentation servers,
• offering a connection to a given server or a search over the
whole set of relevant servers,
• designing and installing an Aquarelle server to assist in the
formulation, translation and emission of queries,
• designing and realizing an environment for the creation of
multimedia files and reuse of reference information available
on the network.
More specific work is being carried out for the French Ministry
of Culture, concerning the General Inventory files and the
contrastive indexing of Web sites.
http://www.inria.fr/Equipes/MEDIACULTURE-eng.html

Génie
Génie's objective is to meet the needs of the French aeronautics
industry that must master the integration of such complex
systems as the Airbus, Falcon or Rafele aircrafts, to preserve
its position on the market. In order to achieve this, industry
must be aware of scientific progress to rapidly spread research
tools into the productivity toolbox, and on the other hand to
integrate those tools together as "concurrent engineering.
" Concurrent engineering means that the personnel and
resources are organized in a distributed fashion during the
entire life cycle of a product, from its design to its operational
exploitation. Information technology is one of the keys for this
type of organization.
Génie currently groups Dassault Aviation, Aerospatiale, eleven
INRIA research projects and three of its technology companies.
The general objectives of Génie are organized in two sets that
encompass the specific objectives of each of the program's
five themes:
• work on the means of communication and cooperation
between computer tools within a local or global network,
• work on tools to gather, exploit and update knowledge in
particular technical areas.
The continuity of the design process and the global coherence
of the data shared by various trades depends on the progress
accomplished for each tool and on their interconnection.
W3C

The International World Wide Web Consortium

W3C's mission is to lead the evolution of the World Wide Web while preserving its interoperability. W3C groups together more than 240 organizations worldwide. The consortium is hosted by three research laboratories: the Laboratory for Computer Science, at the Massachusetts Institute of Technology (MIT-LCS) for America, INRIA for Europe and Keio University for Asia.

W3C is an international industrial consortium whose role is to establish common specifications regarding the evolution of the Web. The consortium issues "recommendations"—technical specifications approved by the member organizations. Important results were obtained in 1997 in the three main work areas:

- architecture (communication between machines): in addition to the HTTP protocol, a recommendation for XML (Extensible Markup Language) for the exchange of data and structured documents on the Web, was issued. A new specification—SMIL (Synchronized Multimedia Integration Language)—to support synchronized multimedia applications— is furthermore under development.

- user interface (human-machine communication):
  - publication of HTML 4.0 (HyperText Markup Language) and development of CSS2 (Cascading Style Sheets) that can be used to specify globally the graphical aspect of HTML documents.
  - DOM (Document Object Model), a programming interface that is both platform-independent and programming language-independent.
  - MathML, a language to represent mathematical formulae within Web pages.
  - development and distribution of the Amaya software, a browser and authoring tool.

- technology and society (communication between persons):
  - PICS (Platform for Internet Content Selection), a platform that can be used to select information depending on the users, e.g., for parental control or personalized information diffusion.
  - Metadata, or how to exchange information about documents that is intelligible by the machines.
  - digital signatures to guarantee the reliability of information exchanged on the Web.

- P3P (Platform for Privacy Preferences), to deliberately choose which personal information is submitted to the servers.

In November 1997, W3C launched the W3C-LA (Leveraging Action) Initiative. The goal of this initiative is to promote W3C work to extend Web usage in the European industry. W3C-LA is financed by the Esprit program of the European Community.

Further information about W3C is available at:
http://www.w3.org/

The technology companies

In 1997, the twenty technology companies stemming from INRIA represented 860 jobs and a combined turnover of approximately 480 MF.

The first goal of these companies is to transfer the know-how or the prototype products from the Institute, bring them up to industrial standards and commercialize them. INRIA contributes to their creation by supplying financial and personnel support.

The companies provide INRIA with high level industrial and technological information that can be used to better orient future research.

In order to reinforce the dynamics of creation and development of advanced technology companies, INRIA founded the "INRIA-Transfer" subsidiary at the beginning of 1998.

The necessary support means are being set up in collaboration with finance professionals.
international relations

The globalization of exchanges and the growing prominence of the Internet are conferring more and more importance to INRIA’s international relations.

A policy of exchange visits for young scientists is a prerequisite for any well planned international cooperation. The other guiding principle of the Institute’s international strategy is to favor cooperation with industry participation.

Launching LIAMA, the Franco-Chinese laboratory, was the main operation of 1997. A joint project of the Chinese Academy of Science and INRIA, LIAMA is located in the Automatic Control Institute of Beijing. Among the seven projects started in 1997, two include industry participation. Two French doctoral candidates are on long-term mission at the laboratory. Open House Days in December provided an opportunity to present the activities of the laboratory to Chinese and French companies.

The Liapunov Institute is a joint department of Moscow University and INRIA. This is another example of a specific institution managed within the framework of structured bilateral relations over several years. The Institute was renewed for three years after an initial period of the same duration.

In addition the Franco-Chinese operation, INRIA is paying particular attention to provide more structure to its collaborations in the Far East.

Cooperation has existed for several years between France and Japan in rewriting, type theory and robotics, to name a few areas. In 1997, a group of researchers visited centers working in virtual reality. A collaboration agreement was furthermore signed with NEC, concerning parallel computing and wireless networks.

In September, the Institute participated in the Asian Computing Conference and renewed its three-year cooperation agreement with AIT.

INRIA presented the CyCab vehicle—a result of the Praxitèlæ development initiative—at the 1997 Tech Connect show in Singapore. An agreement with the Nanyang Technical Institute is in preparation. This agreement provides for the construction of a limited series of this vehicle by the Robossco company. Additionally, a visit to the Institute of System Sciences was the occasion for identifying several other possible cooperation directions.
Cooperation with India is not yet up to par with the capabilities of this country. Two visits in 1997 should result in a targeted cooperation.

Following the French-speaking colloquium in Hanoi in October, a collaboration with the Hanoi French-speaking Computer Science institute is in preparation. INRIA also became a member of Aupelf-Uref, the French-speaking academic agency, and seconded a researcher to the agency to help in network technology training. Aupelf will provide financial support to the CARI'98 conference. INRIA is currently working on the preparation of the fourth edition of this conference that will be held in Dakar in October.

Scientific relations with North Africa were particularly strengthened during 1997. The flux of trainees and doctoral candidates from Morocco and Tunisia should increase significantly in 1998. Scientific relations with North America date from too far back and are far too numerous to be listed here. Let us simply mention meetings with the management of Canadian organizations wishing to enhance their collaboration with INRIA, such as CRM in Montreal and the University of Western Ontario, London, (W.O.) The long standing relations with Brazil and the southern countries of Latin America are steadily growing.

In Europe, the Institute considers the development of the ERCIM consortium of primary importance. Bernard Larroulroux is at the head of ERCIM since November. ERCIM is a European Economic Interest Group entirely financed by its members. It now has 14 organizations representing most countries of the European Union and several Eastern European countries. The ERCIM post-doctoral exchange program is particularly active. The exchange of permanent personnel also fosters the development of bilateral projects and several work groups were constituted into active communities on diverse themes. It is to be hoped that ERCIM will be recognized progressively as a European body representing research in computer science and mathematics.

Morocco

 Signing of a framework agreement between INRIA and the National Higher Education School for Computer Science and System Analysis (ENSAS) in Morocco, on September 5, 1997.

The agreement is to welcome engineering students and developing collaboration with this school.
Training Through Research

Training doctoral candidates or post-docs through research is one of the essential tasks of the Institute, along with developing scientific knowledge and technology transfer. Like all other public scientific and technological institutions, INRIA does not grant diplomas. The Institute, however, actively collaborates with institutions of higher education, i.e., universities and grandes écoles, and welcomes trainees and doctoral candidates.

Two figures will give a better idea of INRIA's involvement in training through research:

- 50 doctoral dissertations in computer science, automatic control and scientific computing prepared within an INRIA research project are defended each year. This represents approximately 20% of all dissertations obtained in France in these areas per year.
- More than 500 doctoral candidates are currently working within INRIA's research projects.

Advising Doctoral Candidates

INRIA pays close attention to the quality of the theses that are prepared within its research projects, as well as to the quality of training received by the candidates and to their professional prospects. It is in this spirit that INRIA supervises the way doctoral candidates are advised and proposes further training.

The doctoral candidates are full members of the research projects and participate in the seminars, work groups, and possibly research contracts. They have the opportunity of leaving INRIA for scientific visits in France or abroad.

Teaching

In addition to doctoral advising, INRIA researchers and engineers participate in numerous graduate and sometimes undergraduate courses at the universities and grandes écoles. This participation represents more than 5,000 hours of teaching and often constitutes an essential contribution to the doctoral programs concerned.

INRIA also welcomes a great many trainees in its research projects, in the framework of training periods at the end of studies in engineering schools or DEA training periods. There were 240 such trainees at INRIA in June 1997. Most research projects are connected to one or several DEAs through these training periods.

Furthermore, 13 doctoral programs have signed a collaboration agreement with INRIA and receive subsidies from the Institute toward their current operating expenses.

INRIA also organizes and supports one to two-week summer schools, in particular the CEA-EDF-INRIA summer schools.

Post-doctoral training

The Institute also offers several opportunities for post-doctoral training:
- Forty-five young foreign researchers are welcomed to its research projects.
- Approximately twenty young French PhDs are sent abroad.
- Seven new scholarships for post-doctoral positions in industry were started in 1997 to transfer the results of research. These positions are for one year.

Diffusion of Knowledge

A Few Conferences

SIGCOMM'97

SIGCOMM'97 is the annual conference of the Data Communications group of ACM (Association for Computing Machinery). The conference was organized by INRIA Sophia Antipolis with the support of the PACA region. It was held in Cannes from September 14 to September 16, with more than 400 attendees. SIGCOMM is a major international event for a specialized circle of researchers and industry representatives who get together to propose technical and scientific evolutions for the Internet protocols (new protocols, new control mechanisms, new applications, and so on).

SOSP: the 16th Symposium on Operating Systems Principles

This symposium is held every other year. It was organized by INRIA and ACM, on the theme "operating systems principles." More than 350 persons attended SOSP in Saint-Malo from October 5 to October 8. It was the first time in thirty years that the conference was held outside the United States. The best academic and industrial departments presented their vision of the future of such research subjects as computer system security, mobile computer systems and multimedia applications.

IROS 97

IROS 97 was a IEEE/RSI International conference on robots and intelligent systems, on the theme "advanced robotics for real world applications." For its tenth anniversary, the conference was held for the first time in France, at Grenoble from September 7 to September 11. It was organized by INRIA Rhône-Alpes. There were more than 400 participants and 274 presentations. Private companies were able to present their latest results and studies in intelligent systems and robots during a show in parallel with the conference.
Engineering and Fractals
This conference held in Arrachon from June 25 to June 27, brought together a hundred researchers and engineers involved in all domains of fractal analysis. Presentations were on recent theoretical advances as well as industrial applications.

Computational Science for the 21st Century (CS21)
This meeting was organized by INRIA, Houston University and Gami/SMAI in collaboration with the Collège de France, Ecomas, the Pierre et Marie Curie University and the University of Tours. It was held in Tours from May 5 to May 7 on the occasion of Professor Roland Glowinski's 60th birthday. Many world experts in scientific computing were present. It is expected that new ideas to tackle the challenges of the 21st century in scientific computing and its applications will emerge from the meeting.

INRIA Researchers Publish

Numerical Methods in Financial Mathematics
L. C. G. Rogers and D. Talay* (Editors)
Cambridge University Press, 1997, 326 pages

Numerical methods in finance recently emerged as a new discipline, situated at the intersection of probability theory, finance and numerical analysis. This book is the only up-to-date reference on the subject. It is aimed at economists, probability theorists and mathematicians who work on financial models. Based on a series of lectures given at the Newton Institute, the book describes a large variety of numerical methods used in financial analysis: option price computation, numerical computation of portfolio management strategies, statistical procedures and model identification, market simulation, among others.

* Denis Talay, project OMEGA, INRIA Sophia Antipolis.

Computational Science for the 21st Century
John Wiley & Sons, 1997, 860 pages

Scientific computing today has an important impact on engineering, physics, biology, management and the social sciences. This book is addressed to the applied mathematicians, computer scientists and engineers who will shape scientific computing in the 21st century. It combines theory and applications. A wide vista of scientific computing is offered, from modeling to linear algebra, domain decomposition, fluid mechanics, structural mechanics, electromagnetism, optimization and control and so on.

* Marie-Odile Brissaud, project M3N, INRIA Rocquencourt

Quality of Computer Calculations
Masson, 1997, 164 pages

In computer science, a round-off error is committed with each mathematical operation. It is important to determine whether such errors tend to compensate each other or accumulate during long numerical computations. This work describes the various aspects of the numerical error problem and discusses some solutions.

* Olivier Beaumont, Joselyne Erhel and Bernard Philippe, project ALADIN, INRIA Rennes

Delaunay Triangulation and Meshing
Applications to Finite Elements
P.-L. George, H. Borouchaki*
Hermès, 1997, 432 pages

Meshing plays a fundamental role in engineering science and constitutes an important economic stake. This book is for students, researchers and engineers who work in the field. It is based on academic and industrial examples. Various meshing techniques are presented, either based on Delaunay triangulation or on "classical" triangulation construction and mesh generation methods. Planar, surfaces and volumic meshes are treated.

* Paul-Louis George, project GAMMA, INRIA Rocquencourt.
Communication

and scientific information

Communication

In 1997, four events witnessed to the development of INRIA in the regions of France:

- The installation of INRIA Rhône-Alpes in the new premises built in Montbonnot near Grenoble. The inauguration of the building in February provided an occasion to present the scientific activities of the research unit to a wide public of invited persons. These activities often are in collaboration with the local universities and industry.

- Setting the first (virtual) stone of the "Innovation and Transfer Center" that is under construction on the Rocquencourt site. This center is a concrete manifestation of the Institute's openness policy. It will foster scientific exchanges by offering a conference center as well as a documentation center fully outfitted with the state-of-the-art equipment. The center will also contribute to the creation of innovative information technology companies by offering the services of an activity hatchery.

- The inauguration of the Ceramics building (Center for Teaching and Research in Mathematics, Computer Science and Scientific Computing) at Sophia Antipolis in September. Ceramics is a joint laboratory of INRIA and the École nationale des ponts et chaussées.

- The creation of Loria (Lorraine Laboratory for Research in Computer Science and its Applications) in November. Loria is a joint research unit that brings together CNRS, the universities of Nancy and INRIA.

The last two events fully illustrate the Institute's commitment to a stronger partnership with the academic community for the development of French research and higher education in computer science.

Another important commitment of INRIA is to open its doors to the general public. Several Open House Days were organized at Rocquencourt and Sophia Antipolis in October during the Science Feast days, and also in Rennes in November. Numerous scientific demonstrations, videos, Web presentations and games were offered to several thousand persons, including many young people. For them it was an opportunity to discover what research actually is and to form an idea of what is its impact on economic, industrial life and day-to-day life. A large diversity of topics were included—multimedia applications, the Internet, virtual images, robotics and simulation, among others. The applications presented, such as CyCab, the small electrical vehicle, were indeed a big success.

In addition to such occasions, INRIA presents its activities using a large number of communication media, either in paper or electronic form:

- INédit, INRIA's newsletter, launched two years ago, is increasingly successful. Its circulation has grown significantly through subscriptions to its electronic version (+400 in one year).
- The publicity brochures of the research units were updated at Rennes, Rocquencourt and Sophia Antipolis, thus offering a new presentation of their activities.
- INRIA's Web server was also rejuvenated, with a new presentation, new organization of the information and richer headings. The internal server is currently being restructured. It offers increased information access and exchange facilities for the Institute's personnel. The agendas and minutes of the main committees, practical guides on how to distribute a publication, write a dissertation or get more training are thus made widely available.

Finally, 1997 was a major year for communication overall. Indeed, the Scientific Communication and Information Unit (UCIS), created four years before, was evaluated. This evaluation was conducted by a group of six experts, three from the Institute and three from outside. It was supplemented by a work session on the future of Scientific Communication and Information attended by approximately forty persons, including the evaluation experts, UCIS members, professionals from other organizations (CNRS, Cemagref, Inrets, GIFI, Van Dijk Bureau) and researchers in communication.

The evaluation made evident the role played by UCIS in terms of initiatives and coordination, the interest of its transversal position in the conduct of the Institute communication policy, in coordination with the persons in charge of communication within the research units as well as with the management and the researchers themselves. A few remarkable achievements were singled out, such as INRIA's Web server, the newsletter INédit, the Annual Report and the electronic publication of the scientific activity reports, the Thesauria electronic bulletin in
Technical and Scientific Information (TSI) and the INRIA-industry meetings, to name the primary recent accomplishments. Following the evaluation and the work session, a new organization of communication will be established in 1998. In particular, a position for a delegate for communication and scientific and technical information will be opened up in the general management, thus confirming the importance of this domain for the Institute.

Email: communication@inria.fr

Documentation centers

INRIA has one documentation center per research unit. Taken together, these centers represent the largest documentation stock in computer science in France and they constitute a reference library in the field. They have also been selected as associated centers for the Bibliothèque nationale de France (the French National Library).

Documentalists must meet the needs of internal and external users, researchers from other institutions or industry, students and so on. Thus, very early on, they opened their catalogs for consultation on the Internet and developed Web servers offering a selection of relevant sources of information. Users can consult documentation bases, thematic electronic catalogs from other libraries, publishers, research reports and journals and bibliographical servers. The documentalists are also involved in making the institute's publications available in electronic form. The starting point is:

http://www.inria.fr/Documentation/centres-eng.html

Users can also consult the most important bibliographical databases in computer science and mathematics on CD-ROM or Web servers: Inspec (IEE), MathSci (AMS), Zentralblatt für Mathematik (EMS).

The documentation centers also participate in various networks:

- The network of mathematics libraries, recently reinforced by the creation of the MathDoc unit.

Due to the current expansion of digital libraries, the documentation centers started to think about the future of their activities and how to accommodate this new environment. The recent change in documentation software should result in a more collective and efficient management of the processing and circulation of documents between the research units. New electronic services are being proposed:

- Calliope (a collaboration Inria/Imag/Rank Xerox research center) an experimental project of distributed digital library based on digitization on demand of articles from mathematics and computer science journals (approximately 65 titles available).
- Electronic journals: in 1997, the centers subscribed to several electronic versions of journals by organizations like ACM and SIAM, and experimentally by publishers like Springer and Elsevier. Access is restricted in Intranet on the documentation servers.
- Bibliographies: several centers bought a subscription to the network version of the bibliographical databases, sometimes in association with neighboring universities. Researchers access these databases by Intranet, either MathSciNet or Zentralblatt für Mathematik depending on the center.

### Documentation stocks

<table>
<thead>
<tr>
<th></th>
<th>Rocquencourt</th>
<th>Rennes</th>
<th>Sophia Antipolis</th>
<th>Nancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodicals</td>
<td>750</td>
<td>210</td>
<td>320</td>
<td>260</td>
</tr>
<tr>
<td>Books/monographs</td>
<td>12 420</td>
<td>5 600</td>
<td>5 700</td>
<td>2 870</td>
</tr>
<tr>
<td>Conference proceedings</td>
<td>9 540</td>
<td>3 300</td>
<td>4 600</td>
<td>2 980</td>
</tr>
<tr>
<td>Doctoral dissertations</td>
<td>10 190</td>
<td>2 900</td>
<td>5 200</td>
<td>3 500</td>
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<tr>
<td>Research reports</td>
<td>45 200</td>
<td>18 600</td>
<td>12 300</td>
<td>9 800</td>
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<tr>
<td>Videos</td>
<td></td>
<td>50</td>
<td>400</td>
<td>100</td>
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<tr>
<td>Standards</td>
<td>1 140</td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The Inria Rhônes-Alpes subsidiary uses the Imag Bibliothèque.
human and financial resources

Staff

Since 1986, permanent staff members of INRIA have the status of civil servants of a public establishment of scientific and technological character (EPST). The body of researchers includes research officers on the one hand, and research directors on the other.

The competitive examination for recruitment is organized on the basis of qualifications and work undertaken at the doctoral thesis level (at least 8 years of higher education) and/or a diploma from an engineering "grande école". Researchers who have successfully passed the RO2 or RD2 examination are assigned to research projects.

There are several categories of engineers, technicians and administrators. The table below gives a breakdown of the various categories of officials:

permanent Positions
As of 31 December, 1997

<table>
<thead>
<tr>
<th>Staff Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researchers</td>
<td>307</td>
</tr>
<tr>
<td>Research Directors</td>
<td>128</td>
</tr>
<tr>
<td>Research Officers</td>
<td>179</td>
</tr>
<tr>
<td>Engineers, Technicians, Administrators</td>
<td>385</td>
</tr>
<tr>
<td>Research Engineers</td>
<td>98</td>
</tr>
<tr>
<td>Design Engineers</td>
<td>62</td>
</tr>
<tr>
<td>Assistant Engineers</td>
<td>47</td>
</tr>
<tr>
<td>Research Technicians</td>
<td>83</td>
</tr>
<tr>
<td>Assistant technicians</td>
<td>28</td>
</tr>
<tr>
<td>Technical Officers</td>
<td>6</td>
</tr>
<tr>
<td>Research Administration Executives</td>
<td>2</td>
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<tr>
<td>Research Administration Attachés</td>
<td>15</td>
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<tr>
<td>Research Administration Secretaries</td>
<td>34</td>
</tr>
<tr>
<td>Research Administration Assistants</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>692</td>
</tr>
</tbody>
</table>

The number of engineering consultants is rising sharply. They are essentially involved in INRIA's contracts and development initiatives.

Regional staff

In 1997, INRIA's research programs were carried out by 307 permanent researchers and 1,239 other scientific staff members (external collaborators, professors, researchers from other institutions, etc.), including approximately 600 doctoral fellows and trainees.

This potential of 1,546 scientists was supported by 210 engineers, 120 technicians and 63 administrative officers, to which should be added 154 short-term, part-time, solidarity employment contracts and other non-statutory personnel.

The staff members collaborating in the research projects of the institute, including joint projects undertaken with other bodies (CNRS, universities, etc.), are distributed over the various regional sites as shown in the table below:

Non-statutory staff
(May/year, 1997 figures)

<table>
<thead>
<tr>
<th>Staff Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Fellows</td>
<td>59</td>
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<tr>
<td>MENRT Fellows w/ complement</td>
<td>46</td>
</tr>
<tr>
<td>Overseas Fellows</td>
<td>16</td>
</tr>
<tr>
<td>CSNE</td>
<td>3</td>
</tr>
<tr>
<td>Post-doctoral Fellows</td>
<td>16</td>
</tr>
<tr>
<td>Industrial Post-doctoral Fellows</td>
<td>8</td>
</tr>
<tr>
<td>HCM Fellows</td>
<td>7</td>
</tr>
<tr>
<td>Research Trainees</td>
<td>51</td>
</tr>
<tr>
<td>Foreign Fellows and Trainees (CIES)</td>
<td>70</td>
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<tr>
<td>Engineering Consultants</td>
<td>108</td>
</tr>
<tr>
<td>Scientific and External Consultants</td>
<td>31</td>
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<tr>
<td>Invited Persons</td>
<td>5</td>
</tr>
<tr>
<td>External Collaborators</td>
<td>26</td>
</tr>
<tr>
<td>Part-Time Staff</td>
<td>36</td>
</tr>
<tr>
<td>Short-term Staff</td>
<td>31</td>
</tr>
<tr>
<td>Solidarity Employment Contracts</td>
<td>8</td>
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<tr>
<td>Consolidated Employment Contracts</td>
<td>19</td>
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<tr>
<td>Apprentices</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>583</td>
</tr>
</tbody>
</table>
The Evolution of INRIA budgeted positions

<table>
<thead>
<tr>
<th>Year</th>
<th>Researchers</th>
<th>ETA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>194</td>
<td>306</td>
<td>500</td>
</tr>
<tr>
<td>1986</td>
<td>206</td>
<td>319</td>
<td>525</td>
</tr>
<tr>
<td>1987</td>
<td>213</td>
<td>321</td>
<td>534</td>
</tr>
<tr>
<td>1988</td>
<td>220</td>
<td>327</td>
<td>547</td>
</tr>
<tr>
<td>1989</td>
<td>233</td>
<td>334</td>
<td>567</td>
</tr>
<tr>
<td>1990</td>
<td>246</td>
<td>346</td>
<td>592</td>
</tr>
<tr>
<td>1991</td>
<td>258</td>
<td>357</td>
<td>615</td>
</tr>
<tr>
<td>1992</td>
<td>272</td>
<td>368</td>
<td>640</td>
</tr>
<tr>
<td>1993</td>
<td>292</td>
<td>380</td>
<td>672</td>
</tr>
<tr>
<td>1994</td>
<td>304</td>
<td>385</td>
<td>689</td>
</tr>
<tr>
<td>1995</td>
<td>315</td>
<td>389</td>
<td>704</td>
</tr>
<tr>
<td>1996</td>
<td>325</td>
<td>388</td>
<td>713</td>
</tr>
<tr>
<td>1997</td>
<td>327</td>
<td>388</td>
<td>715</td>
</tr>
</tbody>
</table>

* Including the 3 staff management positions.

The total amount of INRIA and non INRIA (Universities, CNRS) personnel involved in research projects

As of December 31, 1997

<table>
<thead>
<tr>
<th>Scientists</th>
<th>ETA/COD Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorraine Research Unit</td>
<td>256 86 60 316</td>
</tr>
<tr>
<td>Rennes Research Unit</td>
<td>246 111 74 320</td>
</tr>
<tr>
<td>Rhône-Alpes Research Unit</td>
<td>269 103 53 313</td>
</tr>
<tr>
<td>Aix-Marseille Research Unit</td>
<td>339 93 137 467</td>
</tr>
<tr>
<td>Sophia Antipolis Research Unit</td>
<td>228 93 73 411</td>
</tr>
<tr>
<td>Head office, Development initiatives and Information Unit (UCIS)</td>
<td>116 14 50 266</td>
</tr>
<tr>
<td>Total</td>
<td>1,546 500 547 2,093</td>
</tr>
</tbody>
</table>

The total number of persons remunerated by INRIA in 1997 amounted to 1,286 man-years.

The next table gives a breakdown of human resources by theme and by development initiative, and in terms of operational and technical support.

<table>
<thead>
<tr>
<th>Themes</th>
<th>INRIA positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researchers</td>
<td>ETA</td>
</tr>
<tr>
<td>1. Networks and distributed systems</td>
<td>59</td>
</tr>
<tr>
<td>2. Software engineering and symbolic computation</td>
<td>55</td>
</tr>
<tr>
<td>3. Man-machine interaction, images, data, knowledge</td>
<td>71</td>
</tr>
<tr>
<td>4. Simulation and optimization of complex systems</td>
<td>85</td>
</tr>
<tr>
<td>Development initiatives</td>
<td>9</td>
</tr>
<tr>
<td>Research Units computer support</td>
<td>3</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>282</strong></td>
</tr>
<tr>
<td>Management</td>
<td>21</td>
</tr>
<tr>
<td>Common national services, computer department</td>
<td>1</td>
</tr>
<tr>
<td>Headquarters administration</td>
<td>1</td>
</tr>
<tr>
<td>Research units administration</td>
<td>-</td>
</tr>
<tr>
<td>General infrastructure, supplies, mail, maintenance, restaurant</td>
<td>-</td>
</tr>
<tr>
<td>Social services</td>
<td>-</td>
</tr>
<tr>
<td>Ucis</td>
<td>2</td>
</tr>
<tr>
<td>Documentation</td>
<td>-</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>25</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>307</strong></td>
</tr>
</tbody>
</table>

The 1997 budget

The budget of the Institute, (staff costs, budgetary funds and self-funding resources) amounted to 583,5 MF taxes included, including government subsidies of 465,810 MF and 117,690 MF of self-financing resources.

<table>
<thead>
<tr>
<th>Trends in INRIA budget</th>
<th>a/Personnel Costs</th>
<th>b/Total Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in MF taxes included)</td>
<td>(in MF taxes included)</td>
<td>Ratio a/b</td>
</tr>
<tr>
<td>1987</td>
<td>151,800</td>
<td>3,277,268</td>
</tr>
<tr>
<td>1988</td>
<td>154,250</td>
<td>3,473,073</td>
</tr>
<tr>
<td>1989</td>
<td>169,000</td>
<td>2,782,873</td>
</tr>
<tr>
<td>1990</td>
<td>185,666</td>
<td>3,377,977</td>
</tr>
<tr>
<td>1991</td>
<td>210,968</td>
<td>4,474,744</td>
</tr>
<tr>
<td>1992</td>
<td>234,301</td>
<td>4,269,089</td>
</tr>
<tr>
<td>1993</td>
<td>254,674</td>
<td>4,777,973</td>
</tr>
<tr>
<td>1994</td>
<td>269,799</td>
<td>5,155,974</td>
</tr>
<tr>
<td>1995</td>
<td>278,337</td>
<td>5,366,311</td>
</tr>
<tr>
<td>1996</td>
<td>300,028</td>
<td>5,817,584</td>
</tr>
<tr>
<td>1997</td>
<td>307,980</td>
<td>5,836,500</td>
</tr>
</tbody>
</table>

Regional allocations for the 1997 INRIA budget

| INRIA Lorraine Research Unit | 51,165 |
| INRIA Rennes Research Unit | 72,252 |
| INRIA Rhône-Alpes Research Unit | 36,664 |
| INRIA Aix-Marseille Research Unit | 181,747 |
| INRIA Sophia Antipolis Research Unit | 103,570 |
| Head Office/Ucis/Inter-project Initiatives | 138,578 |
| **Total** | **583,500** |
computer resources

The objectives

In order to achieve the Institute’s objectives, all of INRIA’s personnel must have technical resources, particularly computer resources, at their disposal that:

- are capable of high performance, i.e., at the highest technological level,
- are adapted to the various activities carried out at the institute, in particular fundamental and applied research, development and management,
- facilitate exchanges and cooperation with all of INRIA’s industrial and scientific partners by staying abreast of technological developments.

The means

On each site, the management and exploitation of the computer equipment is handled by computing departments, comprised of nearly one hundred engineers and technicians. Toward the end of 1997, the entirety of computer equipment represented more than 2,500 Unix workstations/servers and X terminals and more than 800 microcomputers. From the architectural standpoint, all the computer facilities form a part of a distributed yet highly cooperative organization based on very high speed local communication networks (Ethernet 10/100 Mbs, ATM commutators) and on Reneter, the national research network, for national and international communications (from 2 to 34 Mbs depending on the site).

The general framework

The deployment of INRIA’s computer resources is outlined in the Computer Resource Master Plan (1995-1998), whose main traits are listed below:

- priority to applications versus technology, which implies more openness to heterogeneous hardware and software configurations,
- an even more cooperative organization of computer resources that will be able to best follow important technological developments,
- diffusion of better integrated workstations, more suited to working at the office, from home or while traveling,
- very high speed communication networks whose throughput should be comparable to that of local networks in the Research Units and the national interconnection infrastructures,
- a wider diffusion of multimedia applications to facilitate cooperative work,
- the extension of the integrated information system already in place,
- reinforcing computer security.

1997 was a year of consolidation of many initiatives already put into operation. The main trends described above were further developed.

1998 will be the last year of the current master plan and the preparation year for the new 1999-2002 master plan.
A few examples in 1997

Regarding workstations and application equipment, in addition to the routine renewal and development of the computer stock, a few facts are noteworthy:

- taking into account and supporting Windows on all sites
- a significant number of Windows platforms were installed as well as at least one Windows application server on each site, accessible from each X-Window workstation or X terminal
- integrating the portable equipment in the global environment in terms of updating, backup and synchronization
- taking steps toward interoperability and complementarity of the Unix and Windows environments, for example through dual-boot Linux-Windows PC systems.

Concerning networks and communications, we can mention:

- the progressive transition of local communication infrastructure from 10 to 100 Mbs, for example by installing 100 Mbs Ethernet commutators or by switching a certain number of workstations and servers to 100 Mbs.
- the installation of the Gigabit Ethernet technology on the Sophia Antipolis site, to establish a federative network of 100 Mbs commutators, which certainly is one of the first French experiments in this area,
- the reinforcement of national connectivity: the Rocquencourt site was switched to 34 Mbs on RenAtM,
- the continuation of INRIA’s participation in the Renater-France Telecom partnership, the Mirhade part of project SAFIR.

A few other significant events

- the Silicon Graphics Origin 2000 supercomputer was put in operational use on the Nancy site, running under Irix 6.4 which can manage 64 processors
- the Cenju-3 configuration was installed in Rennes as a result of the agreement between NEC and INRIA
- computer security was strengthened through the adoption of preventive measures (installation of firewall machines).
- the expansion of AFS and the cooperation between the Rocquencourt and Grenoble units on this system were continued
- Intranet use was generalized, numerous internal and external servers were set up and the associated tools were distributed.
Research / Highlights
Random Phenomena

Random though
not unpredictable phenomena

Is it possible to predict and control random phenomena? This is a priori a paradoxical question. Nonetheless, the reality must be taken into account and it does not always lend itself to a perfectly deterministic description, far from it. This is especially true in telecommunications and networks but also in many other sectors. It is then up to the mathematician or the probability theorist to apply all the tricks of their trade.

The term random is frequently used to mean chance, to such an extent that the two notions have become interchangeable in the eyes of the lay person. For the mathematician, on the contrary, whether he specializes in probability, statistics or computing, or even geometry, it is a very different story.

If randomness calls to mind a feeling of helplessness for the uninitiated, for the mathematician the mastery and predictability of random phenomena take the place of this feeling. Randomness is governed by laws. Probabilistic laws, to be sure, but the behavior of many characteristics of these
laws can be predicted. Such studies, crucial today for all sorts of applications, are situated at the crossroads between advanced mathematics and technological problems. Such is the case in computer science, for algorithm design for example, or in telecommunications, for network management. The point thus is to react to the intrinsically random behavior of the technological system in question. Paradoxically, however, randomness can also become a tool for solving diverse problems in computing. The part of randomness voluntarily introduced thus serves to simplify and optimize the computation algorithms.

Congestion on the networks
During the last few years, the increase in numbers of computer services has led to an ever growing demand on the part of users. However, on a Web server for example, it is impossible to know in advance when users are going to connect and for how long they will stay online. It is also impossible to know in advance the data flow that will result from each request, which will be greater or lesser according to whether it is video, audio or textual data. How should we model this circulation of data in order to guarantee the best service? In other words, how to guarantee that the user will only have a slight probability of waiting beyond a certain delay? This is one of the questions that project MISTRAL is working on. It seems in fact that such circulation cannot be represented by classic random processes such as Markov or Poisson processes. Indeed, the latter are characterized by their very short "memory" — the state of the system at a given instant depends in large part on its state at the previous instant. In the case of networks, long term memory processes must be used. This approach is of great interest to the W3C group. MISTRAL researchers are currently finalizing a Web server performance evaluation environment that is founded on these principles.

How to fluidify the traffic
If the traffic on the network is light, there are obviously no "collisions". Conflicts occur as soon as a large number of people are simultaneously connected. The idea of deciding between users by flipping coins is at the heart of the Ethernet protocol that was designed around twenty years ago. This protocol is based on a progressive increase in retransmission delays. Such a system does not however handle heavy loads very well. In the 80s, a much more effective system was proposed and mathematically validated by the members of project ALGO-HIPERCOM. It is a so-called "tree-protocol" and its principles were extended to other non-Ethernet networks as well. The idea of the protocol is as follows: an initial toss decides between two groups of users, then each one of these groups is itself divided into two subgroups, again by flipping a coin, and so forth until all the individuals are fully distinguished. ALGO-HIPERCOM researchers adopted this algorithm for the access to the incoming path of an urban cable network.

With the support of IBM in particular, the protocol was proposed within the framework of the International Standardization Committee. It was adopted as the cornerstone of the future standards for this incoming path. The goal is to allow Internet access via cable networks. Numerous experiments have been conducted in France within the "information highway" projects in which INRIA participated alongside Lyonnaise Communication.

Mobile telecommunication
Chance also comes into play in GSM-type networks. The very topology of the cells that define the network is random for various reasons — location of the antennas, geography of the surroundings, cost of the land and so on. This randomness is augmented as before by the random distribution in time of the calls as well as by users randomly crossing cell boundaries.

In the framework of an agreement with France Télécom, researchers of project MISTRAL designed stochastic models based on random geometry to represent and predict the characteristics of the traffic. Results of this research have already been used by France Télécom to estimate the cost of communications passing through fixed architectures. They should soon be applied to cellular telephone networks.

As luck would have it
If chance can be modeled, then why not use it deliberately? Such is the rationale behind the work in geometry of project PRISME researchers to reduce the computational time of their algorithms. One of the algorithm that is concerned by this line of research is the "Delaunay triangulation" algorithm. A Delaunay triangulation consists in meshing a region of space using tetrahedra whose vertices are measurement points, in order to visualize a volume that is only known a priori through these points. This is a task that must be performed typically in geological layer reconstruction — project members have a contract on this theme with BRGM (Bureau of Mines and Geological Research). It also occurs in medical imaging. In order to construct the triangulation, the measurement points are fed one by one into the computer. Researchers showed theoretically as well as experimentally that if the data is entered in random order, instead of in the original order, the computational time is considerably reduced. This is the so-called "randomization" technique. The result is due in particular to the negligible statistical weight attributed to the most unfavorable situations. Similar techniques also proved useful in the construction of three-dimensional meshes in numerical analysis. They contributed to the design of very high performance mesh generators by project GAMMA, that are now distributed by several large American software companies. Thus there are cases in mathematics when chance sets things right. It all depends of course on how well you master it.
Learning to remember a new challenge for business

The endeavors of an enterprise are part of a specific history and culture, the same as for any other social group. In view of the complexity of processes and of the increasing mobility of personnel, it is becoming more and more indispensable to keep track of past achievements and ongoing developments.

At a time when the complexity of technology keeps increasing, enterprises are more than ever faced with the problem, crucial for their survival, of how to memorize the amount of knowledge and know-how that is the basis of their competitive edge. Indeed, there are sectors in which no single individual can any longer encompass the whole history of the manufacturing of a product from the design stage to mass production. This is not only true in the automobile industry and the aerospace industry, but for all sorts of products that make use of advanced technology. In fact, companies must amass and make the best use of acquired knowledge and experience. The problem is similar to that of the knowledge-based systems that were invented in the 1980s. Today, computer scientists are in a much better position to tackle this problem. In particular, they have more powerful models for representing knowledge at their disposal, for example object-oriented models. In addition, networks make it possible for engineers and designers to have access to huge amounts of information practically instantaneously.

Representing knowledge
Curiously enough, it is in their experience in biology, or more precisely in their contribution to genome analysis, that project SHERPA researchers found ideas and concepts for this new application. Just as in molecular biology, their objective is to represent knowledge as objects and semantic networks and to link those to textual knowledge via a “lexicon”, i.e., the terminology of the domain. In the case of corporate memory, this knowledge often comes from experiments, in particular accounts of problems encountered and the solution that was found. An agreement was signed recently with PSA Peugeot Citroën, the car manufacturer.

Another example is the capitalization of knowledge at SGS-Thomson, a company specializing in integrated circuit manufacturing. Project StoRIA, which brings together INRIA and SGS-Thomson for the development of Intranet techniques within the company, is in part specifically devoted to these memory problems. The idea is to set up Intranet knowledge servers that include hypertext as well as semantic networks of objects. Initially, studies will evaluate the effect of a server breakdown on such and such assembly line.

Structuring documents
Researchers from project OPERA also participate in StoRIA. The documents that are used to memorize knowledge and experience are more and more multimedia documents. They include texts, pictures, movies and sounds. It is therefore necessary to take into account the temporal dimension in the representation of documents. Time also comes into play when several people are collaborating in the writing of the same document, whether these persons are located on the same site or not. This is the object of cooperative editing. StoRIA offers a framework for experimenting on the cooperative editing tools designed by OPERA. Current work at OPERA aims at taking into account the Internet environment in the definition of cooperative applications.

In addition, research on multimedia documents, and particularly on the synchronization of textual, audio and video data, is of strong interest to the W3C consortium. The consortium is currently designing a new format, called...
SMIL, which will be the multimedia analogue of the SGML/XML textual format. Madeus, a prototype environment for multimedia document edition and presentation realized by OPERA, will be used as an experimentation basis for this format. One of the goals of Madeus is to offer a tool that is accessible to the non-computer literate through a user-friendly interface that avoids programming the temporal scenarios of multimedia documents.

Organizing memory

Effectively, corporate memory, or know-how capitalization, benefits from research in knowledge engineering.

Project ACACIA has been working in this discipline for several years. Researchers from this project adopt a global approach to memory. A collective memory is in effect made up of individual and collective know-how, as well as "tricks of the trade" and knowledge about the history and context of past decisions and so on. Memory is furthermore considered as a cognitive process that is closely linked to the internal nodes of representation of reality on the part of individuals. The problem then is to best organize and model all this data according to the application desired. It should be noted that some studies of project ACACIA use an editing tool from project OPERA.

ACACIA researchers, for example, participated in the development of a "technical memory workshop," that is a set of software, in partnership with Dassault Aviation. The idea was to collect all the skills that get used in the design of an aircraft element, in this case the landing gear. In this framework, researchers developed a library for conflict management in concurrent engineering. Similarly, as an example of project memory, a capitalization system concerning the problems encountered and the decisions made during a vehicle design project is being set up with Renault. Finally, based on the modeling of the expertise of several traffic accident analysts, the project ACACIA will develop a knowledge server for Inrets through the Web.

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(*) Joint project with CNRS
Integrated circuits
the race for performance

Ever smaller, ever faster, such is the circuit designers’ motto. In this area more than in any other, design methodology and production techniques must evolve simultaneously.

For thirty years or so, microprocessor performance has been doubling nearly every eighteen months. Every potential computer buyer can see that once a model is bought, it soon becomes obsolete. Progress in circuit design and manufacturing is at the origin of this evolution. Considerable leaps forward were achieved again this year. These breakthroughs concern improvements in photolithographic processes by using ultraviolet light, copper-based circuits, since copper is a much better conductor than aluminum, and circuits using a four-level coding instead of the classical binary coding, which should result in doubling the memory capacity of microprocessors. Thus, a major challenge for researchers in this field is to continually adapt their design tools. This is all the more important since technological choices in this sector are strongly dependent on economic constraints.

Very specialized circuits
In certain applications it can be judicious to design circuits or architectures that are dedicated to a particular task, instead of using programmable microprocessors. This is the case with processors that always perform the same task, for example, in a car, a cellular phone or a CCD camera. One of the activities of project API is to develop design methods for such circuits. These methods are implemented in prototype CAD tools and are also validated by designing circuits for some applications. Researchers thus designed and constructed an architecture dedicated to the comparison of genetic sequences. The architecture’s designer was recently awarded the Seymour Cray prize for this achievement. Biologists often need to compare a given genetic or proteinic sequence with already identified sequences stored in a gene bank. The problem is even more acute in terms of cost when all the sequences of a bank are to be compared with one another. In order to organize and correlate this data, the exponential growth of genetic banks makes a dedicated architecture an interesting alternative.

Project API devised a “systolic” architecture, which resides in a particular way of networking 128 identical dedicated processors, each of which communicates only with its neighbors. The whole machine consists of two boards. Each board holds 16 VLSI chips working in parallel and each chip contains 4 dedicated processors. The machine was tested and used to find connections between various genetic sequences of yeast. Researchers are currently developing programs to adapt it to a family of functions. The machine is accessible from the Internet and can thus be tested by anybody.

No computation without control
When dedicated or programmable circuits perform operations on data, there is another category of circuits, called microcontrollers, whose function is to manage the functioning modes of systems. Microcontrollers are used in instruction decoding systems, cache management protocols and modems among others. Project MEJIE is conducting research on the design of such circuits. Some fifteen years ago already, researchers from this project devised a language called EstereL for software design. It so happens that this language proved particularly adapted for programming controllers.

Toward the end of the 1980s, EstereL was used for the design and synthesis of the microcontrollers of Digital Equipment’s Perle machine. Members of MEJIE are currently collaborating on the optimization of controllers with Synopsys, a world leader in circuit synthesis, and with Cadence, a leader in circuit CAD. The latter company uses EstereL as input language for their Polys system for mixed hardware-software structure conception.

In return, researchers are now using the circuit optimization techniques perfected with Synopsys and Cadence to optimize software.

Researcher contact: API: Sanjay RAJOPADHYE. E-mail: sanjayrajopadhye@inria.fr — MEJIE (*): Robert de SIMONE. E-mail: robert.de_simone@inria.fr

(*) Joint project with the Applied Mathematics Cell
Specialized processors for embedded systems

One of the sectors in which processors are playing an increasingly decisive role is transportation. This is true for air transportation, of course, but also for railways and automobiles. This type of application involves processor networks and specialized circuit networks. Researchers from project SOSSO are developing a hardware-software co-design methodology in particular for rapid prototyping and optimized implementation of these embedded systems. This methodology makes it possible to automatically distribute the programs to the processors and to synthesize the necessary specialized circuits. One of the ongoing studies is to design a processor that is better adapted than available commercial processors to this specific context. The objective of the researchers is to integrate more efficient interprocessor synchronization and communication functions into the silicon. Initially, the circuit will be built using synchronous technology, that is to say the almost universally used technology these days. SOSSO members are already thinking of building it using asynchronous technology. Instead of following the rhythm of a single clock, the circuit's constituents will be self-synchronized. This technology makes for a more modular design and is less sensitive to the problems posed by sub-micron manufacturing processes.

SOSSE: Michel SORINE, E-mail: michel.sorine@inria.fr
of the École des mines de Paris
Culture

The cultural heritage
at the time of networks

Here are a few of the dreams that the internationalization of culture can make come true: discovering the riches of a museum anywhere in the world, consulting its catalog, visualizing architectural works or reading the various translations of a literary or philosophical text.

All cultural institutions, museums, libraries and the like, are now creating databases that contain their catalog. Already more than thirty years ago, André Malraux had initiated the creation of the General Inventory in France. The inventory aimed to describe the entirety of monuments, sculptures, paintings etc. in France. These databases are totally heterogeneous, however. They differ in their structure, their platforms and their means of access.

To make sure that all these databases become available online as easily as possible is an ambitious objective. INRIA's Médiaculture development Initiative contributes to this objective through several projects. Artistic and cultural
Databases contain both textual and iconographical documents. Furthermore, they are constantly changing. Curators, in particular, are likely to add all sorts of new information, such as exhibit catalogs or visit guides. Additionally, since each national heritage has its own special appeal, the question of multilingualism is also an issue.

**Accessing heritage resources online**
Preparation entails access to the catalogs of various museums all over the world. In order to facilitate such tasks, the European project AQUARELLE, which gathers twenty-two members from four different countries under the direction of INRIA, is currently designing a simple information search system. The idea is to define a virtual database scheme that can act as a common denominator for all existing actual databases.

When looking for information, the user will only have to formulate a query to the virtual database, with only forty or so fields to fill out (author, title, type of object and so on). The query will then be redirected to the primary databases involved after having been, so to speak, translated as so to be understandable within the structure of these databases.

One of the designers’ task is thus to make provision for the correspondence of the forty fields of the virtual database with the hundreds of fields of primary bases. Conversely, the responses received from the primary bases will be presented to the user in a homogeneous format. One of the first applications concerns the General Inventory. If the user wishes to create a documented file, for instance a commented presentation of an exhibit, SGML (and later XML) editing tools will be available. The system designed by AQUARELLE will in addition allow for simple cut-and-paste of the references of the objects found by the query into the file. The first prototype system has just been finalized. Six databases are already connected to it. The project also benefits from close cooperation with Cimi (Computer Interchange of Museum Information), a large American consortium whose objectives are very similar.

**Putting order in your files**
It only makes sense to set up files if a publisher or museum curator is able to find them back easily. Structural indexing of textual data is the object of work undertaken by project DIALOGUE. Researchers from this project devised a method called contrastive indexing. This method aims to index a document by comparing it with other documents of the same set rather than on the basis of its intrinsic content. The point is to spot statistically significant themes in order to form document classes that are homogeneous regarding their set of themes. In a set of texts dealing with painting, for example, the word “painting” would not be a very pertinent choice as an indexing key. On the other hand, such terms as “baroque” or “Rome,” that are only found together in certain documents, will be retained in the indexing and will be used to automatically form the class of those documents that treat Roman baroque art.

Contrastive indexing is also used within an initiative by the French Ministry of Culture and the General Delegation for the French Language. The task of this initiative consists in designing a tool capable of supplying the user with a sort of terminological chart of all HTML pages of French-speaking Web sites.

**Images to be protected**
The primary databases involved in AQUARELLE also contain photographic archives, particularly the Fratelli Alinari archive in Italy, which is the largest European photographic database. Project CODES, concerning coding and cryptography, was naturally solicited by AQUARELLE to design an image marking technique. This challenge presents various difficulties, since the marking must be invisible, totally independent of the image format and robust. Studies were led in collaboration with the Catholic University of Louvain.

A choice was made in favor of a parameterized coding with keys, which is more secure than a nonparameterized coding. A device was needed however, to avoid that in case the proprietor of an image wanted to assert his rights, he would have to turn over his key to a third party. The idea was to use a “trusted third party,” whose job is to store the keys and perform the verifications when needed. To avoid the circulation of an image between the proprietor and the trusted third party prior to its marking, the Diffie-Hellman key exchange protocol will be applied. This protocol makes it possible for the proprietor and the trusted third party to derive a common key that the proprietor can use himself to mark his image.

**From one language to another**
Project DIALOGUE is working on a linguistic analysis tool for textual resources, whose code name is SiliRe (Interactive Server for the French Language, Its Identity, Its Diffusion and Its Study). This project is in collaboration with CNRS and the Association of Partially or Entirely French-Speaking Universities (Aupelf-Uref). SiliRe is a Web server that will offer linguistics or literature researchers access to a whole set of linguistic resources—literary texts, newspaper articles, lexicons, mono- or multilingual dictionaries, and so on.

A prototype version of the server has been online for a few months. A researcher can thus access a corpus of texts. Text selection is by author, date, keyword, etc. The researcher can perform concordances on the corpus, for example, looking for all the occurrences of a word or analyzing its usage according to the context or the author, among other possibilities. Other tools are currently in preparation to make lexical statistics and multilingual concordances based on a sentence and its translation into another language, it will be possible to determine the translation of such and such a word in various contexts.

Computers and networks will thus be extraordinary tools for the interchange of culture throughout the world.
Symbolic Computation

The computer and mathematics

Until quite recently, computers were only able to perform numerical computations, which was already remarkable. Nowadays, computers are also used to check formal properties in mathematics. Mathematicians are like puppeteers, hiding behind these new accomplishments.

In barely three decades, computers have become so banal that we tend to forget the long hours spent on numerical computations by yesterday’s researchers and engineers. No doubt tomorrow’s researchers and engineers will find it equally archaic to spend weeks solving certain algebraic or geometric problems that are in the process of being automated. Does this mean that computers will replace mathematicians? Far from it. There is no way around it, computers can only do what they are told to do. If a computer is to automatically perform proofs, then it is up to the mathematician to develop the necessary theories. Whether in solving polynomial equations, finding geometrical properties or validating algorithms, the new ease of use brought about by the computer is equalled only by the complexity of the mathematics involved.

From approximate to exact computations
Finding the number of roots, in particular real roots, of a system of polynomials or their exact value, is a typical example of a problem that numerical analysis cannot solve and for which it is necessary to have recourse to the so-called symbolic or formal calculus. This is one of the research themes of project EURECA. The first objective is to gain as much exact information as possible on these roots and their spatial location in the case of systems with a finite number of roots. But how do we go one step further and determine the roots? Clearly, it is better to simplify the problem as much as possible. During the last few years, researchers had shown that a problem in several variables can be reduced to a problem in one variable by using symbolic calculus. They then devised algorithms that can be applied to concrete situations.

Using a kind of “black box,” any user, mathematician or not, will be able to solve systems of polynomial equations exactly. Additionally, the black box is capable of deciding whether the system in question has a finite or infinite number of roots. The infinite case cannot yet be treated in all generality, but in certain cases, researchers have shown that it could be reduced to the previous problem and hence that the black box can be used.

As one example of application among many others, projects EURECA and SAFIR are collaborating on computing tools for the design of parallel robots. A six-legged robot—also called a Stewart platform—comprises, in addition to six bars, a platform and a base, both equipped with six anchorage points. Stewart platforms are for example used in flight simulators. The question is what are all the possible configurations for these robots?

Zero-defect objective

Formal calculus is also used for validating algorithms and programs in symbolic calculus. The problem is to improve the reliability of a program based on a given algorithm to solve polynomial systems. The goal is to obtain 100% of correct results. Unfortunately, some of these algorithms have been known since the 1960s and were entirely programmed by hand, hence there is a high risk of errors. Such is the case of Buchberger’s algorithm, which is used to test whether a given polynomial belongs to a particular family—an ideal—of polynomials in order to solve various problems in mechanics and kinematics that are described by this polynomial.

This year, researchers from project CROAP succeeded in formally provising Buchberger’s algorithm. One of the tasks involved was to prove that the program terminates under all circumstances, i.e., that it cannot loop indefinitely. Another task was to show that it actually solves
the problem at hand, in this case that it actually produces a complete basis of the ideal. Concretely, the work consisted in writing some 9,000 lines of code for a program designed within the COQ environment, whose exact purpose is to translate mathematical proofs into computer language.

Proving oneself
The COQ tool is indeed meant to supply methods and a language for representing mathematical specifications and proofs. It has been developed for ten years or so by INRIA in collaboration with the École normale supérieure in Lyons. The idea is to devise a language that is capable of expressing both logical and algorithmic properties. The language of the COQ tool stems from type theory, which has the same generality as set theory. This language can also be used to represent complex algorithms and to reduce the verification of certain properties to a simple computation. This methodology was used to prove arithmetical properties of the number that can be translated into an executable program. For example, checking that a number is a prime number furnishes a factorisation algorithm for this number.

This year, COQ was used, for instance, by the DYADE Economic Interest Group, in which Sull and INRIA collaborate, to verify the cryptographic protocols used in electronic commerce over the network. The objective is to guarantee that the transaction between the bank, the vendor and the buyer proceeds soundly. In other words, each party must be assured that the others are who they claim they are and not somebody else, and that the transaction is actually taking place. The COQ environment makes it possible to formalize the adequate proofs and to check them. More generally, it can be used in any situation involving complex and critical software.

From computer vision to image transmission
In geometry also, certain properties can be proved automatically. Such is the case for example in deciding whether or not certain points in a figure are on the same straight line, the same circle, the same sphere or any other simple geometric shape. Researchers from project SAFIR solved this problem formally, either by computing on polynomials that represent the geometrical constraints, or by computing directly with the geometrical objects.

They applied their results to computer vision problems, notably in three-dimensional scene reconstruction.

Another application of symbolic calculus in image processing is compression. Here again, image filtering can be formulated in terms of polynomial systems. The results of project EURECA alluded to above were used to devise a system of filters that perform much better than other filters in the same family (linear phase, non separable orthogonal filters). These new filters are in the process of being patented.

As a result of extremely theoretical mathematics, symbolic calculus nonetheless seems to find many applications. It is a prominent example of transfer of fundamental results to concrete problem solving.

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The Internet victim of its own success: how to improve the service?

It is not that often that demand precedes offer. In view of the exponential growth of the number of Internet users, it would not be reasonable to only respond to this growth at the level of material infrastructures. On the contrary, a more intelligent and economic management of the network must be achieved through research on the improvement of protocols and access modes.

After having swept the United States, the Internet is now taking over France. However, in order to fully satisfy users, quality service is required. The user expects to be able to log on at any time according to need and to face only reasonable delays for data transmission, whether it is text, sound or images. Such demands are not always met and this leads to many studies. On the one hand, the way traffic is organized has to be understood and its laws have to be formulated. On the other hand, solutions must be devised to optimize the traffic, given the fact that the number of users keeps increasing whereas the material infrastructure has only a limited capacity. In this context, no single improvement in terms of quantity of data transmitted or connection time can be neglected.

Modeling the traffic
Until recently, network traffic was represented by models based on short memory processes of Markovian type, such as Poisson processes, that have been in use in telephone traffic modeling since the beginning of the century. At the beginning of the 1990s, fractal phenomena were exhibited in high performance networks. These phenomena manifest themselves through sudden "jumps" in traffic that render Markovian models inadequate. One of the objectives of project MISTRAL is precisely to devise new traffic models that are capable of representing long term memory processes for Web servers or Internet type networks.

Researchers are currently developing a Web server simulator based on their models. One of their goals is to use this simulator to test the new generation of the HTTP protocol. Initially, the simulator will serve for the evaluation of various traffic improvement strategies, such as cache optimization.

All-out economies
Improving the traffic, and in particular optimizing the HTTP protocol, the most commonly used protocol on the Internet, is obviously one of the main concerns of the W3C Consortium. The HTTP protocol was jointly developed by the Internet Engineering Task Force (IETF) and W3C. The consortium brings together INRIA, MIT and Keio in Japan. This year, a certain number of mechanisms was added to the new HTTP 1.1 version. The first objective is to lower the number of connections between clients and servers. Formerly, a request resulted in the establishment of a series of connections, one per object (image or text). The mechanism of "persistent" connections consists in using only one connection to transmit all the objects. In addition, this mechanism makes it possible to make the best of the information concerning the congestion of the connection in use. Indeed, this information is lost in case of multiple connections/deconnections.

Another way of clearing the network is to regroup queries and replies. This is the pipe-line technique. The new protocol also involves compression techniques. Up to now, only the images were compressed, but not the text. Finally, cache management is improved. Even when the transfer is interrupted, the cache will store the partial document, which avoids restarting the download from scratch if the request is repeated. HTML page compression typically yields a 68% gain in packet size and 65% gain in transmission time. The first two mechanisms can result in up to a factor ten decrease in the number of packets transmitted through the network. It also happens that using the CSS style sheet language, recently developed at W3C, has a positive impact on bandwidth. This language, originally conceived to free HTML pages from the visual and graphic description of the documents, makes it possible to transmit less information. It is more compact than HTML and a single style sheet is capable of describing several HTML pages.
What to do in case of transmission error?
Optimizing traffic also means compensating for transmission problems on the network. These problems are of various types: loss of packets, excessive transmission delays and variability of transmission delays—the latter being particularly detrimental to multimedia applications such as audio, video or Internet games. When the network is saturated, nearly 50% of the packets can get lost. One of the first tasks that project RODEO researchers had to undertake was to describe and model these losses as well as the delays, based on a traffic analysis at reception points scattered all around the world. They were then able to propose compensation mechanisms. Obviously, simply retransmitting a lost packet is not a satisfactory solution since it takes too much time and thus cannot meet the demands of an audio or video-conferencing application. Hence the idea of anticipating the error corrections. Each packet contains a sample of the previous or two previous packets, based on the loss process analysis performed above. In this way, gaps are reduced without increasing the data flow too much, which results in a quite acceptable audio quality. Due to redundancy, this quality is in addition practically constant, even when the network is under heavy load.

This technique opens up perspectives for quality Internet telephone or audio-conferencing applications. Nonetheless, in case of a congested connection, it is not desirable to increase the data flow. RODEO researchers are thus working on the definition of a compromise in order to optimize service quality, the proportion of packets to be sent in primary form must be evaluated, as well as that of packets to which redundancy will be added. The researchers are also working on applying this technique to video transmission. Due to the fact that only the modifications from one image to the next need to be transmitted, adding redundancy means transmitting the modifications from the two previous images. Another possibility for improving service is admission control. Rather than accepting a connection on the sole criterion of the information supplied by the user, RODEO researchers propose to base the decision on the behavior of flows at the moment of the request. This behavior is then either measured or estimated.

It remains that the more the traffic improves, the more the number of users increases and with it the network load. This remark alone shows that the new tools need to be distributed on the widest scale.
Seeing in three dimensions: 
the computer scientist and the geometer

Geometry might be a forgotten art. It has been nearly dropped from school curricula. However, and now more than ever, geometry is back in style. Simulation and three-dimensional modeling have become indispensable tools in numerous areas, in particular for testing ideas or projects before they even start to materialize.

The boundaries of the possible seem to be ever receding: simulating freeway traffic, optimizing the installation of antennas on a satellite or even reconstituting such archeological sites as the Athena sanctuary in Delphi, such feats look more like a dream or magic to the lay person. On the scientific level, however, progress in the last few years in three-dimensional computation to represent actual or imaginary scenes is the result of state of the art research in modeling and simulation.

Shadow and light
The realism of a scene is obviously due in large part to the plausibility of the lighting. Zones of shadow and light, as well as the reflection of light on objects or between objects must be respected, as well as the nature of light itself—natural or artificial. Several INRIA teams are working on this theme. This year, for example, project IMAGIS researchers designed a novel lighting simulation method based on finite element techniques.

Scene lighting is a complex problem. In order to be as close to reality as possible, it is necessary to decompose the surface of the objects into as many facets as is required. Add to this the difficulty of dealing with movements in animated images.

IMAGIS' method consists in adopting the so-called clustering approach, which is a hierarchical approach. Initially, the scene is described as groups of objects, which are considered as entities as far as light interaction is concerned. The simulation is then progressively refined. This method is particularly interesting for animated images, since it should be relatively easy to update the lighting when only certain objects are moving inside the scene.

Researchers of project ISA propose a new, radically different, theoretical approach. They compute the radiance equation (radiance is a slightly more general concept than radiosity) using a subdomain decomposition method applied to the environment. This computational method reduces geometric computations to their simplest expression, whence not only a reduced computational time, but also a great physical precision in addition, this technique should be easy to implement on parallel computers.

Lighting is also one of the research topics of project SIAMES. Researchers are designing simulation tools that are systematically validated by measurements. Some of these tools are already in use. Applications are essentially in lighting engineering. Lighting of the Grand Stade de France or of the inside of the Louvre were designed using a light propagation software written in collaboration with CSTB (Scientific and Technical Center for Construction).

Simulating movement
Whether in simulation or in animation, a large number of applications concern moving three-dimensional objects. One problem for example is to represent the displacement of a vehicle in an urban environment. This is another theme of project SIAMES. Researchers perfected a simulation platform that integrates a virtual urban environment, with entirely autonomous vehicles in this environment, pedestrians and bicycles. The idea now is to include humans as vehicle drivers or cyclists.

Project SIAMES is currently participating in the Diats European project. The goal of this project is to simulate the various scenarios for integrating automatic control tools into vehicles in order to improve the fluidity of freeway traffic. A test case, only too well known by car drivers, was thus simulated, involving 3000 vehicles on a freeway section narrowing from three lanes to two lanes. In addition to the mechanical and dynamical data, the simulation also took into account each driver’s perception of the environment.

The geometrical “toolbox”
Modeling a three-dimensional environment or physical phenomenon requires previous advanced research on how to implement theoretical properties and theorems in geometry on a computer. Very often, for example it is necessary to have a discrete representation of the objects to be simulated. This is typically the case for the computer simulation of physical phenomena that are modeled by partial differential equations.

One technique consists in meshing the space using tetrahedra following the so-called ”Delaunay triangulation” method.

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Project GAMMA wrote mesh generator codes for this purpose. These codes were integrated by large American software publishers and are now used by industry throughout the world. Researchers are now working on extending this technique by incorporating various constraints. The idea is to create an "adaptive" mesh. The size and the more or less narrow shape of the tetrahedra could vary according to the needs of the application.

Project PRISME is also interested in algorithm design for Delaunay triangulation, in the framework of algorithmic geometry. Meshing techniques, and more generally algorithmic geometry methods constitute very valuable tools for any three-dimensional modeling problem, in particular for modeling natural objects. Such is the case, for example, in the modeling of geological layers undertaken by projects ISA and PRISME. It is precisely by making use of algorithmic geometry results that PRISME perfected an optimization software for the placement of antennas on a satellite, in collaboration with Matra Marconi Space. The question was how to solve a three-dimensional geometry problem in which antennas must be placed to transmit and receive without disturbing one another.

From 2 to 3 dimensions, and back
The construction of a three-dimensional model becomes a necessity as soon as such physical phenomena as light or sound propagation, among others, must be simulated. This situation occurs in particular in architecture to construct a three-dimensional representation of a building from the architect's blueprint. This is one of project ISA's research themes. The question arises as well in medical imaging. The problem is to construct a volumic model of an organ from two-dimensional images obtained for example from nuclear magnetic resonance. Project PRISME developed a software based on its work on Delaunay triangulation that solves this problem efficiently. The software is currently being commercialized. It is then possible to calculate the displacements in the obtained model, in order for example to perform an endoscopy simulation.

Conversely, once a virtual three-dimensional environment has been simulated or constructed, the user might want to view it from different viewpoints. In this case, a two-dimensional representation must be derived from a 3D world. ISA researchers designed a method to realize such a visualization in real time, based on a geometric simplification algorithm that preserves all the realism of the scene.

Another kind of problem is how to construct three-dimensional images from partial or implicit geometrical reconstructions. This question arises especially in urban planning. In this case, research of project SAFIR in automatic verification of geometrical properties is applied, such as showing that points are aligned, belong to the same circle or to the same sphere and so on. These techniques are currently used in the framework of the European project Cumuli. Project ROBOTVIS is also part of this project. One objective for example is to reconstruct a three-dimensional scene based on the two-dimensional images of a group of buildings and possibly to try out the possibility of integrating a new edifice.

From now on, archeology will also benefit from the ability to reconstruct an image from partial or implicit information. Project ISA is thus involved in a cooperation with the French School of Athens and EDF to reconstitute the site at Delphi. For their part, IMAGIS researchers have perfected a numerical model that makes it possible for the user to stroll virtually through Montmartre.

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Images drastically change day-to-day medical practice

There is little doubt that Leonardo da Vinci, whose genius is best known perhaps through his famous anatomical drawings, would marvel over the images obtained by computer five centuries later. Images of the heart and the brain are now used for early diagnosis and for the preparation of surgical interventions.

In medicine images play a vital role, in both senses of the word. Images bring an invaluable help to the clinician for diagnosis or during a surgical intervention, as well as to the researcher in scientific knowledge. An image in raw form is of little use, however. For a few years, numerous teams have been contributing to image processing and interpreting methods, in particular for three-dimensional images of the heart and the brain.

Methods differ widely for these two organs, even though certain imaging devices, such as Single Photon Emission Computed Tomography (SPECT), can be used for both. The problems also are of different types. In cardiac imaging, for example, the study of the muscle function (motion or perfusion) is paramount compared to that of its anatomy. On the contrary, in cerebral imaging, the difficulties are essentially due to the complexity of structures and their functioning, as well as to the extreme variability from one individual to the next.

Brain anatomy

As part of project VISTA, INRIA researchers are collaborating with the Rennes Teaching Hospital and the SIM (Signals and Images in Medicine) from the University, to analyze brain images obtained by MRI and magnetoencephalography, in order to detect the cortical fissures. These fissures are indicative of the localization of functions. This year, a three-dimensional statistical model for these fissures was established based on a population of sound individuals. This type of model can be used to detect pathologies by comparing an image from an affected brain with a reference image derived from the statistical model.

Other work undertaken by project EPIDAURE, in collaboration with General Electric Medical Systems Europe, aims at extracting the vascular network in three-dimensions, by a reconstruction from the subtraction of two two-dimensional angiographic images, one of which is obtained directly and the other after a contrast product has been injected inside the vessels. The objective of this work is to detect certain pathologies such as the presence of aneurysms, whose shape can thus be identified and whose therapy can be defined. Indeed, the shape of the aneurysm is the determining factor in deciding the operating technique.

From structure to function

On a more fundamental level, cortical fissure models should also be useful for the cartography of cerebral functions, a key issue in neurosciences. In this regard, a new program involves projects VISTA and EPIDAURE among others, was just approved within the National Scientific Interests Group, "Cognitive Sciences." The program subject is on these modeling problems.

The study of cerebral functions is also one of project ISA's subjects, however from a clinical perspective. Research in collaboration with General Electric Medical Systems Europe was initiated last year on merging anatomic and functional data. By combining X-ray images to localize the arterial network with MRI, which points out functional regions, such as that of language or motion, neuro-radiologists will thus be able to know, before an intervention, which functions might be affected by the planned intervention.

The idea of merging anatomical and functional images, in particular for MRI images, is also one of the research directions taken today by the future VISTA project.

Seeing the heart, this ever beating organ

As far as cardiac imaging is concerned, one of the major challenges is to detect coronary problems sufficiently in advance. This theme is another center of interest of project EPIDAURE. A software to automate the diagnosis of an ischemia, i.e., a circulatory insufficiency provoked for instance by partial arterial occlusion, was designed. This software is being brought to industrial standards by the Focus Imaging company, with the American market as a primary target.

The software is based on an analysis of the so-called myocardial perfusion study, or "stress-rest test," from Single Photon Emission Computed Tomography (SPECT) images.

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(1) Joint project with CNRS
One image is taken at rest, the other during exercise. The comparison of luminous densities in the muscular regions irrigated by the arterial network between both images indicates the presence or absence of ischemia. There is a certain uncertainty, to be sure, but it is lower than with a strictly visual interpretation. More generally, researchers are developing a model for the motion of the cardiac muscle. Images are again obtained by SPECT and are gated to the electrocardiogram, and by MRI with the same gating.

Three-dimensional ultrasound gives another means of representing the cardiac muscle, especially the left ventricle, as was shown by ISA researchers. In this case, the goal is to devise a user-friendly software that can be used by any cardiologist. There are two difficulties. On the one hand, ultrasound exams a priori only supply 2D images. On the other hand, the images are of very poor quality. In fact, volumes are reconstructed from ultrasound images taken from various angles, using an ultrasound probe that is rotating around its axis.

From cardiac imaging to cerebral imaging

For certain applications, techniques devised for cardiac imaging can be applied to cerebral imaging. Thus, researchers from project EPIDAURE are working on early diagnosis of neurodegenerative diseases, such as Alzheimer disease, by a stress-rest test. Alzheimer disease is characterized by memory losses. The idea is to point out this malfunction by comparing images from the brain at rest, that is to say in the absence of stimuli, with images of the brain when the patient is submitted to tests usually used in this pathology. Just as in the case of the heart, the images are obtained by Single Photon Emission Computed Tomography. This approach, which is conducted in collaboration with the Centre Antoine Lacassagne in Nice, is also based on image processing and statistical modeling techniques.
Environment

Keeping a close watch on the ocean

Modeling, stochastic process analysis and computer science are some of the disciplines that are involved in oceanic studies today. These disciplines are necessary to describe and predict the movements of such huge masses of water, but also to model the behavior of marine ecosystems.

Research in oceanography has grown phenomenally in the last few years, due essentially to two factors. One is need. Indeed, knowledge of oceanic circulation is a prerequisite for the analysis and prediction of climate evolution. It should contribute, among other things, to a better understanding of the absorption mechanisms of carbon dioxide by the ocean, and thus to a better evaluation of the amount of this gas that is likely to reinforce the greenhouse effect.

The other factor is scientific and technical. Oceanography is barely half a century old as a discipline and it benefits from increasingly sophisticated tools. After the launching in 1992 of the Topex-Poseidon observation satellite and other such satellites, scientists now have a continuous stream of altimetric data concerning the whole ocean at their disposal. Up to then, the only available data were collected in situ by oceanographic or fishing ships, hence relatively localized in time and space.

In addition, the current extraordinary increase in computing power makes it possible to use numerical models for the general circulation and various other oceanic phenomena.

From analysis to prediction

The enormous amount of data involved requires new mathematical tools. This is the so-called data assimilation problem. Meteorologists had to face this problem much earlier than oceanographers. The difficulty is due to the large dimension of the system and the fact that the equations are nonlinear, among others.

Project IDOFT developed two approaches to solve this problem. The first approach is a deterministic approach and was applied to a simplified ocean model, the multi-layer quasi-geostrophic model. This model gives a good approximation of the oceanic circulation through the whole depth based on the altimetric data. Using variational methods coupled to multidimensional analysis to reduce the system’s dimension, researchers succeeded in diminishing the cost of the assimilation, i.e., the computational time, by a factor of 20 while obtaining a good reconstruction of the deep oceanic circulation. The next step is to obtain similar results with oceanic models that are closer to the reality and to do prediction. The second approach is of stochastic nature and is based on Kalman filters. The ocean dynamics is represented

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by a stochastic process whose initial state is one of its realizations. Using a so-called extended filter, in order to take the nonlinearity of the system into account, researchers obtained a very good approximation of the circulation in the Tropical Pacific. It remains to adapt the method to the Atlantic, which is considerably turbulent.

Predicting, yes, but on which time scale?
Prediction is also one of project NUMATH's interests. Researchers from this project use models similar to those above, but the question they ask is significantly different: it is to decide after which amount of time does oceanic circulation prediction become illusory. This is the predictability problem, which is well-known by meteorologists, and weather report aficionados. The predictability threshold due to the nonlinearity of the equations. The prediction error grows exponentially with time at a rate which is measured by the Lyapunov exponents. These exponents were computed for several prediction times— one week, one month and so on. In addition, the NUMATH team computed the Lyapunov functions that can be used to estimate the geographical distribution of errors and in particular to point out regions where the error is likely to grow the fastest. Using this information for prediction, it is possible to decide in which regions does the initial data need to be known with the most accuracy. Another question treated this year was the evaluation of the amount of complexity of prediction at a given moment as a function of the state of the system. This study is based on the theory of dynamical systems and in particular that of attractors.

The ocean, an extraordinary life reservoir
The influence of the ocean on the climate is not its only interest. Researchers from project COMORE are developing models for biological, in particular marine, systems by adopting an approach based on automatic control. This year, they studied the validity of Droop's model for phyto-plankton growth. They used a small, entirely computerized biological reactor, a chemostat, constructed by the Marine Biology Laboratory of Villefranche-sur-Mer (CNRS). This study was conducted in equilibrium situations as well as, and more originally, non-equilibrium situations.

The management of fish resources is another center of interest of project COMORE. A fundamental question concerning fishing is the relationship between the available fish stock and the quantity of young fish that are supposed to renew the stock, in order to study this relationship, researchers devised a model for the evolution of the egg and larvae stocks.

Information is necessary for prediction
Keeping watch on ecosystems and more generally on the state of the environment requires large amounts of information. Following the launching of THETIS, a European project, at the beginning of this year, researchers from projects AIR and RODIN are now participating in the development of an integrated management system applied to the Mediterranean. The idea is to facilitate remote data searches, through requests, for further processing and visualization. Researchers from project RODIN are in charge of the database part of the project. AIR researchers are working on the analysis of constraints on the data, requests and models, as well as on the development of image processing algorithms. This system will become a precious tool for the management of Mediterranean coastal areas, which so often have been victims of humankind's negligence.
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Director for Computer Science and Advanced Technology, Peugeot SA

Max Dauchet
Professor at the University of Lille

Denis Randet
Director of Leti

Michel Sintzoff
Professor at the University of Louvain

Gérard Comyn
Director, European Commission, Directorate General III

Martin Karplus
Professor at the Le Bel Institute, Louis Pasteur University, Strasbourg

Jérôme Avrin
Principal Defense Engineer, Dret/STRD/GI

Elected Members
Representatives of Scientific and ETA Personnel

Philippe Massi
Research Director, INRIA Sophia Antipolis

Christian Rétoré
Research Officer, INRIA Rennes

François Chaumette
Research Officer, INRIA Rennes

Michel Martin
Research Engineer, INRIA Sophia Antipolis
evaluation committee
As of December 31, 1997

Chairman
Pierre-Louis Lions
Professor at the University of Paris-Dauphine

Deputy Chairman
Jean-Jacques Lévy
Research Director,
INRIA Rocquencourt

Appointed Members
INRIA appointed members

Alain Dervieux
Research Director,
Chairman of the INRIA
Sophia Antipolis Project Committee

Jocelyne Erhel
Research Director,
INRIA Rennes

Bernard Esplau
Research Director,
Chairman of the INRIA
Rhône-Alpes Project Committee

Claude Kirchner
Research Director,
Chairman of the INRIA
Lorraine Project Committee

Paul Le Guernic
Research Director,
Chairman of the INRIA
Rennes Project Committee

Elected Members
Scientific and ETA Personnel

National Basis

• A Electoral College - ETA
  Denis Buffenoir
  Research Engineer,
  INRIA Rocquencourt

  Michel Martin
  Research Engineer,
  INRIA Sophia Antipolis

  Nicole Szwarcbbaum
  Research Engineer,
  INRIA Rocquencourt

• B Electoral College - Researchers
  Jean-Daniel Boissonnat
  Research Director,
  INRIA Sophia Antipolis

  Patrick Bouthemy
  Research Director,
  INRIA Rennes

  Philippe Flajolet
  Research Director,
  Chairman of the INRIA
  Rocquencourt Project Committee

  Michel Sorine
  Research Director,
  INRIA Rocquencourt

Regional Basis

Lorraine Research Unit
Olivier Coulard
Research Officer,
INRIA Lorraine

Rennes Research Unit
Thierry Priol
Research Director,
INRIA Rennes

Rhône-Alpes Research Unit
Jérôme Euzenat
Research Officer,
INRIA Rhône-Alpes

Rocquencourt Research Unit
Sophie Cluet
Research Officer,
INRIA Rocquencourt

Sophia Antipolis Research Unit
Loïc Potier
Research Officer,
INRIA Sophia Antipolis
Where to find electronic information about INRIA
http://www.inria.fr

The documents referenced in the text
can be obtained from INRIA information department
Some of them can also be accessed via the INRIA Web server.

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Fax: 01 39 63 51 87  International: +33 1 39 63 51 87
Electronic mail: diffusion@inria.fr

Chapters

Guidelines of INRIA's policy
- the main points of INRIA's 1994 strategic plan
  http://www.inria.fr/Presentation/plan-strat-eng.html
- INRIA's 1995 objectives contract
  http://www.inria.fr/Presentation/contrat-objet-fra.html
- INRIA's strategy (1996)
  http://www.inria.fr/Presentation/strategie-eng.html
- INRIA 10 years from now (1997)
  http://www.inria.fr/Presentation/essai-prospectif-fra.html

Introducing the Institute
- brochures on the research units
  (Lorraine, Rennes, Rhône-Alpes, Sophia Antipolis, Rocquencourt)

Outstanding Facts
- activity reports on the research units (Rennes, Lorraine, Sophia)

Industrial Relations, International Relations,
Training, Communication
and Scientific Information
- activity reports on:
  - development initiatives http://www.inria.fr/Rapports/
  - international relations http://www.inria.fr/Partenariats/rel-international-eng.html
  - training http://www.inria.fr/Formation/formation-eng.html
  - communication and scientific information http://www.inria.fr/RRRT/sommet-eng.html

- brochure on INRIA's technology companies
  http://www.inria.fr/Partenariats/societes-technologie-eng.html
- brochure on the Franco-Russian Lapunov Institute http://www-direction.inria.fr/International/lapunov.html
- brochure on ERCIM and ERCIM News (quarterly) http://www.ercim.org/
- INédit (periodical, 5 issues per year) http://www.inria.fr/inedit/INedit-eng.html
- scientific conferences http://www.inria.fr/Colloques/cours-col-eng.html
- doctoral and post-doctoral fellowships and grants http://www.inria.fr/Bourses/summaire.html
- publication catalog http://www.inria.fr/RRRT/sommet-eng.html

Human Resources
- INRIA's organizational chart http://www.inria.fr/Organigramme/organigramme-eng.html

Computer Resources
- activity report of computer resources http://www.inria.fr/RRRT/sommet-eng.html

Research
- the scientific appendices of the annual report (themes 1 to 4)
  http://www.inria.fr/Rapports/
- project descriptions http://www.inria.fr/Recherche/activites-eng.html

The 1997 edition of the report offers a new view of the Institute through a series of articles by Dominique Chouchan, a journalist specializing in scientific issues. By highlighting nine specific research themes, while not claiming to be exhaustive, these articles clearly demonstrate the diversity and originality of the work carried out at INRIA. Readers wishing to obtain more detailed information on any particular aspect should refer to the activity reports of the four research themes.
Films

* Videocassettes Illustrate some of the subjects covered in the annual report. They are available upon request at the Communication and Scientific Information Service, Department of Multimedia Scientific Communication (tel.: +33 1 39 65 55 12)
The catalog of INRIA films is available on the Web at: [http://www.inria.fr/multimédiac/](http://www.inria.fr/multimédiac/)

**Intelligence Inside the Roll-Mill**
French 16 mn 30
How does a cooperation between engineers at the Sollac Steel Mill and researchers in artificial intelligence at Crin and INRIA Lorraine manage to integrate a control system based on neuron networks into a cold processing roll-mill.
At the end of the steel sheet production line, the Skin-Pass gives the sheet its final mechanical characteristics. Very imposing due to its size, noise and the force used (several hundred tons), this machine is a precision tool.
To increase the fine-tuning of the presetting of the force to be applied to the sheet diminishes the quantity of scrapings and improves the homogeneity of the final results. There are no ready-made solutions. Researchers have developed a generic tool that in part makes use of the physics of the problem and in part the statistical knowledge “learned” by the neuron networks.

**The Beta Gamma Quadrangle Scheme**
French 8 mn
Numerical simulations on the C3 Onera test case were performed in the framework of a study of the coupling between hydrodynamic instabilities and acoustic perturbations in the powder boosters of Ariane 5.
This film demonstrates the extreme sensitivity of the eddy detachment of the flow upon the dispersive error of the scheme through the use of a parametrized scheme—the beta gamma scheme.

***Analysis of Medical Images: Recording, Atlas, Motion, Simulation***
French 11 mn
This film is a compilation of the research work of the Épidaure team in the area of medical imaging. It touches on the following subjects: segmentation, rigid matching, non rigid matching by the "demons" method, morphometric atlas of the skull, following and analyzing the motion of the left ventricle of the heart, simulation of hepatic surgery.

**Diffraction of a Two-Dimensional Elastic Wave by a Crack**
Music / French Subtitles 9 mn 30
A presentation of a numerical simulation of the diffraction of an elastic wave by a crack in a two-dimensional homogeneous, isotropic medium. First the diffraction of a pressure wave (P) is shown, then the diffraction of a shear wave (S). Both waves are emitted from a source point located at various positions.
The computation was effected using a new method to solve the elastodynamics equations written in the form of a mixed velocity-stress system. The method is based on two novel aspects: The first aspect is the use of a new mixed finite element that allows for mass condensation. The second original aspect is that the crack is taken into account by a fictitious domain method.
list of research projects

As of January 4th 1998

Theme 1: networks and systems

Program 1A: Parallelism and Architecture
Projects
- APACHE (6): Parallel algorithms and load balancing
- API (2): Parallel VLSI architectures
- CAPS (2): Compilers, parallel architectures and systems
- ReMaP (3): Regularity and massive parallelism
- SLOOP (4): Simulation object-oriented languages and parallelism

Brigitte Plateau
Sanjay Rajopadhye
André Seznec
Yves Robert
Jean-Claude Bermond
Rhône-Alpes
Rennes
Rennes
Rhône-Alpes
Sophia Antipolis

Program 1B: Networks, Systems, Performance Evaluation
Projects
- MEVAL: Modelling and performance evaluation of computer systems
- MISTRAL: Modelling in parallel systems and communication networks
- MODEL (2): Modelling random systems
- REFLECTS: Distributed real-time fault tolerant computing systems
- RESÉDAS (3): Software environments and tools for telecommunication
  and distributed systems
- RODEO: High speed networks open networks
- SATURNE (6): Fault tolerant and intrusion tolerant distributed systems
- SIRAC (7): Distributed systems for co-operative applications
- SOLIDOR (2): Languages and parallel systems
- SOR: Distributed object systems

Guy Fayolle
François Baccelli
Raymond Marie
Gérard Le Lann
André Schaff
Walid Dabbous
Yves Desswarte
Roland Balter
Michel Banatre
Marc Shapiro
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Rocquencourt
Lorraine
Sophia Antipolis
Rocquencourt
Rennes
Rhône-Alpes
Rocquencourt

Program 1C: Distributed and Real-Time Programming
Projects
- ADP (2): Distributed algorithms and protocols
- EP-ATR (2): Real-time environment project
- MEJE (8): Concurrency, synchronization and real-time programming
- PAMPA (2): Models and tools for programming distributed parallel architectures
- PARAS: Parallelism
- PARAGRAPHE (2): Parallelism and graphs

Michel Raynal
Paul Le Guernic
Robert de Simone
Claude Jard
Jean-Jacques Lévy
Philippe Daronneau
Rennes
Rennes
Sophia Antipolis
Rennes
Rocquencourt
Rennes

Theme 2: software engineering and symbolic computing

Program 2A: Semantics and Programming
Projects
- CALLIGRAMME (5): Linear logic, proof nets and categorial grammars
- COQ: Formal specifications and program validation
- CRISTAL: Typed programming, modularity and compilation
- CROAP: Design and implementation of programming tools
- LANDF (2): Software design and validation
- LOCQ (9): Constraint logic programming
- PROTHEO (5): Constraints, automated deduction and proofs of software properties

Philippe de Groote
Christine Paulin
Michel Mauny
Yves Bertot
Daniel Le Metayer
Philippe Codognet
Hélène Kirchner
Lorraine
Rocquencourt
Rocquencourt
Sophia Antipolis
Rennes
Rocquencourt
Lorraine

Program 2B: Algorithms and Computational Algebra
Projects
- ALGO: Algorithms
- CODES: Codes and information protection
- PRISME: Geometry, algorithms and robotics
- SATIR (4): Algebraic formal systems for industry and research

Philippe Flajolet
Pascale Charpin
J.-Daniel Boissonnat
Stephen Watt
Rocquencourt
Rocquencourt
Sophia Antipolis
Sophia Antipolis
Theme 3: human-computer interaction, image processing, data management, knowledge systems

Program 3A: Databases, Knowledge Bases, Cognitive Systems

Projects
ACACIA: Knowledge acquisition for explainable multi-expert systems
ATOLL: Software tool for natural language
DIALOUGE (S): Man-machine dialogue with a strong natural language component
OPERA: Tools for electronic documents
ORION: Smart problem solving environments for autonomous systems
PSYCHO-ERGO: Ergonomic psychology
RODIN: Database systems
SYCO (S): Basic models and applications of perceptive and cognitive processes
VERSIO: Databases

Participants:
Rose Dieng
Bernard Lang
Jean-Marie Pierrot
Vincent Quint
Monique Tonan
Dominique Scapin
Patrick Valduriez
François Rechenmann
Jean-Paul Haton
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Sophia Antipolis
Rocquencourt
Rocquencourt
Rhône-Alpes
Lorraine
Rocquencourt

Program 3B: Vision, Image Analysis and Synthesis

Projects
AIR: Computer vision and dynamic remote-sensing data
ÉPIDAURE: Medical imaging and robotics
IMAGES (S): Models, algorithms, geometry for graphics and image synthesis
ISA (S): Image, synthesis and analysis
MOVI (S): Modelling, location recognition and interpretation in computer vision
ROBOVIS: Computer vision and robotics
SHARP: Automatic programming and decision-making systems in robotics
SIAMES (S): Image synthesis, animation, modelling and simulation
VISTA (S): Spatiotemporal active vision

Participants:
Isabelle Herlin
Nicholas Ayache
Claude Puech
Jean-Claude Paul
Roger Mohr
Olivier Faugeras
Christian Laugier
Bruno Arnoldi
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Rhône-Alpes
Lorraine
Rhône-Alpes
Sophia Antipolis
Rhône-Alpes
Rennes

Theme 4: simulation and optimization of complex systems

Program 4A: Control, Robotics, Signal

Projects
BIP: Rapid robot
COMORE: Modelling and control of renewable resources
CONGE (S): Geometric control of non-linear systems
FRACATLES: Fractal approaches for analysis and modelling of signals
ICARE: Instrumentation, control and architecture of advanced robots
ISZS: Statistical inference for industry and health
META 2: Mathematical and computer science tools for automatic control
MIAOU: Mathematics and computing in automatic control and optimization for the user
PROMAT: Mathematical programming
SIGMA 2 (S): Signals, processing and control
SOSSO: Automatic control theory and applications

Participants:
Bernard Espiau
Jean-Luc Gouzé
Gauthier Sallet
Jacques Levy-Vehel
Claude Samson
Gilles Ceux
Jean-Pierre Quadrat
Laurent Baratchart
Claude Lemaire
Bernard Delyon
Michel Soreine
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Sophia Antipolis
Lorraine
Rocquencourt
Sophia Antipolis
Rhône-Alpes
Rocquencourt
Rhône-Alpes
Rennes
Rocquencourt

Program 4B: Modeling and Scientific Computing

Projects
ALADIN (S): Advanced algorithms for scientific computing
CAIMAN (S): Scientific computing, modelling and numerical analysis
ESTIMATE: Parameter estimation and modelling in heterogeneous media
GAMMA: Automatic mesh generation and adaption methods
IDOPT (S): Identification and optimization of systems in physics and environment
M3N: Multi-models and numerical methods
NUMATH (S): Mathematical analysis and numerical simulation of non-linear models
OMEGA (S): Probabilistic numerical methods
ONDES (S): Modelling, analysis, simulation of wave equations
SINUS: Numerical simulation for the in engineering sciences
SYSDYS (S): Stochastic dynamical systems

Participants:
Jocelyne Erhel
A. de la Bourdonnaye
Jérôme Jaffré
Paul-Louis George
Jacques Blum
Benoît Perthame
Olivier Coulaud
Denis Talay
Patrick Joly
Jean-Antoine Désidéri
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Rennes
Sophia Antipolis
Rocquencourt
Rocquencourt
Rhône-Alpes
Lorraine
Sophia Antipolis
Rocquencourt
Sophia Antipolis
Sophia Antipolis

Notes:
(6) Joint project with IMAG (CRNS, INPG, UJF)
(7) Joint project with IMSL, the University of Rennes 1 and INSIA Rennes
(8) Joint project with IPR (CRNS, ENSI), location Lyon
(9) Joint project with CRNS and UGRA
(10) Joint project with CRNS, the Henri Poincaré Institute, University of Nantes, and INP.
(11) Joint project with CRNS, location Toulouse
(12) Joint project with INP, UJF, and the University of Savoie
(13) Joint project with CNRS (ENMP)
(14) Joint project with the University of Orleans
(15) Joint project with CNRS
(16) Joint project with AMAS (University of Metz) and CNRS, location Metz
(17) Joint project with CEMICS (ENPC)
(18) Joint project with the École Centrale Institute (Henri Poincaré University and CNRS)
(19) Dual location project at Sophia-Antipolis and Lorraine
(20) Joint project with the SADP Laboratory (CRNS and ENST)
(21) Joint project with CNRS and the University of Provence, location Marseille

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM</td>
<td>Association for Computing Machinery</td>
</tr>
<tr>
<td>ADBS</td>
<td>Association des professionnels de l'information et de la documentation (Association of Information and Documentation Professionals)</td>
</tr>
<tr>
<td>AGF</td>
<td>Assurances générales de France (an insurance company)</td>
</tr>
<tr>
<td>AMS</td>
<td>American Mathematical Society</td>
</tr>
<tr>
<td>ATM</td>
<td>Asynchronous Transfer Mode</td>
</tr>
<tr>
<td>AUPELF-UREF</td>
<td>Association des universités partiellement ou entièrement de langue française - Université des réseaux d'expression française (Association of Partially or Entirely French-Speaking Universities - University of French-Speaking Networks)</td>
</tr>
<tr>
<td>BNP</td>
<td>Banque nationale de Paris</td>
</tr>
<tr>
<td>BRGM</td>
<td>Bureau de recherches géologiques et minières (Bureau for geological and mining research)</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
</tr>
<tr>
<td>CARI</td>
<td>Colloque africain sur la recherche en informatique (African Colloquium on Research in Computer Science)</td>
</tr>
<tr>
<td>CCN</td>
<td>Catalogue collectif national des publications en série (National Common Catalogue of Serial Publications)</td>
</tr>
<tr>
<td>CDD</td>
<td>Contrat à durée déterminée (Determined duration contract)</td>
</tr>
<tr>
<td>CEA</td>
<td>Commissariat à l'énergie atomique (the French Atomic Energy Agency)</td>
</tr>
<tr>
<td>CEMAGREF</td>
<td>Centre national du machinisme agricole, du génie rural, des eaux et des forêts (National Center for Mechanized Farming, Rural Engineering, Water and Forests)</td>
</tr>
<tr>
<td>CERMICS</td>
<td>Centre d'enseignement et de recherche en mathématiques, informatique et calcul scientifique (Center for Teaching and Research in Mathematics, Computer Science and Scientific Computing)</td>
</tr>
<tr>
<td>CGEA-CGFTE</td>
<td>A transportation subsidiary of the Compagnie des Eaux</td>
</tr>
<tr>
<td>CHU</td>
<td>Centre hospitalier universitaire (Teaching Hospital)</td>
</tr>
<tr>
<td>CIES</td>
<td>Centre international des étudiants et stagiaires (International Center for Students and Trainees)</td>
</tr>
<tr>
<td>CMA</td>
<td>Centre de mathématiques appliquées (Center for Applied Mathematics)</td>
</tr>
<tr>
<td>CNET</td>
<td>Centre national d'études des télécommunications (National Center for Telecommunication Studies)</td>
</tr>
<tr>
<td>CNRM</td>
<td>Centre national de recherches météorologiques (National Center for Meteorological Research)</td>
</tr>
<tr>
<td>CNRS</td>
<td>Centre national de la recherche scientifique (National Center for Scientific Research)</td>
</tr>
<tr>
<td>CNUSC</td>
<td>Centre national universitaire sud de calcul (National University Computing Center in the South)</td>
</tr>
<tr>
<td>CRIM</td>
<td>Centre de recherche informatique de Montréal (Montréal Computer Science Research Center)</td>
</tr>
<tr>
<td>CRIN</td>
<td>Centre de recherche en informatique de Nancy (Nancy Computer Science Research Center)</td>
</tr>
<tr>
<td>CSTB</td>
<td>Centre scientifique et technique du bâtiment (Scientific and Technical Construction Center)</td>
</tr>
<tr>
<td>DEA</td>
<td>Diplôme d'études approfondies (a graduate degree)</td>
</tr>
<tr>
<td>DRET</td>
<td>Direction des recherches, études et techniques de la direction générale de l'armement (General Armament Department Research Center)</td>
</tr>
<tr>
<td>EDF</td>
<td>Électricité de France (the French Electricity Company)</td>
</tr>
<tr>
<td>ENPC</td>
<td>École nationale des ponts et chaussées (Civil engineering school)</td>
</tr>
<tr>
<td>ENSAM</td>
<td>École nationale supérieure des arts et métiers (Engineering school)</td>
</tr>
<tr>
<td>ENSL</td>
<td>École normale supérieure de Lyon (Higher education Institution)</td>
</tr>
<tr>
<td>ENSMP</td>
<td>École nationale supérieure des mines de Paris (Engineering school)</td>
</tr>
<tr>
<td>ENSTA</td>
<td>École nationale supérieure des techniques avancées (Engineering school)</td>
</tr>
<tr>
<td>EPST</td>
<td>Établissement public à caractère scientifique et technologique (scientific and technological public institution)</td>
</tr>
<tr>
<td>ERCIM</td>
<td>European research consortium for Informatics and mathematics</td>
</tr>
<tr>
<td>ETA</td>
<td>Engineers, technicians, administrators</td>
</tr>
<tr>
<td>GAMNI/SMAI</td>
<td>Groupe pour l'avancement des méthodes numériques de l'ingénieur/sociétés des mathématiques appliquées et industrielles (Group for the Promotion of Numerical Methods in Engineering Science/French Society for Applied and Industrial Mathematics)</td>
</tr>
<tr>
<td>GDMO</td>
<td>Guidelines for the Definition of Managed Objects</td>
</tr>
<tr>
<td>GFII</td>
<td>Groupement français de l'Industrie de l'Information (French Information Industry Group)</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>GIE</td>
<td>Groupement d'intérêt économique (Economic Interest Group)</td>
</tr>
<tr>
<td>HCM</td>
<td>Human Capital and Mobility</td>
</tr>
<tr>
<td>HTML</td>
<td>Hyper Text Markup Language</td>
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<tr>
<td>HTTP</td>
<td>Hyper Text Transfer Protocol</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IMAG</td>
<td>Institut d'informatique et de mathématiques appliquées de Grenoble (Grenoble Institute for Computer Science and Applied Mathematics)</td>
</tr>
<tr>
<td>INPG</td>
<td>Institut national polytechnique de Grenoble (Engineering school)</td>
</tr>
<tr>
<td>INPL</td>
<td>Institut national polytechnique de Lorraine (Engineering school)</td>
</tr>
<tr>
<td>INRETS</td>
<td>Institut national de recherche sur les transports et leur sécurité (National Institute for Research on Transportation and Security)</td>
</tr>
<tr>
<td>INSA</td>
<td>Institut national des sciences appliquées (Engineering school)</td>
</tr>
<tr>
<td>INSERM</td>
<td>Institut national de la santé et de la recherche médicale (National Institute for Health and Medical Research)</td>
</tr>
<tr>
<td>IRISA</td>
<td>Institut de recherche en informatique et systèmes aléatoires (Computer Science and Random Systems Research Institute)</td>
</tr>
<tr>
<td>ISDN</td>
<td>Integrated Service Digital Network</td>
</tr>
<tr>
<td>LAAS</td>
<td>Laboratoire d'analyse et d'architecture des systèmes (System Analysis and Architecture Laboratory)</td>
</tr>
<tr>
<td>LEPT</td>
<td>Laboratoire énergétiques et phénomènes de transfert (Transfer Phenomena and Energetics Laboratory)</td>
</tr>
<tr>
<td>LETI</td>
<td>Laboratoire électronique et technologie de l'instrumentation (Instrumentation Electronics and Technology Laboratory)</td>
</tr>
<tr>
<td>LIAMA</td>
<td>Laboratoire franco-chinois de recherche en informatique, automatique et mathématiques appliquées (Franco-Chinese Laboratory for Research in Computer Science, Automatic Control and Applied Mathematics)</td>
</tr>
<tr>
<td>LIP</td>
<td>Laboratoire de l'informatique du parallélisme (Parallel Computing Laboratory)</td>
</tr>
<tr>
<td>LORIA</td>
<td>Laboratoire lorrain de recherche en informatique et ses applications (Lorraine Laboratory for Research in Computer Science and Its Applications)</td>
</tr>
<tr>
<td>MAIA</td>
<td>Machine pour les applications en intelligence artificielle (Machine for Artificial Intelligence Applications)</td>
</tr>
<tr>
<td>MENRT</td>
<td>Ministère de l'éducation nationale, de la recherche et de la technologie (Ministry for Education, Research and Technology)</td>
</tr>
<tr>
<td>MIT-LCS</td>
<td>Massachusetts Institute of Technology-Laboratory for Computer Science</td>
</tr>
<tr>
<td>MMAS</td>
<td>Méthodes mathématiques pour l'analyse des systèmes (Mathematical Methods for System Analysis)</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation</td>
</tr>
<tr>
<td>OMG</td>
<td>Object Management Group</td>
</tr>
<tr>
<td>ONERA</td>
<td>Office national d'études et de recherches aérospatiales (National Institute for Research in Aeronautics)</td>
</tr>
<tr>
<td>PSA</td>
<td>Peugeot SA</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>SGML</td>
<td>Standard Generalized Markup Language</td>
</tr>
<tr>
<td>SIAM</td>
<td>Society for Industrial and Applied Mathematics</td>
</tr>
<tr>
<td>SIM</td>
<td>Signaux images en médecine (Image Signals in Medicine)</td>
</tr>
<tr>
<td>SIMD</td>
<td>Single Instruction Multiple Data</td>
</tr>
<tr>
<td>SMAI</td>
<td>Société de mathématiques appliquées et industrielles (The French Society for Industrial and Applied Mathematics)</td>
</tr>
<tr>
<td>SMIL</td>
<td>Synchronized Multimedia Integration Language</td>
</tr>
<tr>
<td>SMP</td>
<td>Simulation et modélisation des phénomènes de propagation (Simulation and Modeling of Propagation Phenomena)</td>
</tr>
<tr>
<td>TCP-IP</td>
<td>Transmission Control Protocol-Internet Protocol</td>
</tr>
<tr>
<td>UCIS</td>
<td>Unité de communication et d'information scientifique (Communication and Scientific Information Unit)</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNSA</td>
<td>University of Nice - Sophia Antipolis</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>VLSI</td>
<td>Very Large Scale Integration</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
<tr>
<td>WWW/W3</td>
<td>World Wide Web</td>
</tr>
</tbody>
</table>
INRIA

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THE FRENCH NATIONAL INSTITUTE FOR RESEARCH
IN COMPUTER SCIENCE AND CONTROL

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