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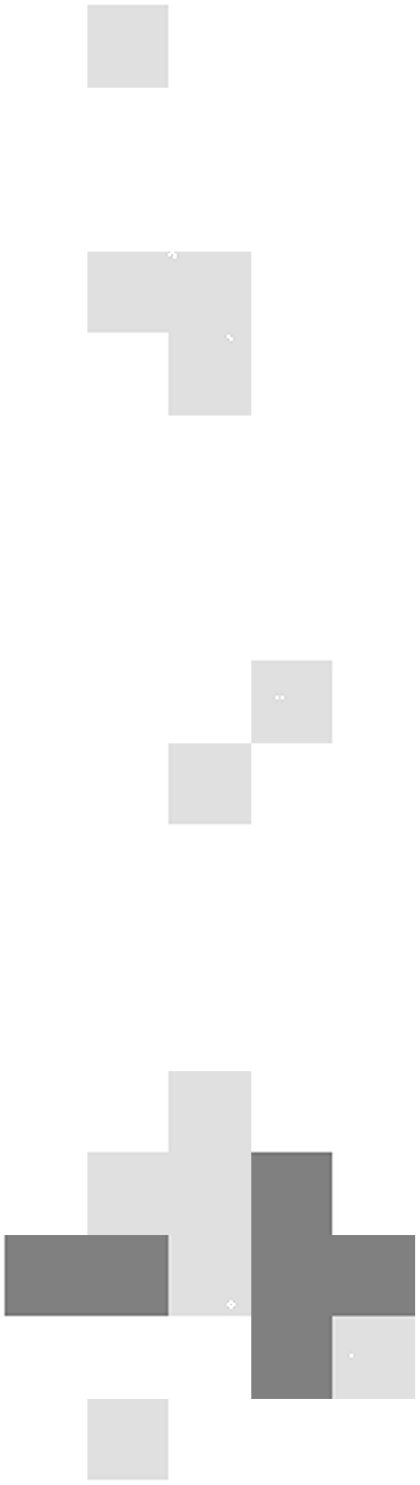
Commission of the European Communities
DG XIII: Information Technologies and Industries, and Telecommunications
R&TD: Information Technologies



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Contents

List of illustrations

Foreword

by Michel Carpentier, Director-General, DG XIII

ESPRIT was set up in 1984 to coordinate and focus pre-competitive research in Europe and so strengthen the ability of European companies to compete in world markets. This was done based on the perception that no single IT company could succeed on its own, given the rising costs and risks of investment in information technologies and the increasing globalization of the market.

ESPRIT has proved to be highly successful in promoting industrial cooperation. The programme has not only led to many outstanding technological results, well recorded in this report; it has also catalysed collaboration between large, medium-sized and small companies and between industry and universities and research centres. Its catalytic effects often extend beyond the R&D phase: cooperation in R&D has led to a marked change in the attitude of companies and has fostered the necessary, if at times painful, process of industrial restructuring.

Compared to the situation a decade ago, the IT industry's influence on the development of our industrial, economic and social fabric has grown enormously, but it has also experienced unprecedented turmoil worldwide, especially in the period covered by this report. Prices of semiconductors and personal computers alike have fallen by half over the past 12 months. Growth in data-processing and consumer electronics has been largely flat. Restructuring and lay-offs are widespread. It is clear that the IT industry has now entered a period of growth rates far lower than any in the past 20 years or more. And yet the rate at which the technology itself has been advancing during those same years is forecast to continue at least into the first decade of the next century.

This is the background to current considerations of the form that future concerted Community action in information and communications technologies should take. Originally conceived as a 10-year programme, ESPRIT is now approaching completion, and is due to be followed by new initiatives under the Community's fourth framework programme for research and technological development (R&TD). Scheduled to start in 1994, this is now undergoing its first examination by the Council of Ministers and the European Parliament. The initiatives proposed are based on the consensus view of many hundreds of IT vendor and user companies of all sizes, and of research centres throughout the Community. Intensive independent assessments of Community R&D programmes, including ESPRIT, have contributed to this forward planning exercise.

Industrial competitiveness has been confirmed as an EC priority by the 12 Member State governments in the text of the Maastricht Treaty, and the Commission has submitted a major communication to the Council and the Parliament on the ensuing implications for research strategy. The IT industry needs the single European market, due to come into effect on 1 January 1993. At the same time, optimizing the beneficial impact of the single market on industrial competitiveness requires the Community to play a role in R&TD that is both more necessary and more complex than ever. At a critical time for the IT industry, and on the threshold of the single market, Community-sponsored R&D will continue to provide the framework within which industry's efforts can be brought to fruition.

Introduction

by J.-M. Cadiou, Director, ESPRIT

Highlights

It gives me very great satisfaction to report that over **225 new results** were registered in the 12 months covered by this report, largely stemming from projects launched in 1989 at the start of ESPRIT's second phase. This tremendous achievement has raised the cumulative total recorded since the beginning of the programme **to over 720 major results** as of mid-1992, either leading directly to commercial products or services, contributing to the establishment of international standards, or in the form of tools, methods and processes taken up by industry. Many of these were presented last November at the annual ESPRIT **conference exhibition**, open to the public for the first time, where a record 125 projects were featured. Attracting over 3 500 participants and visitors, the conference continues to function as a leading forum where researchers can learn of the latest results, keep abreast of leading-edge IT developments, share experiences and discuss issues of common concern.

The period under review witnessed the launch of the **third phase** of ESPRIT. More than 1 650 companies and 720 universities and research institutes from all over the Community and EFTA took part in submitting the 1 259 proposals received. An exhaustive evaluation process by independent experts led to the selection of **213 new industrial projects** (including those contributing to JESSI, the EUREKA Joint European submicron silicon project) and a number of **special actions** (with several devoted to fostering the future participation in the programme of organizations from the new German *Länder*). In basic research, **99 new projects** and **nine networks of excellence** were chosen.

New ESPRIT projects	
Microelectronics	40
Information processing systems and software	54
Advanced business and home systems — peripherals	37
Computer-integrated manufacturing and engineering	62
Open microprocessor systems initiative	20
Basic research	99
Total	**312**
Total Community funding (MECU)	452

The many new projects initiating ESPRIT's third phase are in fact mainly focused around a few clearly defined technological themes: **CMOS technology in microelectronics, high-performance computing, software platforms, distributed processing, multimedia** technology, and **computer-integrated manufacturing** systems. We have also launched the **open microprocessor systems initiative (OMI):** drawing on all other areas of the programme, OMI's objective is to bring the open systems concept to the level of on-chip microprocessor systems and their associated software. In peripherals, a major R&D project on high-resolution **liquid-crystal display** (LCD) technology has been launched, following on from the establishment of a joint-venture manufacturing enterprise committed to commercial exploitation of the R&D results in screens for HDTV and other applications. ESPRIT contributes to the funding of the R&D, but not to that of the manufacturing enterprise. This is a novel approach: the existence and requirements of the R&D project are derived

from the needs of the joint venture. This is the strongest possible form of commitment to exploitation that can be expected at the start of an R&D project.

On the international front, we have developed our contacts with **East and Central European countries** and are managing, with DG XII, the new cooperation programme for encouraging researcher mobility, information exchange and joint research projects. In mid-1992 the operational framework for an **international feasibility study on advanced manufacturing** was agreed by high-level representatives of the industrial and research communities of Europe (the EC and five EFTA countries), Japan, the USA, Canada and Australia. ESPRIT's CIME division is providing the European secretariat. The feasibility study is designed to examine the prospects for setting up a full-scale programme in this field, if and when it is felt that international collaboration could help improve European manufacturing operations, many of which are increasingly global in scale. The proposed intelligent manufacturing systems (IMS) initiative would bring together researchers from industry and academia, initially drawn from the regions participating in the feasibility study. The study itself will get under way with a limited number of R&D test-case projects early next year. The test-cases are designed to determine if a full-scale IMS programme will be workable in practice, and to assess whether it would be likely to result in a equitable balance of contributions and benefits: the programme will not go ahead unless the prospects for achieving this are demonstrably sound.

An **evaluation of the previous phase** of ESPRIT (ESPRIT II) was also completed in mid-1992. The independent review board found that ESPRIT II had produced good technological results in numerous projects and many new standards on which exploitation activity can be based. The great majority of the industrial participants reported that a significant contribution to the development of new products and services had been made by the projects in which they were involved, although the board noted that the coupling between R&D and product development, especially in large companies, needed tightening (this point has already started to be addressed in ESPRIT III, for example with the new approach used for the LCD project previously mentioned). The board's suggestion that in future the programme be concentrated around a more limited number of well-focused technology areas has been partially realized in the new phase, and will be fully put into effect in its successor. The board also drew attention to several administrative issues in need of attention, and we are examining how to improve our programme management procedures yet further.[1]

Preparations are now under way for the **next phase of the programme**, notably focusing on software, semiconductors, high-performance computing and peripherals. Before describing this more fully, I will first expand on the results which have arisen from ESPRIT projects and then analyse the changing industrial context.

ESPRIT technology results

Results from ESPRIT projects can be grouped into three broad categories. First are those consisting of advanced technologies, ranging from improvements to breakthroughs, that lead to products or services brought to market. Second are results that make key contributions to the work of the various international standardization committees and lead to the specification, drafting and ratification of IT standards. In the third category are tools, methods or procedures that enhance the performance of industrial manufacturing processes in terms of shorter development times, higher quality, better yields and lower costs.

The table shows an analysis of the 721 major results reported as of mid-1992.

Results arising from ESPRIT projects as of mid-1992	
Contributing directly to products or services	417
Contributions to international standards	72
Tools and methods used outside ESPRIT	232
Total results	**721**

Over 225 of the total number of results have been recorded since mid-1991: i.e., nearly

1 The review board's report also considers other activities within DG XIII, notably RACE and DRIVE, and makes suggestions for the future orientation of DG XIII's programmes as a whole. The Commission's views on this report are being formulated in an appropriate document.

one-third of all results produced so far have appeared in the last 12 months.

The ESPRIT programme was launched in 1984 for a 10-year period. Three major IT domains have been addressed from the outset: **microelectronics**, where the aim has been to develop advanced hardware component technologies and increase their take-up and range of applications; **information processing systems and software**, where the main objective has been to develop advanced systems integrating the hardware and software technologies required for future IT products; and applications, concentrating on **computer-integrated manufacturing** and **business and home systems**, where the focus has been on improving the ability to advanced IT concepts of broad applicability in the factory, office and home. A **basic research** component, added in 1988, has the dual goals of generating fundamental technological advances in areas of long-term industrial relevance and providing a framework for training doctoral and post-doctoral students.

A key objective in **microelectronics** has been to enhance the ability of manufacturers to create their own ASICs (application-specific ICs). The programme has successfully fostered the continuing development of the tools and process technologies necessary to design and manufacture ASICs, and has encouraged companies to explore the potential benefits of using them in their products. Special attention has been paid to building cooperation between manufacturers and users as a basis for the establishment of fast prototyping services, and state-of-the-art designs for high-performance circuits for consumer product and telecommunications applications have been produced. Excellent results have emerged from research on CAD, typified by the CATHEDRAL technology, which decreased digital signal processing (DSP) chip design times 10-fold and has led to a suite of commercial products. In basic technologies, strong synergetic links have been established with the EUREKA project JESSI in work on advanced submicron CMOS, and leading-edge research has led to a world-class, high-speed bipolar semiconductor technology. Collaboration between IC and equipment manufacturers has led to the timely development of world-leading equipment such as high throughput, industrial-scale reactors and wafer-steppers; the associated processing techniques enable the fine geometries, complex materials and large wafer sizes used in making state-of-the-art ICs to be dealt with cost-effectively. Throughout this area of ESPRIT great stress has been placed on involving SMEs, whose capacity for quick innovation is a very important factor in maintaining the competitiveness of the industry. A general Europe-wide action to boost their participation has been accompanied by local technology transfer and awareness-raising measures in Spain, Portugal, Greece and southern Italy: together these have significantly advanced the ability of SMEs to make use of the full portfolio of microelectronic technologies, especially ASICs, and to participate in future phases of the programme.

In the **information processing systems and software (IPSS)** area, ESPRIT has made a key contribution to the commercial success of parallel systems and of distributed memory systems in particular, where Europe now has a significant market share. Thanks to ESPRIT-supported work in this field, Europe has started to compete with real effect in the massively parallel machine market. The data-processing world has also grasped the opportunity of obtaining improved response times and throughput by using parallel processing, and significant achievements have already been made in ESPRIT in efficiently implementing business applications such as decision support, transaction and parallel database systems on parallel machines. IPSS has also had a strong focus on improving software quality, the productivity of programmers and software engineers, methodologies for managing the development process, and development tools themselves. These tools are part of a complete CASE environment compatible with the Portable Common Tools Environment (PCTE), an outstanding result of the programme. PCTE is increasingly being adopted as a standard in the USA and Japan, as well as in Europe, as a basis for building programmer environments.

Results from the **advanced business and home systems** area have given a major impetus towards the acceptance of the open systems concept and strongly influenced the development of the office document architecture (ODA). The ODA standard has now been adopted by leading European and other IT companies, with many ODA-based products available. Work in this area has also made a major contribution to the ISO standard on open distributed processing (ODP). In multimedia, ESPRIT has supported a number

of projects designed to give European industry a strategic advantage in a quickly expanding market. World firsts include the basic concept underpinning the CD-I product range, advances in true-colour image systems, and ISO standards for encoding still and moving images. Related research on workstations has led to the development of a family of multimedia authoring and delivery products and to the increasingly successful ARM risc processor, the basis of Apple's recently launched Newton range of pocket computers. The special emphasis on advanced user-interfaces has resulted in a number of development tools, now licensed to several major IT companies. ESPRIT work has also enabled the industry to position itself to take advantage of the growing 'intelligent home' market, with leading appliance manufacturers and utility companies collaborating to develop the necessary framework of standards and architectures.

Substantial progress has been made in **computer-integrated manufacturing** (CIM) in establishing an open systems framework for a modular and flexible architecture for CIM systems and in developing compatible applications. Shop-floor advances such as low-cost vision sensors, real-time schedulers, product data exchange protocols and CIM management information systems have led to the development of generic technologies for the company-wide and multi-site integration of manufacturing processes. Considerable effort has been devoted to improving the ease with which operators can monitor and control complex process plant and equipment using CIM concepts, with results in use in a range of process industry and power generation sites. An important objective has been to accelerate the diffusion of CIM know-how throughout the Community, particularly to SMEs, and this has been undertaken through a variety of project-based workshops and thematic seminars.

In the **basic research** domain, important linkages have been forged through the 'networks of excellence', groupings of research teams sharing common long-term research goals and closely coordinating their research and training activities. The VLSI design training action has proved to be an outstanding success, with more than 5 000 students, well over the targeted number, trained in VLSI design skills, and is being extended for three years in the new phase. The first wave of research actions has promoted collaborative research in areas with the potential to produce future advances and breakthroughs relevant to the long-term goals of the IT industry and its users. Fundamental work of very high quality has been performed in a range of key areas, including superconductivity, optical computing, nanoelectronics, logic programming, databases, knowledge representation, computer vision and speech recognition.

Results stemming from ESPRIT are found incorporated in a wide variety of products and processes. Here are a few recent examples taken from the 721 results so far recorded:

- *Pocket computers:* the Newton 'personal assistant', an all-in-one portable electronic notebook, word processor, fax machine and computer recently launched by Apple, is based on a reduced instruction set (RISC) microprocessor chip developed in ESPRIT. The ARM 610 offers the performance of an up-market personal computer combined with low-cost and low power consumption. These characteristics make the ARM chip ideal for portable products made in large volumes, such as small consumer electronic devices. The ARM was developed by Acorn, the UK technology division of Olivetti, and is based principally on results from MULTIWORKS (2105).[2]

- *Open systems:* a major step towards freeing software products from dependence on particular computer architectures has been made possible by a recent agreement between the Defence Research Agency (UK) and Unix System Laboratories, USL (USA). The agreement will lead to the marketing to software vendors of a standard format that allows software packages to be used in a wide range of software and hardware platforms without modification. Developed in OMI-MAP (5386), the format has been adopted by the Open Software Foundation (OSF) as part of an agreement with USL on the future evolution of the Unix family.

- *Software engineering:* a platform based on the PCTE (Portable Common Tool Environment) has recently been adopted by IBM (USA) to replace its proprietary AD/Cycle product. Developed in a coordinated set of

2 Every ESPRIT project has a number and most have an acronym as well. For more information about a project, look it up in the projects and participants list (p. 119).

eight ESPRIT projects, PCTE led to the establishment of the first public standard in this area (ECMA 149). PCTE environments are now commercially available from Bull (F), DEC (USA) and Hewlett-Packard (USA), and PCTE-compliant tools are being offered by SFGL (F), Syseca (F), GIE Emeraude (F) and Ipsys (UK). The PCTE has now passed a NATO validation of its suitability for defence needs.

- *Factory automation:* the Communications Network for Factory Automation (CNMA) projects (944/2617/5104) have led to over 25 commercial products so far. The range available from Alcatel (F), Bull (F), GEC (UK), Olivetti (I), Robotiker (D) and SNI (D) includes local area network (LAN) gateways, LAN test equipment, kits for connecting minicomputers and PCs to LANs, and software packages for supervising integrated shop-floors. Users played an extremely important role in validating early project results, with implementations of pilot networks in Aeritalia, British Aerospace and BMW factories. Subsequent production pilots installed by Aérospatiale, Magnetti Marelli and Renault demonstrated interoperability between equipment from different vendors, and the use of standard data exchange protocols on a variety of different interlinked networks.

- *Consumer electronics:* CD-I, the interactive CD multimedia entertainment product recently launched by Philips, delivers text, images and sound through the medium of the now-familiar compact disc allied to a TV set. The concept is based on a prototype multimedia storage and selective retrieval system developed in the DOMESDAY (901) project and the world-standard coding system for video images (ISO 11172) developed in COMIS (2102).

- *Semiconductor packaging:* the leading-edge chip packaging technology used by Bull (F) and Siemens-Nixdorf (D) for their major mainframe product-lines resulted from the APACHIP (2075) project. TAB (tape automated bonding) replaces the customary wires connecting a chip to its ceramic base and external pins, improving reliability and allowing higher packaging density. MCTS (F) can now supply state-of-the-art TAB tape in industrial quantities. Through its participation in the project, Hoechst Ceramtec (D) has developed a ceramic packaging technology which is on a par with those of its competitors in world markets.

- *Semiconductor manufacturing:* results from three projects have given Europe a world lead in the lithography equipment used for manufacturing integrated circuits. ASM-L (NL) has brought to the market a wafer-stepper that uses deep ultraviolet light to define structures as small as 0.18 microns. This instrument, a direct outcome of project 2048, is being used to develop the processes required for next-generation 64 Mbit memory chips and beyond. It incorporates a unique through-the-lens alignment system, enabling record-beating alignment accuracy to be achieved. The advanced optical system needed was developed in project 5002, with Heraeus Quartz (D) producing the state-of-the-art lens material and Carl Zeiss (D) the lens itself. The photoresist technologies required for DUV stepper operation were developed by Hoechst (D) and Siemens (D) in project 2048, and by IMEC (B) and UCB (B) in DRYDEL (2265).

- *High-performance computing:* one of the world's most powerful risc processors, the T9000 from Inmos (UK) launched last year, was developed through work in three projects, SUPERNODE (2528), PUMA (2701) and GENESIS (2702). Today's transputer-based products provide supercomputing power at one-fifth the cost of a conventional supercomputer. Through continuing development, the processing capabilities of the transputer have increased more than 10-fold in three years. The T9000 succeeded the T800, developed in an earlier ESPRIT project.

- *Process control:* a power-plant in Spain, a nuclear power station in France and three Italian chemical plants are now equipped with a control system that integrates intelligent sensors and actuators with a high-speed communications network to provide substantial improvements in safety, reliability and efficiency. The sensor network technology, developed in DIAS (2172), provides more consistent and integrated information to operators than the system it replaces, and greatly simplifies control and instrument wiring.

- *Computer-aided testing:* testing remains one of the major bottlenecks in the process of bringing advanced electronic products

to market. The boundary-scan test (BST) technology allows complex multi-chip systems, often assembled on 'wrap-around' circuit boards to fit into miniaturized products, to be tested quickly and economically. Based on the results of project 2478, Philips (NL) has launched a low-cost range of BST products for testing chips, boards and systems. The tester range includes a notebook-computer compatible module for use in the field.

- *Basic research training:* the VLSI Design Action, EUROCHIP (3700/6573), launched in 1989 to increase the number of students trained in VLSI techniques, has substantially exceeded expectations. More than 5 000 students have already been trained in VLSI design skills, and around 600 of the over 1 000 designs produced have been fabricated at the five state-of-the-art European foundries involved.

- *Basic research applications:* industry is already capitalizing on concepts and prototypes developed in basic research projects, demonstrating early examples of industrial applications:

(i) Siemens (D) is using a spectroscopic procedure developed in EPIOPTIC (3177) for aligning batches of virgin silicon wafers in the same crystallographic direction at the start of the chip fabrication process, a step that improves the uniformity of the finished product. The non-destructive RAS (reflection anistropy spectroscopy) technique can achieve an angular resolution of better than 0.1°.

(ii) Danish National Railways now check the software that runs its automatic signalling system by using techniques developed in PROCOS (3104) for proving the formal 'correctness', or validity, of real-time, safety-critical systems. Such systems are particularly difficult to validate, given the very large number of cases with which the software concerned must cope.

These results, and the many others like them, stem from the cooperation between European companies and between industry and academia fostered by ESPRIT. Cooperation is, above all, about **sharing**: sharing the costs and also the manpower that make up R&D resources (money, even if available, is not sufficient to mobilize highly skilled people quickly if they are simply not there); sharing the risks of working at the frontiers of knowledge in constantly changing market and technology environments; and sharing in the results. *Resource sharing* has enabled companies to compensate for the scarcity of qualified manpower and to share ever-higher R&D costs. When companies get together in a collaborative project in order to achieve a common objective, each only has to contribute a fraction of the total resources required. Even if extra overheads arise from the collaborative nature of the project, these are more than compensated for by the Community's contribution. From an individual participant's point of view there is a multiplier effect, enabling it to have leverage over a project several times the size of its own effort. The cooperation mechanism also enables *risk sharing* by allowing the parallel exploration of alternative routes towards the same goal; different technologies and approaches can be explored much more quickly, and a timely decision then taken on which stands the best chance of success and should therefore be continued. Of course, resource and risk sharing can only work if the *results* are also shared: each company needs guaranteed access to the full results of the entire project, including those aspects in which it has not itself participated.

Evidence that this cooperative mechanism is working well comes from the companies themselves. The largest IT companies estimate that roughly 20% of their IT-related products in recent years contain technology arising from their participation in ESPRIT projects, whereas in funding terms the programme only contributed 2% or so of their total R&D expenditure. For SMEs, the main benefits quoted are gaining access to a broader range of leading-edge technologies and obtaining a better appreciation of potential market opportunities.

A time of change

It is remarkable that all this has been achieved against a backdrop of dire crisis for the IT industry. In its short history, few periods have been marked by upheavals on the scale that has characterized the past five years. The unabated pace of technological evolution resulted in sharp decreases in unit prices, while the emergence of open systems established a new and harshly competitive playing field. The conjunction of these two factors, together with the recent slowdown in de-

mand growth, forced severe industrial restructuring. The traditional model of the computer manufacturer designing, producing and supporting a full product range, from components through to services, and counting on a customer base tied to proprietary computer architectures, has simply ceased to exist. The difficulties experienced even by IBM, which last year posted a loss and a turndown in sales for the first time in its history, are the most striking example of this transformation in the IT industry. Several once-famous company names, accustomed to appearing at the top of the industry listings, have been absorbed by other firms, while others have disappeared from the top rankings altogether.

Of course, the European IT industry was unavoidably caught up in the global crisis affecting the electronics industry. Indeed, it has suffered the most: not only were European companies faced with increased competition and falling prices while simultaneously engaged in deep restructuring, but they also ran the risks incurred by making the large investments needed to maintain or increase their market share. The latter was largely achieved through a strategy of expansion by acquisition, though this was often to the detriment of their balance sheets. The increasing importance of the software and services sector has provided ample opportunities for SMEs, who play a dominant role in this area. In general, the growth of European SMEs, both in numbers and average enterprise size, has so far been particularly significant.

The overall situation still gives rise to serious concern and calls for a coherent strategy at European level. It is important, however, to acknowledge that progress has been made by European companies, both large and small, and to appreciate that their efforts to improve the European technology base at such a critical time have received every possible encouragement from ESPRIT.

Preparing the future: focusing on industry's priorities

A major characteristic of the IT industry, and one which the changing content of ESPRIT continues to reflect, is the dynamic nature of the technology itself. The technology pace is not slowing down, even though the market is doing so, and while the pace of new products is also easing up. The reason why the technology race is still as fierce as before is that companies want to be first on the market with new generations as soon as the market picks up again — and no one doubts that it will. This is exemplified by semiconductors and LCDs in Japan. Therefore, the current market slowdown should not be used as an argument for Europe to ease up on technology investment — indeed, it provides an opportunity for European industry to press forward. In fact, the rate at which technology has been advancing for the past 20 years is forecast to continue for at least another decade, and it is vital that companies continue to have access to leading-edge developments if they are to make competitively priced products with the features that customers want.

Extensive analyses carried out in collaboration with the IT industry and leading-edge users have identified several key technology areas that are critical for the future: **semiconductors, high-performance computing, software** and **flat-screen (thin) displays** are those which should be emphasized in the next phase of the programme. Furthermore, the work recently started in **open microprocessor systems** and **basic research** should be continued to maintain momentum and build on the successes that have already become apparent. Because of the pervasiveness of the technology, the participation of users in the programme — already large, especially in **CIME** and **multimedia** — needs to be increased: this will help pull technology from the R&D stage through to the marketplace.

The Community is already committed to support of a major effort in **semiconductor technology**, where new generations are still expected every three years, on average, for at least the next decade. Here extensive exploration of the many alternative routes to next-generation technologies is required in a timely manner, and in particular to select the right moment at which technology discontinuities must be introduced: this is extremely resource-intensive. The Community contribution will be focused on CMOS technologies, particularly ASICs, which are becoming increasingly complex as more and more functions are integrated on a single chip (e.g. memory plus processor).

The work in information processing systems has prepared the way for a new **high-performance computing and networking (HPCN)** initiative. High-performance computing is

central to research activities in a growing number of fields, including the automotive, aerospace and pharmaceutical industries, chemical engineering and environmental sciences. Developments in HPCN make it possible to considerably reduce or eliminate time-consuming and costly experiments (for example, into the effects of crashes on cars) by running simulations based on accurate models of reality. An aggressive and forward-looking policy of support for the development and exploitation of HPCN is required if Europe is to maintain its industrial competitiveness, and is particularly urgent in view of the major American initiative, already into its second year, that forms a central plank of the new US technology policy.

Europe also needs to build on its considerable strengths in the area of **software**, particularly in **software infrastructures** to develop heterogeneous and open distributed systems. A substantial effort is also required to **increase the take-up of 'best practice' software programming and engineering techniques** by establishing a documented repository of the experience gained in using advanced software methods and tools, and by providing training in their use.

In peripherals, R&D requirements are increasing in the area of **flat-screen displays**, especially those based on LCs (liquid crystals), following European industry's recent decision to launch a joint-venture manufacturing enterprise for such displays.

In **CIME (computer-integrated manufacturing and engineering)**, projects have been characterized by a pioneering emphasis on strong user participation and a very close relationship between R&D and its transfer into practice. Europe is well-positioned in CAD/CAE, production management and control software. However, only a small proportion of IT systems used in manufacturing are currently integrated on an enterprise-wide basis, and future R&D work will be oriented towards IT integration and 'lean production' in order to speed up the design/manufacturing/marketing cycle.

The open microprocessor systems initiative, aimed at extending the open systems concept to on-chip microprocessors and their associated software, is the first example of a focused **cross-area initiative**. This approach could well be taken in the future for topics such as computer-aided design and microsystems.

These priorities will determine the main lines of the new R&D work to be launched in the next two years under the present phase of ESPRIT within the Third Framework Programme for Research and Technological Development. They also indicate the major axes of the next R&D programme for the IT area, which is now being drawn up in the context of preparations for the Fourth Framework Programme (1994-98).

The scale of the IT industry and its importance for the whole European economy call for a sustained effort to stimulate increasing investment in R&D by industry players. No slowdown can be afforded in a period when competition has become tougher, technology is more important than ever in determining a company's future, and structural and technological change repeatedly challenge established market positions. It is clear that when this period of rapid growth stabilizes and the IT industry becomes mature — and it will, sooner or later — market positions will freeze and situations will become irreversible.

However, R&D alone is not enough. There are fundamental structural differences in the industrial and economic environments in which companies operate in the three major world trading blocs. They concern financial conditions, commercial practices and access to markets, and their net result is a clear disadvantage for European companies. For the European IT industry to be able to take on the challenge fairly and squarely, it is essential that such disparities are eliminated. Compatible rules of the game must be established and a level field of play must be achieved. Only then will the European IT industry's efforts bear fruit.

Microelectronics

Overview

Major changes have taken place in the European semiconductor industry in recent years, with companies transforming their long-term R&D strategies, cooperations and mergers occurring, and new system house/producer relations being established. In this rapidly changing world ESPRIT has shown its merits in establishing cooperative industrial projects that continue to act as stabilizing factors amongst the many and diverse developments taking place. In these projects ESPRIT, acting with the joint European submicron initiative (JESSI), the Eureka project, brings together the main players in microelectronics to create an environment that fosters their ability to supply the market with competitive technologies and products in a timely manner and so gain advantage over their competitors.

Last year the first call for proposals for the third phase of ESPRIT resulted in an overwhelming response, with 140 submissions to the microelectronics area. The increased number of SMEs involved was particularly noteworthy. The period under review started with 54 ongoing projects and special actions, of which 20 have now been completed; approximately 47 new projects will be launched during 1992.

Core CMOS technology

The global CMOS market is forecast to grow from ECU 24 billion in 1990 to ECU 62 billion in 1996, when it will cover 73% of the entire merchant semiconductor sector. In the new programme more than 50% of the microelectronics sector has been devoted to silicon microelectronics, with advanced CMOS as the key technology. The participation of JESSI is vital in this respect. This core activity forms the basis for the other clustered programmes under way within JESSI, including its application-driven 'Europrojects'. An even stronger relationship with JESSI is envisaged in the third phase of ESPRIT.

Work for the core CMOS technology and its derivatives (e.g. BiCMOS and non-volatile logic) includes the complete range of supporting topics from methodologies, tools and systems for design and verification, via equipment and materials, to testing and packaging. In 1991/92 the start-up phase of three large ESPRIT/JESSI infrastructural projects was completed, covering the JESSI common frame (JCF, 5082), CMOS process technology (JLP, 5080), and manufacturing science and technology (MST, 5081). These three activities are underpinned by a number of very important ESPRIT projects on manufacturing equipment and materials (photolithography, clustered tools), design methodologies, and CAD tools and test systems, which offer a complete package of product design and manufacturing facilities.

Complementary technologies

Since 1989 the merchant market for GaAs microwave and digital ICs has grown at 40 to 50% per year, and is expected to reach over USD 1 billion in 1994 in the computer, automotive, and communications industries. Demand for III-V-based products in Europe, especially for applications in communications, is expected to grow more quickly than in the rest of the world. Several ESPRIT projects have been established to strengthen Europe's position, aiming to achieve cost reductions, higher performance and better cooperation (second sourcing) between the main European players.

Optoelectronics is a field in which European industry has invested heavily in R&D and production. Europe supplies more than 25% of the world's market for semiconductor optoelectronic transmitters and receivers for fibre-optic communications and specialized

applications. There is also a rapidly accelerating trend to use optoelectronics for short-distance interconnections in high-performance computing applications, as well as in advanced information-processing networks. Optoelectronics and optical connectivity are continuing as important parts of ESPRIT. In a complementary partnership, the RACE programme, which targets system-oriented aspects of telecommunications applications, builds on ESPRIT projects by developing enabling technologies and specific circuits.

ESPRIT has always recognized the importance of research in areas which complement semiconductor microelectronics. Examples of this work can be found in the projects which have underpinned the development of large-format, high-resolution flat-panel displays. Substantial markets also exist for new generations of electronic components and sensors, and it is essential for European industry to participate by both producing the devices themselves and by gaining the added value from integrating these elements into complete systems. New projects addressing the field of integrated smart sensors have been launched to further this goal.

An example of a field diagnosis module employing advanced test procedures using boundary scan testing (BST) developed by Philips in project 2478. The range of equipment includes full production board test systems, with a competitive edge coming from the advanced test concepts built into the software, which has had a significant impact on international standards.

Technology access for SMEs

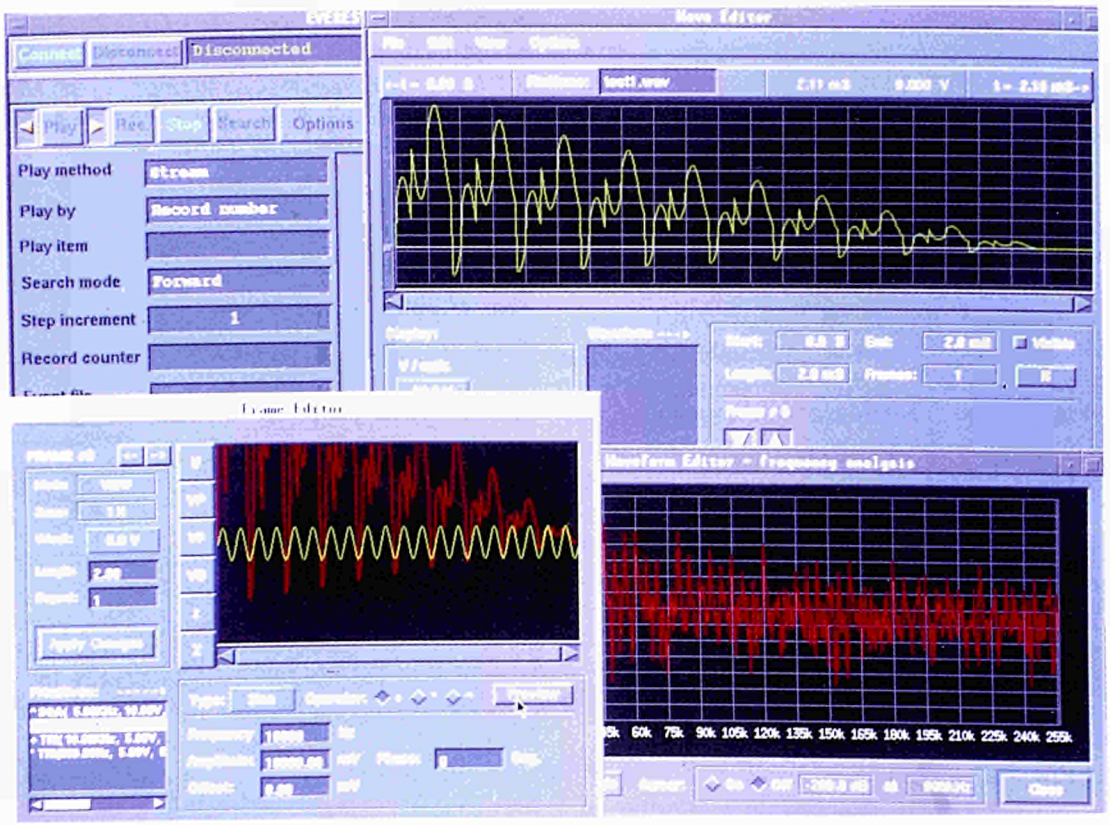
For the many SMEs that could benefit from the use of ASICs, easy access to design facilities and a quick turn-around time from the initial design to the final product is essential. Activities aimed at encouraging and assisting SMEs in this respect include a concerted technology access action (CTA-SME, 5084), launched to enable enterprises to benefit from the full portfolio of technology packages developed within ESPRIT. For SMEs in Spain, Greece, Portugal, and southern Italy, special actions have been successfully organized to increase awareness, create favourable conditions for the utilization of ASICs, and to encourage participation in future ESPRIT R&D projects.

Design methodologies and tools

The CAD market in Europe is entering a period of flux, with several announcements of plans for joint ventures between European and US companies. It is clear that a new symbiotic relationship between some indigenous CAD vendors and those from the USA is a strong probability, strengthening the tendency for many large companies, which have traditionally invested heavily in large teams of CAD engineers, to partially buy in this expertise. In-house CAD development is being focused on those areas where CAD vendors cannot supply needs within the time required. As the market matures and competition increases, there is a beneficial side-effect as the opinions of end-users have more influence on the development strategies of CAD tool suppliers. This trend is affecting the competitiveness of the companies involved, and is illustrated in the exploitation of the results reported below.

Support for specific methodologies

Two ESPRIT projects have generated results that are already helping industrial designers to produce leading-edge products. AD 2000 (5056) is a design methodology project on advanced analog and digital signal conversion. Early results with the potential to improve design capability and productivity include a tool for the behavioural simulation of high-speed converters, and a synthesis tool for high-resolution converters called TOSCA. Prototypes have been made available to other research groups active in the analog design field. A demonstrator has been developed in the form of a re-configurable analog/digital-digital/analog conversion system whose performance can be externally programmed.



Shown is an example of a graphical interface from the EVEREST (project 2318) prototype verification tool. This allows the system to cope with the complexity of VLSI test problems. The picture demonstrates how a modulated sinewave is sampled for further processing and analysis. The sampled signal can be analysed in several different ways: in this case a frequency analysis is being performed (bottom right corner). The signal can also be edited and re-used in test waveforms (stimuli) or for the generation of test templates.

This technique provides a good basis for further development into a self-testing architecture.

Critical time-to-market requirements, as found in the consumer products sector, are being satisfied by linking a number of results from ESPRIT CAD projects. The CATHEDRAL-I and CATHEDRAL-II high-level silicon compilers for digital signal processing, which resulted from close cooperation between IMEC (B) and Philips (NL) in project 97, have been combined with the test environment results from EVEREST (2318) to produce the PIRAMID system. One of its first productive applications is a multifunctional stereo digital sampling filter IC containing 133 000 transistors for use in high-end Philips CD players. The automated design of this IC has indicated that it is possible to build a chip with only one person-year of effort, a 10-fold reduction in design time compared with previous methods. The PIRAMID technology has been transferred to EDC, a Belgian SME, for further exploitation as a commercial CAD product, MISTRAL. This has already been integrated into EDC's DSPstation, a high-end CAD product for the design of digital signal processing systems, launched in early 1992.

Testing electronic components

Testing remains one of the major bottlenecks in the process of bringing advanced and cost-effective electronic solutions to the market. Two projects active in this area have made significant progress during the past year.

Project 2478, working in the area of boundary scan testing (BST), produced results of profound importance for miniaturized, complex multi-chip electronic systems, which are often assembled on flexible 'wrap-around' boards that frustrate attempts to test them using conventional techniques. This work started in the mid-1980s when a small amount of ESPRIT funding initiated a special interest group, the Joint Test Action Group, or JTAG, that grew to become an international lobby group which greatly contributed to the establishment of the IEEE 1149 standard for boundary scan testing. The project has achieved a major breakthrough with the conversion of boundary scan theory into accepted practice, now being commercialized.

The project has produced prototypes of commercial products including boundary scan cell libraries, on-board self-test controller devices, board-level pattern generator software, and a significant and continuing contribution to forthcoming international stan-

dards on interface languages and data formats. Based on the results Philips (NL) has produced a range of competitive low-cost board test systems for full production machines, as well as a notebook-computer compatible module for field diagnosis.

The results of EVEREST (2318) are already being industrialized and brought to the market. Philips Electronic Design & Tools (NL) has recently been established to boost the commercialization of tools incorporating new approaches to the design of testable devices. The Panther tool-kit embodies a testability strategy based on the concept of 'macro-test', i.e., partitioning an IC into testable blocks. Panther is particularly suitable for modern VLSI design styles, with up to 100% test coverage claimed at an acceptable cost, and is the first tool that includes both the assurance that an IC design will be adequately testable, and the ability to generate and validate the actual test data.

Standardizing design tools

The design efficiency achievable by combining the many new tools which are becoming available needs international standards if the full benefits are to be enjoyed. In IDPS (5075) all partners have agreed a standard language for the exchange of module generators, which define components in the library used to build a complex IC. The key to the cost-effectiveness of the IDPS approach is that designers should be easily able to move designs between European silicon suppliers who have adopted a common design library. The standard language agreed within the project is MODGEN (itself a result of ideas developed in project 97), and the language and the supporting software system have been turned into a commercial product by Silicon Software Systems (IRL).

The start-up phase of JCF (5082) aimed at the efficient integration of a wide range of design tools into a flexible environment. This will greatly reduce the costs of integrating new design tools into a design system and enable adaptation to designer requirements whilst providing control over design integrity. Problems caused by selecting incompatible design data sets are acknowledged to be the largest single cause of costly re-design. The start-up phase of the project has successfully achieved its goal by merging frameworks developed by the project partners into the first version of a combined prototype core system.

The CAD framework initiative (CFI) is an int national body which aims to establish agre standards for all CAD frameworks, so tl tools can be easily exchanged between c ferent systems. The partners in JCF, who a well represented in ECIP, the European CA integration project (2072), are heavily involv in this international standards activity. T JCF prototype was successfully demc strated at the Design Automation Conferen in June 1991.

In the start-up phase of QUICKCHIPS (504 the software and hardware elements need for very quick turnaround ASIC productic were developed and evaluated. One of tl early results is the building of pre-productic models of a direct-write laser lithograpl system for defining gate array interconne tions. The collaborative evaluation of th equipment built by HIMT (D) has resulted in i novative enhancements to the system. Th ambitious project for fast turnaround ASI production is complementary to the oth Community actions stimulating the take-up ASICs, and advancing the utilization of ope design frameworks.

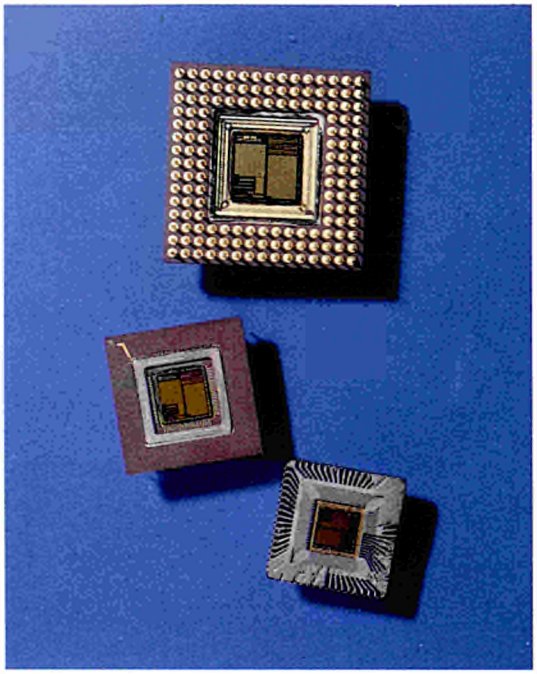
Silicon technologies

Based around the core CMOS technolog needed for digital applications, processes ar being further developed for a wide range c applications, incorporating multifunction re quirements such as mixed analog and digita circuits. Each of the IC process technolog projects now include IC users, and inco porate application-specific packagin developments, reliability developments, an quality assurance procedures. Strong link have been established with design-oriente projects, enabling applications to benefit fror emerging technologies. Each action line ir corporates European universities and ir stitutes, who contribute by undertakin longer-term research activities.

Core CMOS

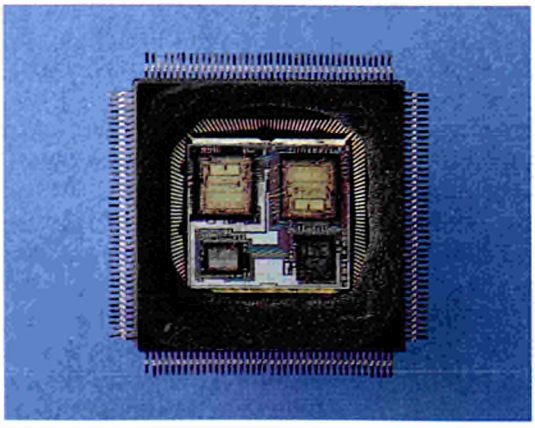
The development of three generations of cor processes (1 micron, 0.7 micron, and 0. micron) has been undertaken in two projects JLP (5080) and ACCES (5048). These merge into one last year, consolidating the 0.7 micro generation and developing and qualifying th 0.5 micron process. The participants includ

all the principal logic manufacturers in Europe (Philips, SGS-Thomson, Siemens, GEC-Plessey, Matra-MHS, Mietec, ES2 and TFK-Eurosil).



Three generations of CMOS gate array (110K gates) illustrating the progressive advances in technology achieved in the JLP (5080) project. From the top down, the technologies are 1.4, 1.0 and 0.7 micron. Established device designs are preserved and translated into newer processes that improve device performance and wafer yield. Note the knock-on effect on packaging technology requirements which results from shrinking the device size.

ACCES (5048) aimed to develop and install advanced 0.7 micron CMOS processes in the production lines of the European manufacturers of CMOS ASICs: ES2, GEC-Plessey, Matra-MHS, Mietec-Alcatel and STC. All project goals have been met and the industrial partners have demonstrated and tested functional circuits using compatible 0.7 micron design rules. The research centre partners IMEC and CNET have demonstrated an experimental process that paves the way for 0.5 micron developments at the industrial sites. BT (UK), SEL-Alcatel (D) and Telefonica (E), the users involved, have gained early access to the 0.7 micron design rules and have finalized the design of complex demonstrators, now being fabricated at the industrial partners' sites. The project allowed the manufacturers involved to introduce two generations of processes in two and a half years.



Four integrated circuits in one plastic quad flat package (PQFP): this example of an HDTV television decoding system stems from the JLP (5080) project, which brought together TEG's ceramic substrates experience with ST's in plastic lead frame volume packaging (ST).

JLP (5080), a JESSI project funded by ESPRIT, aims to realize and qualify the 0.7 micron technology for digital applications, and also addresses analog and non-volatile memory at 1 micron CMOS. The goals of the start-up phase were achieved according to plan, with the processes qualified at several partners' sites, and the technology demonstrated as well as the production of a multi-chip assembly.

The results of ACCESS and JOINT LOGIC are being used in a wide variety of communications, consumer, and automotive applications, and are being exploited in the development of a number of complex proprietary circuits. The partners are also shrinking designs of existing families of products to gain further advantage from the new technology.

Making CMOS more flexible

The core process described above has provided a solid platform for product-driven process extensions. The JLP (5080) project has successfully qualified analog, memory, and special low-voltage CMOS process circuits, which have been developed for microcontrollers, digital signal processors, ICs for smart cards, battery-operated circuitry, composite arrays and applications in the audio, TV, telecommunications and automotive markets. Memory options have been developed in a 1 micron CMOS process, and specific ISDN chips and other digital signal processors have demonstrated analog application capabilities, while a family of standard components (3.3 V) and a microcontroller (1.5 V) are demonstrating the low-voltage options. Results include the Philips low-voltage high-speed CMOS logic family, claimed to deliver the fastest low-voltage CMOS logic in the world.

ADCIS (2193) has extended basic CMOS to include building blocks for analog/digital functions, and CAD tools are being developed for mixed-mode ASIC design and simulation. An industrial demonstrator (an analog-to-digital video decoder for multimedia terminals and videophones) has already been designed and produced by Matra MHS (F); and Mietec-

Alcatel (B) has adopted some of the modules to improve the performance and manufacturing capability of its CMOS production technology. The software tools are being commercialized by ANACAD Computer Systems (D).

In APBB (2039), which is integrating non-volatile memories into CMOS logic, several demonstrator circuits were produced by GEC-Plessey (UK), SGS-Thomson (F/I) and Eurosil (D), as well as by a number of SMEs, who have thus gained early access to the technology. The demonstrators include a gate array, a microcontroller, and ICs for identification and fine tuning of analog functions. In particular, the SGS-Thomson microcontroller incorporates both EPROM and EEPROM on the same chip. The processes have applications in automotive, consumer and telecommunications products. The development of 0.8 micron technology is in progress, along with the necessary CAD tools and building blocks, while the results obtained from the first two years of the project at 1.2 micron have already been transferred to production, with applications in credit cards, pay TV, computer peripherals and automotive products.

BiCMOS

BiCMOS combines the ability to use high speed bipolar technology in conjunction with high-density, low power consumption CMOS circuitry, giving advantages that could well lead to the eventual replacement of many bipolar and CMOS ICs. The merged technology has also become especially popular for high-speed SRAMs (with data access times half those of equivalent CMOS devices at the same density), and is forecast to account for a quarter of the total SRAM market in 1996.

In BiCMOS (2430), Philips (NL) and Siemens (D) have optimized all key process modules down to 1 micron bipolar CMOS and have produced several demonstrators at 0.8 micron including a very advanced trench isolation. They have demonstrated the process in a wide number of application areas, including a reduced instruction set computer (RISC) multiplication/division unit, a finite impulse response filter, a programmable signal generator, a 75 MHz analog/digital converter, and an ECL sea-of-gates array. Processes based on project results have now been transferred to production lines.

In CANDI (2268), SGS-Thomson (F) and Telefunken (D) have completed development of their 1.2 micron BiCMOS technology. A catalogue with over 100 cells, including complex analog modules, has been created. Several sophisticated demonstrators were produced including an HDTV-RGB decoder, a cellular network receiver module, and a scrambler circuit for telephone networks. Silicon has also been processed at 0.8 micron using special poly-emitter self-aligned emitter base and salicide technologies, and the first process lots have been completed with good results.

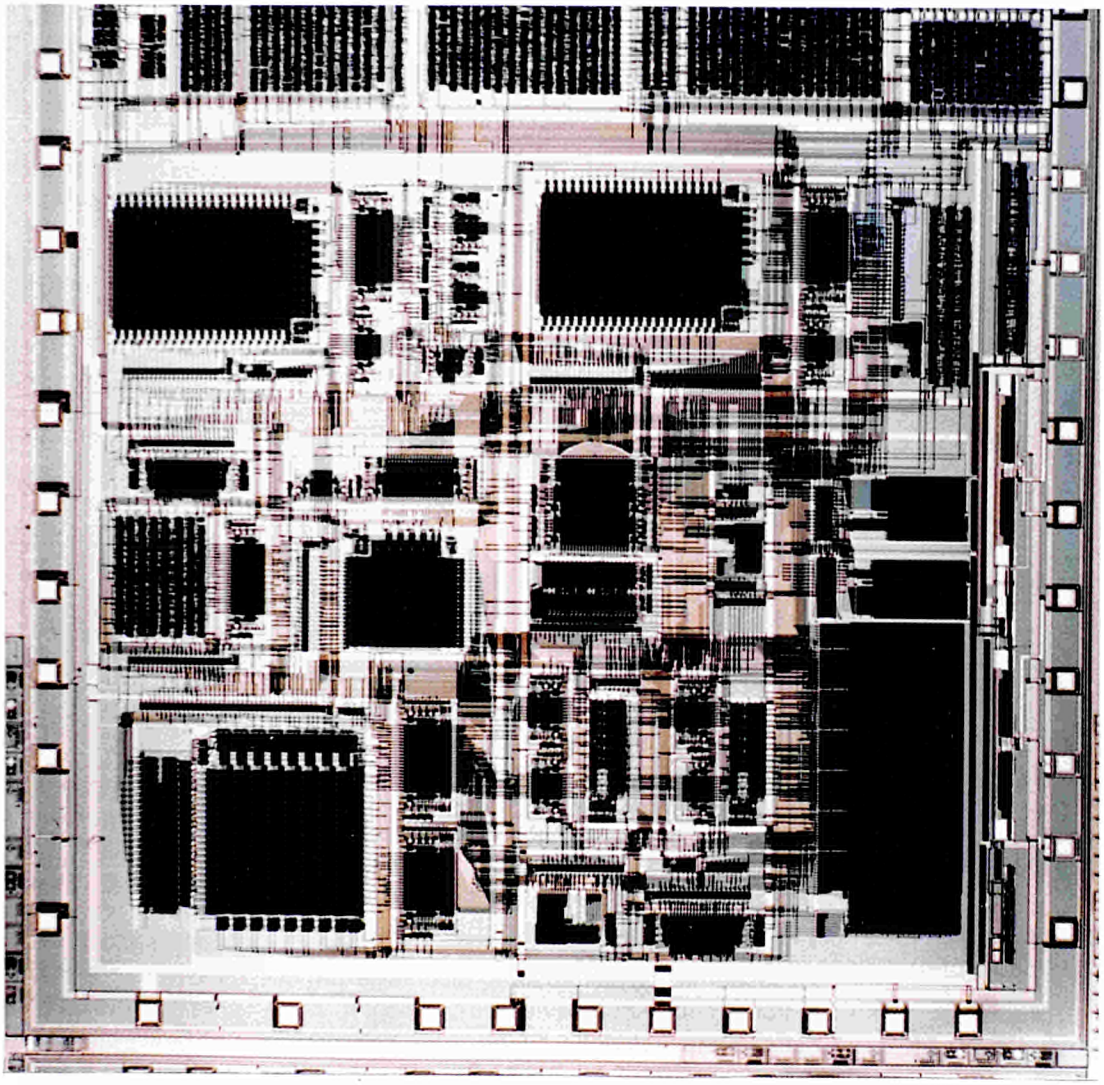
Bipolar technology

High-speed bipolar technology fills an important area between the medium speed but high chip packing density of MOS, and the very high-speed but lower complexity, high cost per function of GaAs semiconductors. The application areas foreseen are consumer products and telecommunications.

BASE (2016) has now finalized technology development, and circuits have been designed and fabricated by the industrial partners. The performance of the newly developed technology is in line with the best results reported in the literature for silicon bipolar devices: gate delays lower than 30 ps; power/delay product under 25 fj; noise figures at 2 GHz of 5 dB; cut-off frequency of 25 GHz; three-layer metallization at a pitch of 3.5 micron. Demonstrators include a 10 Gbit/s pattern generator and a wide-band amplifier (Telefunken, D); a 2:1 23 Gbit/s multiplexer and laser driver (Siemens, D); a radio amplifier/mixer for mobiles and an ISDN 2.5 Gbit/s multiplexing circuit (SGS-Thomson, F/I); an 8 bit 350 MHz analog/digital converter (Philips, NL); and a direct frequency synthesizer with a 1.6 GHz clock and maximum 400 MHz output (GEC-Plessey, UK). The project has also investigated innovative device concepts (heterojunction transistors) and new materials (silicon germanium).

SMILE (2272) has successfully integrated low- and high-voltage devices on the same chip under 650 V operating conditions. The technology can be assembled in low-cost plastic packages with good reliability. This process is being applied to a fluorescent lamp ballast (a high-volume market), and will extend lamp life, save energy, and provide features such as dimming and flicker suppression.

Multifunctional stereo digital up-sampling filter IC for high-end audio systems, designed at Philips using PIRAMID, based on the results of SPRITE (2260). It contains 133 000 transistors and measures 57.5 mm² on a 1 micron CMOS process. Approximately 80% of the design was automated.



Packaging and reliability

APACHIP (2075) has analysed and modelled all aspects of packaging (mechanical, thermal and electrical), and developed and demonstrated innovative packaging solutions. In tape automated bonding (TAB), MCTS (F) has developed tapes with 100 micron and 75 micron inner lead pitches, and Bull (F) has optimized new wire-bonding equipment, demonstrated on silicon at 100 micron pitch in a 548 input/output ceramic package. SNI (D) and GEC-Marconi (UK) have evaluated a gas discharge adapter for substrate tests with a 0.375 mm grid and a 100 x 100 mm test area, and two-electrode layers for matrix addressing have been produced by two different techniques (thin-film and PCB lamination).

Souriau (F) has developed a multistep prototype tool to deal with the complexity of the contacts. Two industrial multi-chip module demonstrators have been produced using different substrates (polyimide copper on ceramic and organic) with provision for cooling.

In PLASIC (5033), a mold compound and die-attach epoxy optimized for mechanical stress resistance and high reliability have been developed. Comparisons of reliability test methods have resulted in the implementation of the highly accelerated stress test method (HAST), which saves qualification time compared with the existing temperature humidity bias (THB) method.

The impact of integrating new technologies was demonstrated by MORECO (5051), in combination with MORESYS (5470 in the advanced business and home systems area). MORECO developed an innovative smart card based on bidirectional infra-red communication for hands-free access control and accreditation. This advanced product is being commercialized by Elgelec, a French SME, and has been used by Sinorg (F) for payment and control in ski-lift systems, and for access controls in the security office at the recent winter Olympic Games in Albertville.

Research for electrostatic discharge protection of submicron devices is developing structures and guidelines for improved ESD performance. The new methodology for testing (ESD, 5005) was accepted by the international EOS/ESD standardization group as the basis for a proposed standard.

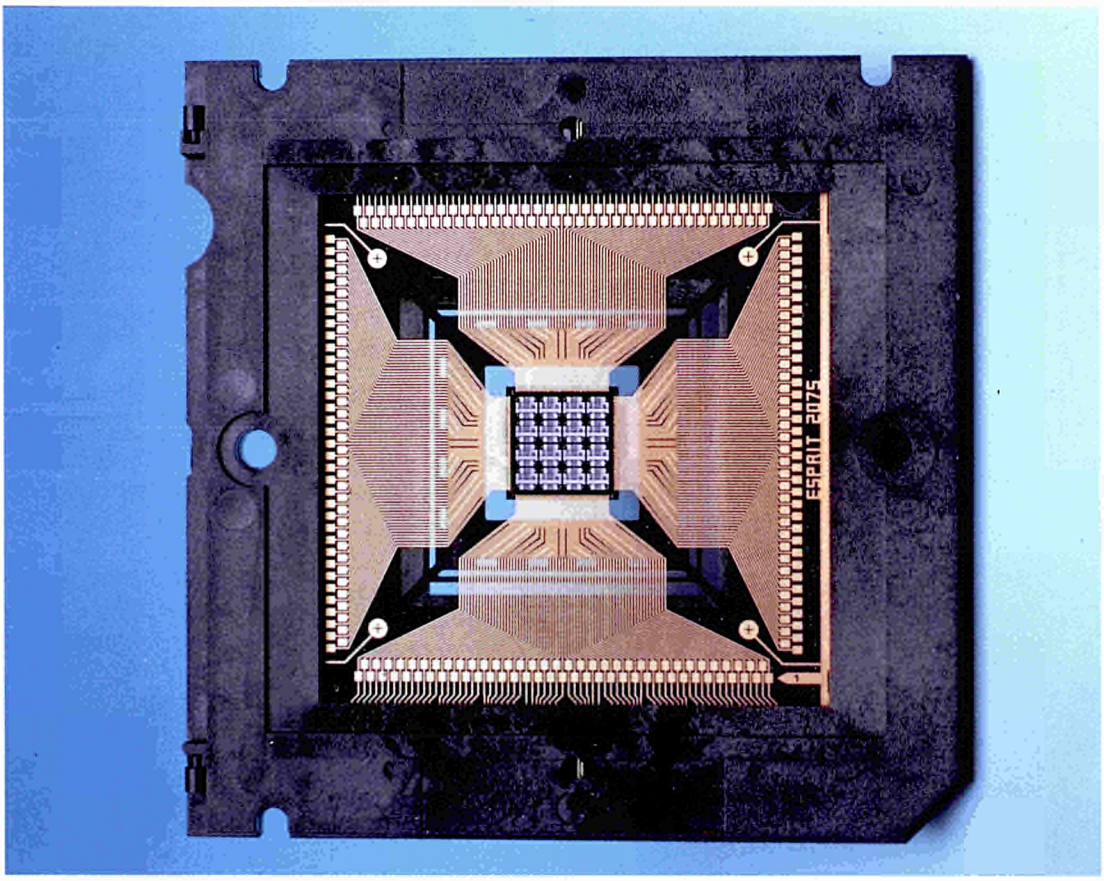
Compound semiconductor technologies

The family of III-V compound semiconducting materials, which includes gallium arsenide (GaAs) and indium phosphide (InP), offers a unique combination of low power consumption and high operating speed, ideal for processing both optical and electronic signals. Current ESPRIT projects provide a comprehensive R&D programme on compound semiconductors for both large- and small-signal microwave and millimetric applications.

Important developments beyond those reported previously in AIMS (5032), such as the results now demonstrated on heterojunction field-effect transistors (HFET), are setting the state of the art in terms of low noise figures and power capabilities. Daimler-Benz (D) is offering commercial foundry services based on 0.2 micron gate length components. In COSMIC (5018), the GEC-Marconi (UK) process based on a 0.25 micron sidewall spacer technique has shown excellent results.

Progress in GIANTS (2035) has been excellent, resulting in a number of advanced InGaAs designs from BNR Europe (UK), GEC-Marconi (UK), Philips (NL), and Thomson (F). The pseudomorphic (PM) high electron mobility transistor (HEMT) has emerged as the best new monolithic microwave integrated circuit (MMIC) technology for small signal applications. Using a 0.25 micron gate PM-HEMT technology, a number of 1-30 GHz amplifier designs have been produced for cordless telephone and direct broadcast by satellite applications. The InP lattice-matched HEMT is ideal for the high millimetric frequencies needed for the new short-range communications band, and the technical achievement by Philips in producing a MMIC amplifier with a minimum noise figure of 4.5 dB at 57 GHz represents an outstanding piece of work. A barrier-enhanced MESFET technology is used in a fully integrated optical receiver with applications for fibre-optic telecommunications. This project has also assisted Picogiga (F), an SME, to establish itself as the leading supplier worldwide of epi-wafers. HELENA, the user-friendly FET simulation software developed by Université de Lille (F), is now being commercialized.

Alongside these technology developments, two projects have focused on the development of advanced deposition equipment for III-V materials. Project 5003 is developing a high throughput, multi-wafer MOVPE reactor, based on the PLANET design, suitable for the growth of structures required for devices such as GaAs lasers and InP waveguides, and has strengthened Europe's world-leading position in MOCVD equipment. The Aixtron (D) 2000 2-inch PLANET reactor is already a commercial product, and a 4-inch model has recently been introduced. Philips Optoelectronic Components (NL) has started production of advanced lasers based on the use of the PLANET reactor, and Polyflow, a Belgian SME, has commercialized its reactor simulation software. In MORSE (5031), a project researching MOMBE growth techniques, SMI, a French SME, is producing its low-toxicity organic precursors to replace highly toxic gaseous sources.



Shown is a tape automated bonding (TAB) frame containing a thermal test chip 12 mm square with 316 connections. Based on the results of APACHIP (2075), this packaging method (already in production) is designed for low-cost, very high volume applications with good reliability. The IC is from NMRC (IRL), the TAB frame is by MCTS (F), and the assembly was carried out by BULL (F).

OLIVES (2289) made significant progress in developing optical components for advanced interconnections between computers, package-switching systems, neural networks and backplane buses. Five major subsystems for optical interconnection at the module, backplane, multi-chip module and chip levels were completed. These demonstrate the following: clock signals at 200 Mbit/s using several key hybrid interface components, allowing low-power interfaces to VLSI circuits; an optical bus link with six operational channels at 700 Mbit/s per channel; an eight-channel waveguide array link for multi-chip modules/backplanes operating at 500 Mbit/s per channel; and backplane interconnects at 1.4 Gbit/s with a synchronous clock at 150 MHz. Additional results in non-linear optical polymers include a second harmonic generator for a low-cost blue/green light source; an electro-optic modulator for waveguide fabrication in thin-film technology; and an organic spatial light modulator (SLM). A real-time optical correlator using this SLM is being exploited in pattern recognition and robotics; it has an equivalent computing capability of 100 million operations per second. Other results from this project are being commercialized in advanced scientific instruments. These technologies provide a sound foundation for optical interconnect subsystems.

Manufacturing, process equipment and materials

Manufacturing science and technology

The Manufacturing Science and Technology (MST, 5081) JESSI project funded by ESPRIT has completed its first phase. Technological excellence alone is not sufficient for establishing a competitive industry; it has to be complemented by an efficiently organized manufacturing process. This is particularly true for semiconductor manufacturing, where product and technology lifetimes are comparatively short. European industry is making concerted efforts to improve its competitiveness, and the eight semiconductor manufacturers involved in MST have jointly addressed several hundred individual factors influencing the optimization of the VLSI manufacturing process. The transfer and systematic implementation of the collaborative solutions found will enable the par-

ticipating companies to make improvements in their process lines, with substantial economy of effort.

Lithography

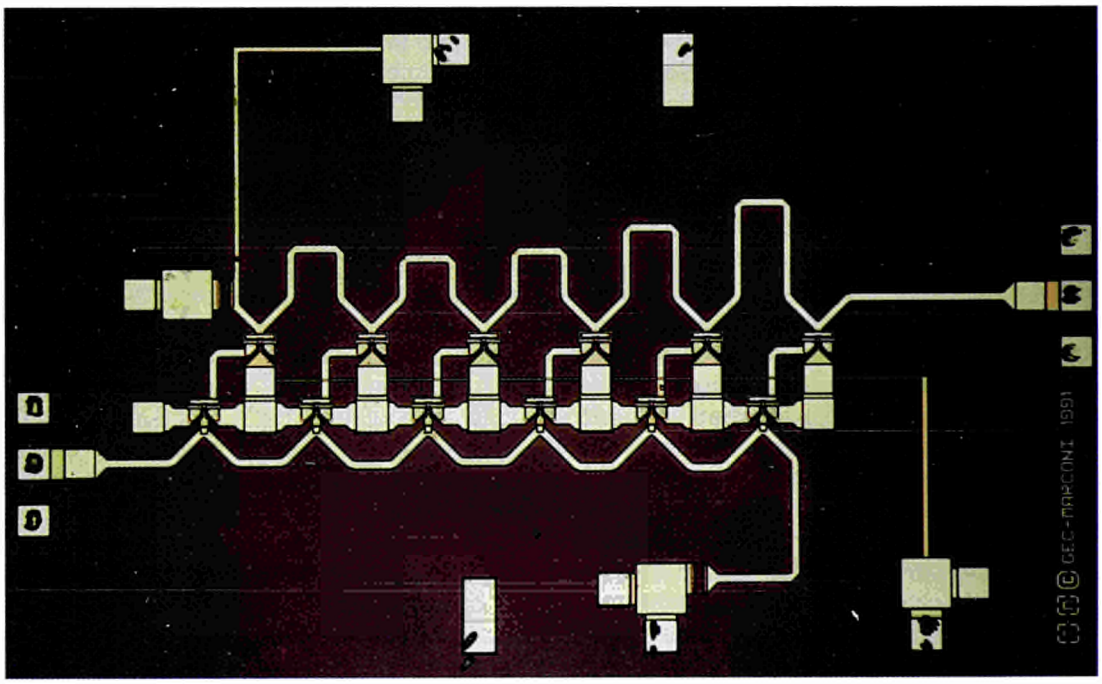
The definition of the microscopic features of each circuit on the surface of a semiconductor wafer involves lithography at every major process step. This operation requires highly sophisticated optical or e-beam equipment, in conjunction with light- or electron-sensitive advanced photoresist materials.

Project 2048 successfully completed the development of the most advanced optical wafer-stepper in the world, employing deep ultra-violet (DUV) light. This tool, suitable for producing leading-edge prototype circuits, has demonstrated record-breaking resolution (down to 0.18 micron with special techniques), alignment accuracy and throughput. The principal partner, ASM-L (NL), has already sold several such steppers worldwide, equipped with Carl Zeiss (D) lenses. The project also tackled the formidable task of developing new DUV resists suitable for production purposes. CARL, a multilayer resist scheme developed by Siemens Research (D), is under production testing. Hoechst (D), through its work in this project, has succeeded in establishing itself among the world's leading suppliers of DUV resists.

Research for a new generation of DUV-stepper optics in project 5002 has tackled the development of production-quality quartz material and wide-field DUV lenses capable of matching the stringent requirements of production steppers. A wide-field, large numerical aperture prototype lens has been produced by Carl Zeiss (D) for testing and incorporation into a production DUV stepper. Heraeus Quartz (D) has synthesized what is probably the best optical material available in the world for this lens, so strengthening its market position.

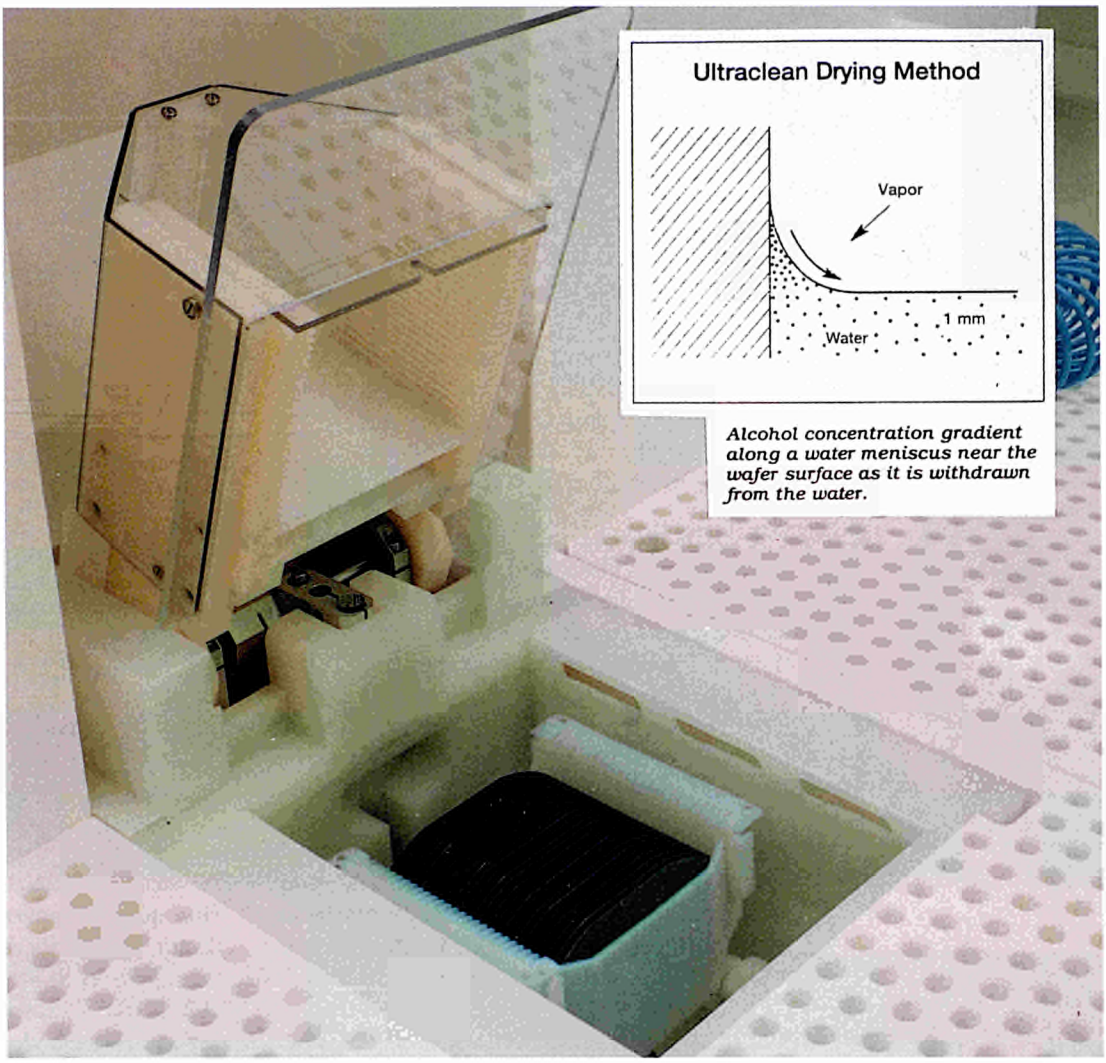
Project 5014, centred around three European mask producers (Compugraphics (UK), Siemens (D), Philips (D)), tackled many of the important aspects involved in optimizing the production of masks and reticles. They now have reticles commercially available suitable for 0.7 micron process technology. Polymer Laboratories (UK) has developed a high-quality base material for pellicles (the transparent films protecting masks and reticles from damage), thus establishing, for the first time, a European source for this substance. Leica (D) has developed and is now testing a prototype laser-scanning system for detecting defects on reticles.

Development work for an advanced critical dimension (CD) metrology tool was conducted in METRICS (5026). A top-quality electron-beam column has been developed by ICT (D), while Philips Electron Optics Division (NL) developed and tested all the remaining major system concepts. The consortium included a



The demonstrator ICs from GIANTS (2035) illustrate the strength of the project's material growth, process technology, and circuit design, furthering the European status in advanced InGaAs devices. These MMIC examples represent the best IC technologies for exploitation in small signal microwave through to millimetre-wave frequencies, as well as for fibre-optic applications.

The MST project (5081) has developed a drying method for wafers or glass plates using the Marangoni effect, shown here, in order to avoid dissolved or dispersed contaminants being left on the surface to the detriment of final product quality and yield. The method causes an increased concentration of alcohol at the top of the meniscus against the surface of the wafer; this results in a surface tension gradient, which in turn induces a Marangoni flow of water back into the bath. The method, developed by Philips, gives the highest yet attained level of cleanliness in drying.



Alcohol concentration gradient along a water meniscus near the wafer surface as it is withdrawn from the water.

number of research institutions and industrial users, and the integration of the system is now being pursued in a follow-up JESSI project.

Layer processing

A critical area in IC manufacturing (which has to make constant advances in order to keep up with the shrinkage in the size of chip features) is layer processing, which involves the deposition or etching of thin films on the wafer surface. The multichamber prototype reactor developed by ASM (NL) within MCBRIDE (2403) was installed at LETI (F), and several structural and electrical experiments carried out, complemented by work at ST (I). This equipment deposits advanced insulating layers using separate chambers in a single integrated wafer-processing system. Extensive characterization work has been completed, optimizing film growth, and a high level of understanding of the oxide-nitride-oxide (ONO) process reached. Concepts developed in the project for improving maintainability and control architecture have already been implemented in the newly released Advance 6000 system (ASM, NL), considered to be one of the best semiconductor equipment products of 1991.

Peripherals

Flat-panel displays

The global market for high-resolution colour flat-panel displays is expected to double every year as laptop and pocket computers become increasingly popular. Device development is the subject of fierce competition worldwide, and is also being driven by the market for HDTV. The targeted products include small-size light valves for large-screen projection systems, and medium-sized flat-panel direct-view displays for HDTV and terminal applications.

MATRIX-LCD (2283) has been developing active-matrix liquid-crystal display (AMLCD) technology, recognized as the most promising at present, with one thin-film transistor integrated into each pixel. Two routes are being followed: amorphous silicon with external drivers, and polysilicon with integrated drivers. The latter and technically more challenging solution shows more promise for applications in the medium term, and could substantially decrease manufacturing costs. One of the partners, Thomson-LCD (F), has started a new facility in Moirans dedicated to flat-panel display manufacturing, where 5-inch colour displays have been demonstrated as part of the project.

FELICITA (2360) has gained international recognition for its contribution to the development of the alternative and newly emerging technology of ferroelectric liquid-crystal display (FLCD). This technology is based on the bistability (i.e. the display has memory and can maintain its image with no power) and fast switching of ferroelectric liquid crystals, which when combined with the optical properties of these materials can provide flicker-free video displays with wide viewing angles. Several displays were completed by the consortium, including an A4-sized high-resolution monochrome display, and 240 by 256 pixel monochrome video television. Thorn EMI (UK) has shown a fully bi-stable 10.4-inch diagonal colour VGA display which has very good viewing characteristics and can be operated directly from a desktop computer. These passive displays were fabricated using processes similar to those used for commercial supertwist LCDs. GEC (UK) recently unveiled a proprietary very low-power electronic label device taking full advantage of the non-volatility of ferroelectric LCDs.

Mass memory systems

The amount of information that needs permanent storage is steadily increasing, and MAGNOPT (2013) has contributed to the improvement of magneto-optical recording technology, which allows high-density recording on removable disks. Philips (NL) has constructed a prototype 3.5-inch optical drive system with a 128 Mbyte removable cartridge, and has actively contributed to the ISO 10090 standard (which is upgradable for the next generation of data-storage systems). The optical read-only memory capabilities included in the development have now been transferred to production. LETI (F) has produced integrated magneto-optical read/write heads fabricated on silicon wafers, merging integrated optics and magnetics technologies for the first time. They allow the production of recordable disks including pre-embossed non-erasable commercial software.

Accompanying measures

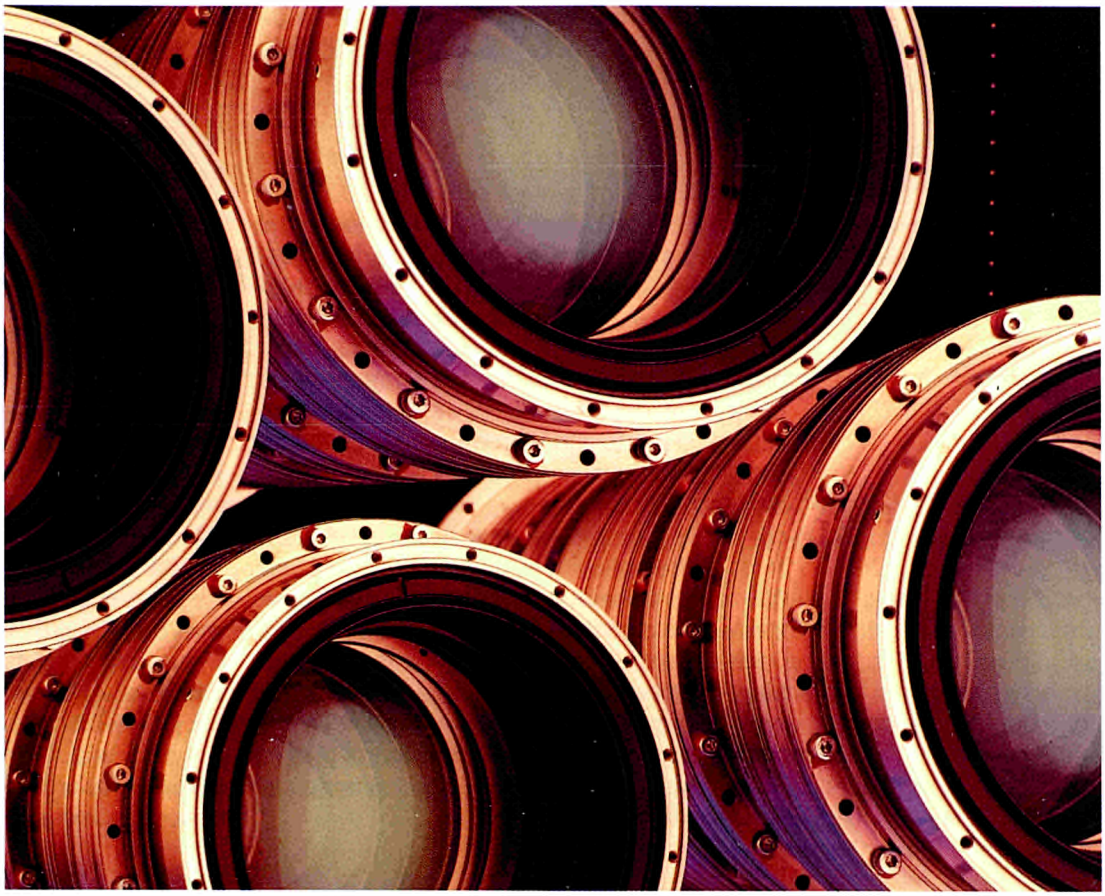
The aim of accompanying measures in microelectronics is to stimulate the use of advanced microelectronics technologies by raising awareness, improving the rate of technology transfer from producers to users, and encouraging the provision of industrial training and technical assistance for new users.

Special actions

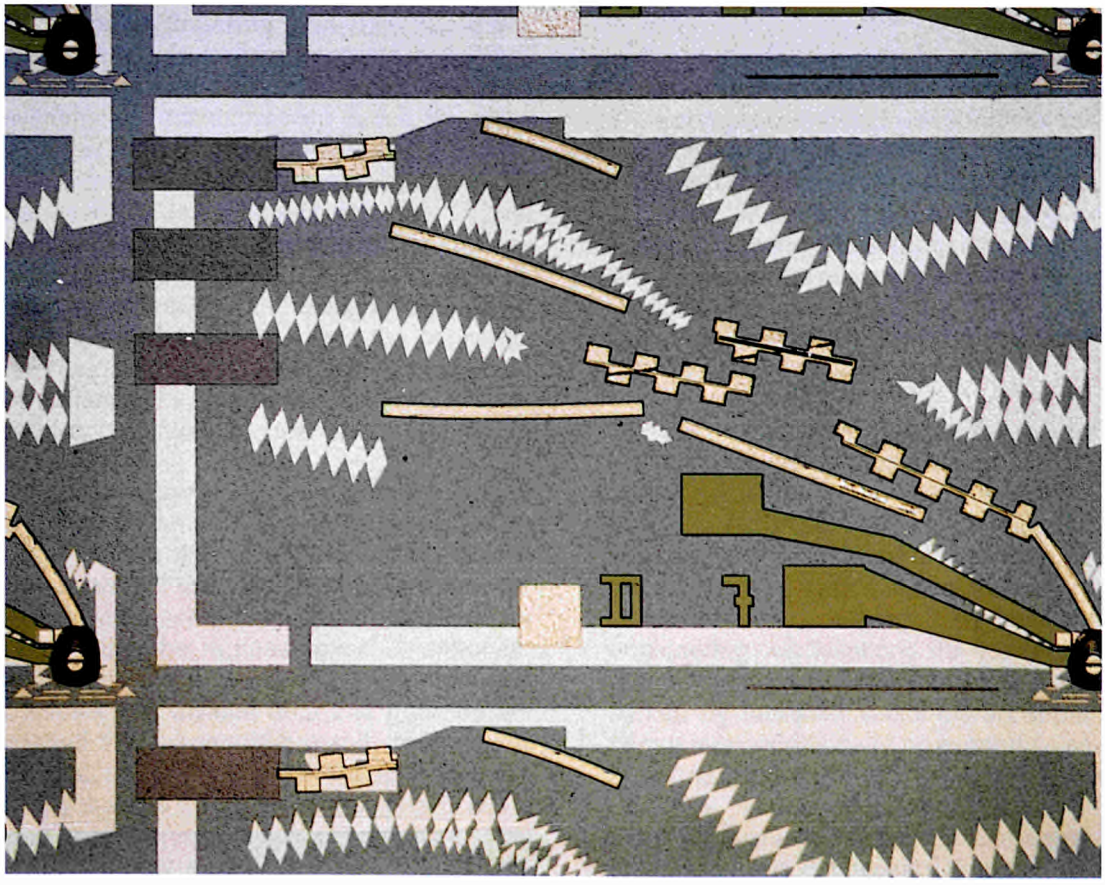
During 1991/92 efforts were primarily concentrated in the launching and consolidation of special actions in Spain, Portugal, Greece and southern Italy. The October 1991 joint technical review confirmed that these special actions were on the right track, with numerous results already evident.

The special action for microelectronics in Spain, GAME (5083), stimulated a great deal of activity in its first 18 months of operation, and there is already evidence of increased capacity for IC design in both the industrial and academic sectors, as well as a notable increase in Spanish organizations participating in calls for proposals. During this initial period some 60 firms submitted their project proposals to the GAME organizing committee, and 42 projects have been launched. Two of these are working on smart power, four on sensors, and the rest on ASIC demonstration activities. Whilst all of these projects are being executed in Spain, they are developing further transnational links with other European counterparts. By the spring of 1992 five of the ASIC demonstrator projects had been successfully completed, indicating how quickly the action had got off the ground.

In Portugal, AICI (5691) is coordinated by INESC (P). Several workshops in Lisboa, Oporto and Aviero have been held to motivate key managers and technical personnel from approximately 250 SMEs. Connections with other INESC and national projects have been made, and these are intended to bring about a coherent approach to microelectronics, stressing technology transfer aspects to bring



ASM Lithography and Carl Zeiss engineers have developed a whole new generation of wide field i-line and deep UV lenses made from high transmission optical elements which deliver outstanding resolution and depth of focus performance. Choosing the right narrow aperture and wavelength optimizes process latitude for the required minimum resolution. Heraeus Quartz produced the state-of-the-art lens material and Carl Zeiss the lenses themselves (project 5002).



A view of a LETI magneto-optical circuit constructed on a silicon wafer developed in project 2013, MAGNOPT. Each circuit will be cut out to fly on a magneto-optical disk. A laser beam will enter by an optical fibre connection; a microguide and two parabolic mirrors focus the light for the writing function at the output. The analysis of the reflected beam is achieved by a small interferometer, and the read signal leaves the circuit by two optical fibres.

know-how to the Portuguese industry. Three demonstrator designs have been achieved, and four more are under way.

The initial objective of VLSI-DPE (5692), the special action in Greece, was to establish a small network of centres providing access to equipment, software, training and technical assistance for companies (particularly SMEs) wishing to start designing VLSI circuits for incorporation into their products. A leading role has been taken by one industrial participant in providing design coordination, supported by centres of expertise in universities and institutes. The design environment is now well established, with a number of pilot industrial designs from five companies (four of which are SMEs) completed or close to completion. Most of the software and know-how to set up the design coordination centres and upgrade the technological level of the participants has been acquired from other Community countries (such as Italy and France). In parallel, the consortium has launched a number of activities throughout Greece with the objective of increasing awareness and stimulating Greek industry.

I-SMILE (5085), the special action in Italy focused on the south, aims to promote the development of local R&D capabilities and establish international contacts. The action will enhance cooperation between SMEs and academic and research centres by the joint design and testing of prototype circuits.

SMEs: access to new technologies

Small and medium-sized enterprises are receiving particular attention within the accompanying measures. The concerted technology access for SMEs action (CTA-SME, 5084) is to provide the means for special action participants to communicate with participants of other projects, such as JESSI-SMI and EUROCHIP, which have similar or complementary targets, and to enable Community SMEs to utilize results coming from ESPRIT MEL projects. It is expected that this action will become a valuable means of helping the Community's SMEs to take up and use advanced microelectronics technologies.

Information processing systems and software

Overview

The work in information processing systems and software (IPSS) aims to provide a selected range of generic technologies that are critical for the development of competitive European IT systems forecast to be available in the market over the next decade. The technologies selected for development in this area of ESPRIT are needed for a wide range of systems and will provide European vendors with a competitive advantage and users with high value.

These technologies cover four main categories:

Systems engineering and design, where the objective is to contain the costs associated with the ever-present paradox of information systems: the easier they are to use, the more complex they tend to be internally. The software component of systems now forms both the highest cost element and the largest source of potential added value. This domain brings together much of the previous work on systems design and knowledge-based systems, and seeks to extend the concepts, methods and support technology developed in earlier IPSS R&D to embrace both hardware and software components.

Information servers, where work is aimed at overcoming the current constraints placed on users of information systems. Information is one of the IT user's most important assets. The developments supported address issues concerning the representation, distribution, availability and integrity of large volumes of complex and diverse data that must be accessed and presented promptly to a user or application. The challenge is to achieve this in a way that is appropriate to the tasks of users and their varying levels of expertise. This relatively new strand of R&D draws extensively on previous work in both advanced architectures and knowledge engineering.

Advanced computer systems architectures, where work on highly parallel systems is now achieving dramatic reductions in the cost/performance ratio of computer systems. The potential redundancy offered by multiprocessor systems is enabling higher levels of system dependability to be achieved, and the new generation of parallel processing systems now offers supercomputing levels of performance at minicomputer costs. These advances open up opportunities for addressing new applications and markets.

Signal processing systems, where IPSS work focuses on providing interfaces to enable a computer system to respond promptly to data from the external world. In both industrial applications and those with high social value (such as medical imaging or pollution monitoring) large quantities of data have to be recorded and assessed in real time.

In the period under review the important trends have been:

- **Further industrialization of IPSS results**
  The progressive industrialization of IPSS results noted in the previous 'Results and progress' report continues to gather pace. It is clear that major markets are developing for parallel systems and their associated software, ranging from high-end engineering workstations to top-of-the-range computer systems (currently represented by classical vector-driven supercomputers). Additionally, an expanding set of software products and services based on IPSS results are coming onto the market. Examples range from the agreement established between Prologia and

Next (F) to provide Prolog III with every Next workstation sold in France, to a complete service package that addresses the issue of how best to install software quality and metrics systems in organizations concerned with improving their software development and life-cycle management practices.

- **Broader standardization activities**
  Major projects in all sub-areas of IPSS are addressing issues aimed at improving the number and quality of standards. This includes recent work in fields such as information servers and speech recognition, among others, as well as work in more traditional fields such as metrics and product assessment. The standards being developed will offer users wider choice and improvements in the quality of delivered products and will benefit vendors through lower risks and costs. The emphasis is on maintaining compatibility with existing industry standards whilst taking advantage of developments in technology.

- **A continuing systems approach**
  Individual technology strands and disciplines continue to be combined in order to address wider and higher-value problems. For example, the drive towards a new generation of information servers draws extensively on the progressive fusion of work in advanced architectures, intelligent interfaces and deductive knowledge-based systems. Work in advanced architectures focuses on the software aspects of the problem, for example by providing environments to support the efficient development of large-scale software applications. Vision system activities draw extensively on technology developments in advanced architectures and knowledge-based systems. During the past year, a greater emphasis has been placed on the need to base the work on advanced architectures on a more complete consideration of the major classes of applications that can derive benefits from the new types of systems.

- **Growing support for object orientation**
  Object orientation is now a pervading theme in IPSS. For conceptual modelling, software design methods and programming, many innovative approaches are object-oriented. Similarly, object-oriented options are increasingly favoured in the development of new generations of information management systems. Parallel processing projects are finding object-based execution models a convenient means of handling parallelism. In vision applications, some interpretation and understanding is often managed in an object-based fashion.

- **Technology transfer moves forward**
  The parallel computing action (PCA) was completed this year with the final workshop held in Barcelona. The PCA has substantially exceeded initial expectations in the critically important matter of adding to the currently very limited pool of expertise in this domain, and it can now be expected that between 1 500 and 2 000 students per year over the medium term will be exposed to parallel computing technology and develop an appreciation of the benefits it offers and how it can continue to be developed. Additionally, a number of projects in system engineering and design have specific goals related to improving current software practice, providing a useful and complementary set of preparatory activities in support of the European systems and software initiative (ESSI), now likely to be launched in early 1993.

System engineering and design

The continuing rapid growth of software and related services means that this sector is set to become the dominant source of business in the IT industry by the end of the decade. This is in addition to software development undertaken in user organizations, which itself represents an activity which is an order of magnitude larger than that of traded software. Furthermore, software is now clearly positioned to be the major added-value component in most IT systems. These systems make a critical contribution to the competitiveness and responsiveness of the enterprises in which they are deployed, and are having an ever-greater impact on society at large. Against this background, it is vital to both vendors and user industries that R&D effort is put into developing a capability to design and realize predictable, high-quality systems in a cost-effective way.

Central to this aspect of IPSS R&D has been the provision of improved methods and tools

to support the design, realization and management of software components for IT systems. The R&D has evolved from traditional software engineering and knowledge engineering, firstly in the context of the more conventional software systems, establishing a firm engineering basis for the overall production process and management of the full system life-cycle. In the course of this evolution, it has sought to extend the concepts and methods to embrace not only the software component but also the hardware components of a complete system. In pursuing this approach, it has drawn on knowledge engineering technologies as a means of providing intelligent support within the tooling and support frameworks developed, incorporated technology for rapid prototyping as an aid to establishing a better basis for communication with the potential end-users, and experimented with the new paradigms stemming from the knowledge engineering community.

In turn, as knowledge engineering techniques and knowledge-based systems have become increasingly accepted both as approaches to tackling problems previously considered as intractable, and as a technology that adds value by embedding intelligence and knowledge in software-based systems, the engineering of these components has now assumed a special significance. Such components must be capable of efficient integration into larger-scale systems; the process of design, production and management must be placed on a more systematic footing; and issues of validation and the ability to meet hard (such as real-time) constraints must be effectively addressed.

The progressive intersection of these interests has now reached a point where it is beneficial to treat the development of further activities as a single joint set of actions. This was the position established in the most recent round of proposals for the new phase of ESPRIT. The focus of future R&D is on system engineering techniques. The system engineering discipline explicitly supports change in organizations by providing the systems which drive and support the process of change taking account of user needs and requirements. The work done will maintain a balance between activities designed to improve the technology base in the face of continuously more exacting system requirements and the need to support the technology transfer of proven techniques. The European system and software initiative (ESSI) will be instrumental in respect of the latter.

Improving the process

A key focus of IPSS work in system engineering and design has been the need to improve the engineering process through developing a capability to measure and assess both the process itself and the resulting products. The current emphasis is on consolidating the results achieved to date.

The work of the US Software Engineering Institute (SEI) concerned with assessing the operational process has been further developed in BOOTSTRAP (5441). The SEI developed a 'maturity model' which could help users to look at their own software engineering processes and assess them. BOOTSTRAP has helped map the SEI maturity model onto the requirements of the ISO 9000 quality standard. The results have already been used by some 30 firms in Europe who have volunteered to be assessed as a means of improving their own operational practices whilst helping to validate the assessment method itself. Consortium partners are currently developing a fully mature commercial service.

Software sizing, effort forecasting, risk analysis and program monitoring are important activities which need to be carried out as part of system design and engineering. Volmac and Data Management are intending to commercialize an enhanced version of MARK I, developed in MERMAID (2046), which will support estimators and project managers in these activities.

The promotion and use of metrics is an important aspect of improving the process of system design and engineering. Over 30 events promoting the use of metrics have been held under the auspices of projects PYRAMID (5425) and AMI (5494), generally focusing on specific application sectors. A documented set of cases of successful applications of metrics in eight different user classes is now available. The partners in the two projects are exploiting the work through consulting services. Complementing this R&D, METKIT (2384) has produced a complete package of training material for engineers, managers and students in the use of metrics for enhancing software product quality and software production efficiency.

A view of the drainage pipes in the Bordeaux sewage system that will be controlled with the help of the PAYDIRT decision-support system developed in project 5473.

The international community has demonstrated its belief in the importance of product assessment work being done in IPSS by adopting a number of the results achieved in SCOPE (2151) as ISO work items on third-party assessment of software products. Progress in this field assists developers in identifying ways in which the quality of their own products can be enhanced, contributing to their competitive position in the market, and establishes a potentially more open and better relationship between suppliers and their customers. The SCOPE consortium has developed an international reputation through its practical approach to product assessment and is now exploiting the results of its work by developing the basis for a pan-European set of software product assessment centres.

Providing more advanced tools and environments

The R&D in IPSS has resulted in a range of advanced products, services and new standards in system engineering.

Cap Gemini Sogeti has announced a new product line, WEAVER, that includes an application-specific programming environment and tools based on the results of ATMOSPHERE (2565). Based on the outcome of the same project, SFGL has announced AdaNice (an ADA environment), and SNI and associates have announced GRAPES (a high-level graphical system description language). These products are examples of the commercial exploitation already under way. The project has developed five prototype environments, all based on a common architecture and system integration concept, and each aligned with the business of one or other of the main partners. Their commercial potential has been enhanced by ensuring that they have been developed with the active involvement of the system engineers in operational product divisions. The companies concerned are planning to publish a set of books on the R&D in the near future.

A key development in tools and environments is the evolution of interactive programming environments. In this field, Sema Metra Group and other members of the GIPE II (2177) consortium have formed a new company, Connexite, to exploit the results of their work in the project, which has focused in particular on scientific computing and formal languages. Cooperation has been established with companies working in LOTOSPHERE (2304). The LOTOSPHERE work has converted the emerging international standard formal description technique LOTOS (ISO 8807) into an industrial tool applicable to system design and implementation. The work has also provided a Fortran '77 environment for the European Workstation (EWS) developed in the ABHS area of ESPRIT in the EWS (2569) project.

One of the major contributors to the overall cost of an operational system is system maintenance, often accounting for more than half of the total system cost. REDO (2487) has developed a methodology and a software environment for reverse engineering and re-engineering. The approach taken has been to integrate artificial intelligence techniques with current developments in the fields of formal methods, software engineering, software validation and human factors.

Providing knowledge-based system components

ACKNOWLEDGE (2576) has developed a prototype knowledge acquisition workbench based on the KADS methodology. The prototype is being used internally by the partners to develop new applications across a wide spectrum of domains such as telecommunications, avionics, environment monitoring and road maintenance. KADS is gaining momentum in Europe through the KADS II (5248) and VITAL (5365) projects. KADS user groups have been set up in many European countries

and actively contribute to dissemination and experimentation. Tool vendors are announcing first versions of supporting tools with the 'common KADS' label.

The next generation of development environments for knowledge-based systems will allow end-users to develop their own knowledge-based applications by means of reusing knowledge components. CONSTRUCT (5477) has developed a prototype of such a system and demonstrated it at a recent conference in Avignon, where it provoked strong interest from tool vendors and industrial users.

Developments in techniques which allow machines to learn from experience are being used by Alcatel and their partners in telecommunications, financial risk analysis and health-care (MLT, 2154). Thanks to their work, the symptoms of a new heart disease are now better understood.

As knowledge-based components become more widely used in systems, so the need is developing for more advanced tools for verification and validation. The VALID (2148) consortium is among the leaders in this field. Its work has resulted in a prototype set of verification and validation tools that should help facilitate further industrial acceptance and use of knowledge-based components in systems.

Supporting complex applications

The IPSS R&D on system design and engineering is helping system developers to meet the needs of customers in their day-to-day activities. The spectrum of needs ranges from the development and monitoring of complex industrial applications to those of social and environmental concern.

Krupp Atlas Elektronik and their partners have already exploited results achieved in

The intelligent integration decision-support systems developed in PAYDIRT (5473) will be used in this control room to help manage the Bordeaux sewage network.

ARCHON (2256) in power distribution applications and will be further exploiting them in the control of air pollution in and around Athens. Their work demonstrates the potential of multiple intelligent agents to work individually to provide services for which they have been designed and, when necessary, to work together towards the achievement of an overall objective. The project has made an important contribution towards a basis for engineering distributed cooperating intelligent systems.

The need to work in real time has been a significant constraint in building applications in some fields in the past but work in PAYDIRT (5473) is helping to overcome this problem. A system for the management of a major water supply network is under development based on the results of the project, which aims at implementing time-constrained reasoning applications. A prototype of an environment for building real-time knowledge-based systems has been developed in REAKT (5146) and successfully validated on process control applications in an oil refinery.

Training systems can also benefit from intelligent components. Marconi Simulation and their partners are customizing a generic architecture developed in ITSIE (2615) for their internal needs such as safety systems in the oil industry and power distribution, diagnostic trainers and the improvement of existing training systems. The ITSIE results provide a generic platform for developing intelligent training systems aimed at improving the level of training for the operation and maintenance of complex physical systems and potentially hazardous processes.

Information servers and interfaces

The companies working on information servers and interfaces in IPSS are targeting IT products that constitute the server in client-server computing for information systems. This is achieved by addressing technologies for information management and presentation. The R&D is benefiting from the base technologies developed in ESPRIT I and II in parallel processing, knowledge engineering, database management and user-interfaces by integrating and extending these.

The overall objective is to improve the quality of information and of interaction among information systems. This concern is driven by the clear understanding that the business world is becoming more and more dependent upon effective information technology in order to manage the complex and voluminous information necessary to compete in all sectors of the market. The projects in the sub-area set out to provide the technological means to describe and handle information of a complexity and richness that is closer to that manageable directly by humans than existing relational databases can provide. Mastering this complexity and richness is an essential prerequisite to utilizing the power of information technology to manage the 'information explosion' that businesses are currently experiencing.

Handling more and more complex information

A number of projects which started with a technologically-oriented set of objectives are now showing their potential to contribute to eventual products through the development and validation of technologically innovative prototypes.

The work on programming in different object-oriented and logic-based data and knowledge programming languages for the same application (in STRETCH, 2443, and KIWIS, 2424), on rapid data access (also in STRETCH and KIWIS), on integrating existing relational data (in KIWIS), and on data modelling (especially of time, in TEMPORA, 2469) is at the forefront of the field. ISIDE and KIWI (ESPRIT I projects), both started as investigations into the critical technological issue of information management in different representation paradigms (logic, object-based and functional). STRETCH and KIWIS (ESPRIT II) continued the work by focusing on the common components of object stores, data programming languages, external connectivity, and on features (speed, programming support, user-interface) pertinent to the usability of components. The LOCO language developed in KIWIS has been validated as a systems application programming environment (in the simulation of telecommunications services), and the STRETCH object server has been validated for the retrieval of complex graphical (cartographic) data at retrieval speeds that compare favourably with commercially available systems.

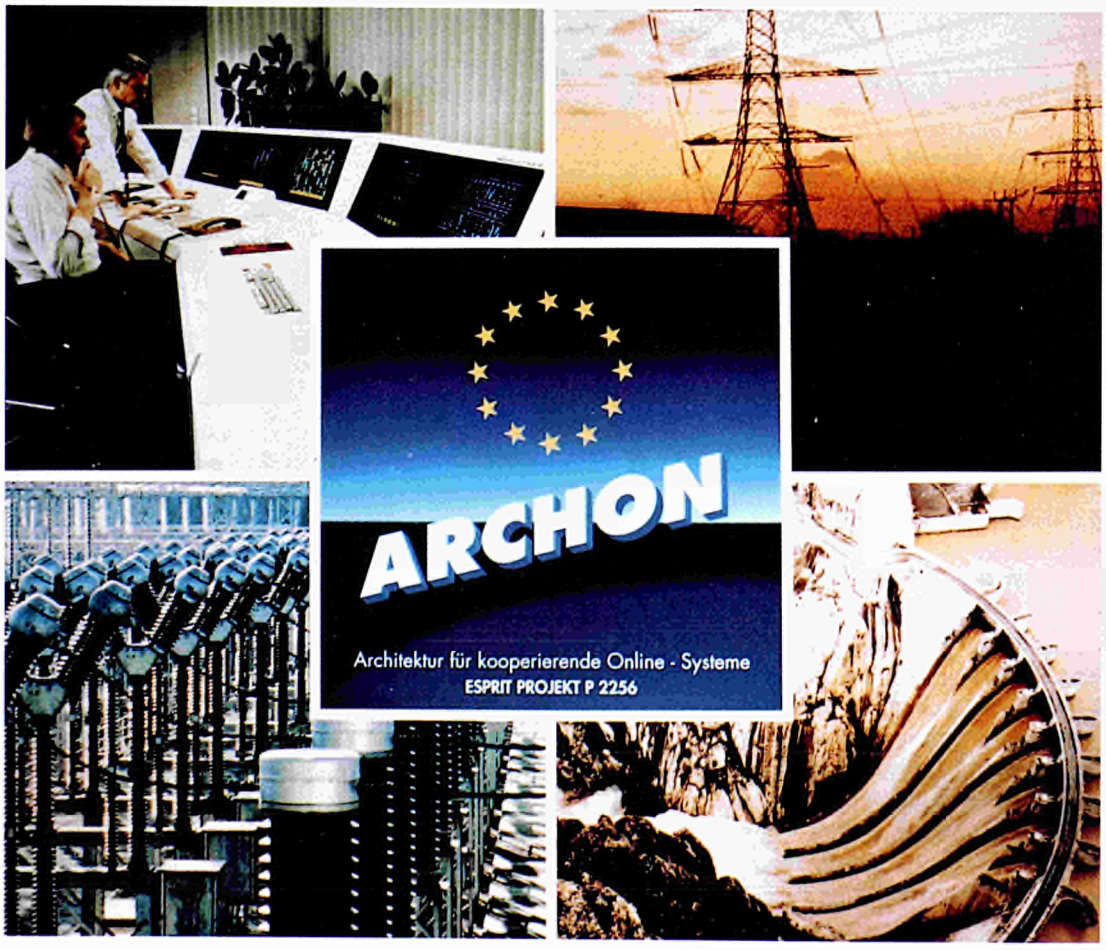
The flexible object server developed in TROPICS and STRETCH is now available as a product, ObServer from Infosys. ObServer, is an extensible object manager, independent of a particular data model: thus the data model and access structures best suited for rapid access to specific complex or voluminous data can be selected, in contrast to a standard database management system. The application used for its validation has been a cartographic one. A specialized cartographic query language, GeoSQL, was originally developed in TROPICS and then re-verified with the object server as modified in STRETCH. Managing cartographic and general image data in a manner that makes it easy to integrate at the user-interface with numerical and textual data has still a long way to go before user needs are satisfactorily covered. Providing efficient storage is a first step in this direction.

Two projects, AIMS (5210) and SHAPE (5398), launched during the past year, are working on technologies that target products for knowledge management and hypermedia development, respectively. SHAPE is providing an advanced development environment for hypermedia applications, usable by database providers in creating their packaged products. The specification was completed during the past year and some of the tools needed have been developed in prototype form. The later part of the project focuses on a prototype which will be usable in pilot form to develop CD-ROM databases and full-text document products.

In the field of large-scale, distributed-store, parallel processing systems, EDS (2025) is making a significant contribution to distributed database technology. Key achievements include an extended SQL on both shared- and distributed-store systems and a language subsystem, ELIPSYS. Developed for the EDS platform, ELIPSYS is based on logic and constraint programming and has been the subject of a wide range of experiments.

Making information useful

A number of IPSS projects concerned with HCI (human-computer interaction) are pro-

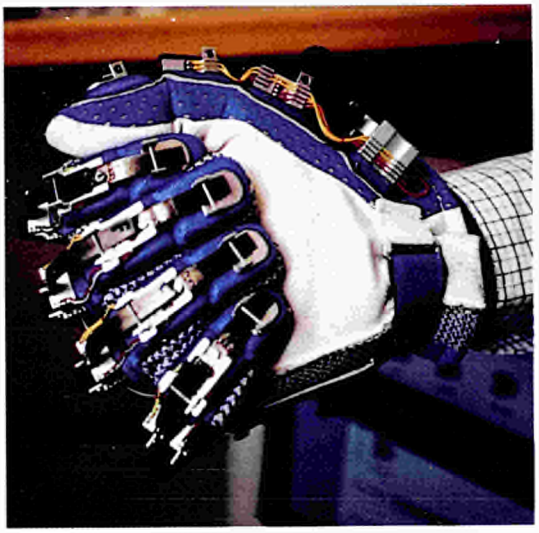


ARCHON (project 2256) has been developing distributed artificial intelligence systems for applications in areas such as the diagnosis and appropriate handling of disturbances in Iberdrola's high-voltage network.

viding a spectrum of technologies that will enhance the quality of interaction between systems and their users. The use of natural language, intelligent front-ends, cursive script interpretation and virtual reality are all contributing to improvements in this field. IPSS work addresses the full range of these issues and also contributes to the emergence of user-oriented standards.

Natural language processing is now emerging as a technology with practical applications in specialized fields in the medium term. PLUS (5254) is using knowledge-based techniques ('pragmatics') to enhance language interpretation at the user-interface to information systems. MULTILEX (5304) is focusing on the creation of machine-readable lexicons, making this resource available in a way that conforms to standards, while EMIR (5312) is using linguistic processing for the creation of indexes for retrieval systems. Machine reading of cursive script is being addressed by PAPYRUS (5204).

In other areas of HCI, IPSS R&D has been developing other generic technologies and demonstrating their practical value in demonstrator systems in important application areas.



A prototype of the instrumented glove developed in GLAD-IN-ART (project 5363) for controlling a 'virtual hand' in a computer-simulated virtual reality.

Virtual reality for telemanipulation is an important area of development in HCI, with applications foreseen in handling hazardous materials or materials in hazardous situations. The instrumented glove being built in GLAD-IN-ART (5363) enables 3-D visualization and offers 'force feedback', where the operator not only receives important visual information but also feels what is happening through touch and force sensors. The work has already given rise to patent applications.

In the field of process control, PROMISE (2397) has been developing the means of quickly tailoring process control human interfaces to users' needs. The consortium has developed a prototype system which uses predefined user-interface elements to make system data about temperature, pressure and other factors readily available at the operator interface in a user-friendly manner. The system works on a specific set of scenarios drawn from the user partners' own operational experience.

In a contrasting application domain, ITSIE (2615) is using advanced interaction techniques to support training. User modelling and course modelling are used to enable 'intelligent' reaction on the part of the machine to the student's questions or mistakes. A strength of the approach is that this capability is equally applicable to more general help systems, so the technology is reusable.

MUSIC (5429) is focusing on the development of usability metrics. A set of tools and methods has been developed which is now being exploited in a wider set of potential industrial users outside the direct members of the consortium. To date, some 10 companies propose to take up the results to validate the project results as well as their own product offerings. Similar interest is being expressed by a number of organizations in the USA, and a significant contribution is being made to ISO standards work.

Advanced computer systems architectures

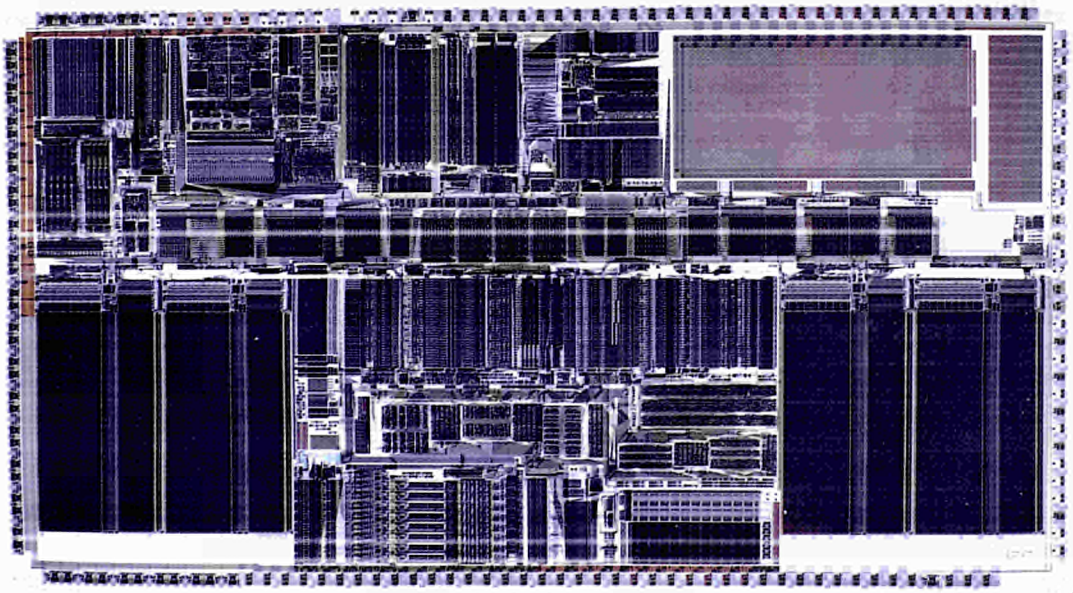
ESPRIT has been a long-term and consistent investor in the development and exploitation of parallel architectures. The widespread acceptance that has developed during the course of the last two years that the future for high-performance systems lies with highly parallel systems has acted as a welcome endorsement of this policy.

The R&D supported has covered a variety of forms of parallel architectures, producing high-quality prototype systems and, where appropriate, the basic components necessary for incorporation into such systems. As a result, a range of commercial systems have become available on the market and have

been vigorously marketed worldwide, whilst basic components such as the T800 transputer have enjoyed worldwide success. The successor of the T800, the T9000, is now available. Parallel computing systems are now poised to become a significant force at the high-performance end of mainstream computing, and through the activities in ESPRIT and national programmes, a range of European players have established a set of technical capabilities that are regarded worldwide as second to none.

tions of transputer-based systems resulting from PUMA (2701), chips have been designed and produced by the EDS (2025) consortium and by GENESIS (2702). The main partners in these projects intend to exploit the designs commercially during the course of 1993.

On the microprocessor side, standard available microprocessors are used in the systems under development. These include transputer, SPARC and Intel chips in EDS, targeted at commercial applications, and in



The first implementation in silicon of the T9000 transputer. The cache memory and communication subsystems were developed in PUMA (project 2701).

The transition from a position of promising specialized system to mainstream computing still holds a number of significant challenges. Chief amongst these is the challenge of usability and programmability. This is now seen as the key to the broader acceptance by the wide body of industrial users of this new computing architecture and its accompanying innovations. These have been the issues that have been the main focus for the work in this sub-area since the last 'Results and progress' report. In addition, and complementing this focus of the R&D, the components critical for the success of such systems have continued to receive attention.

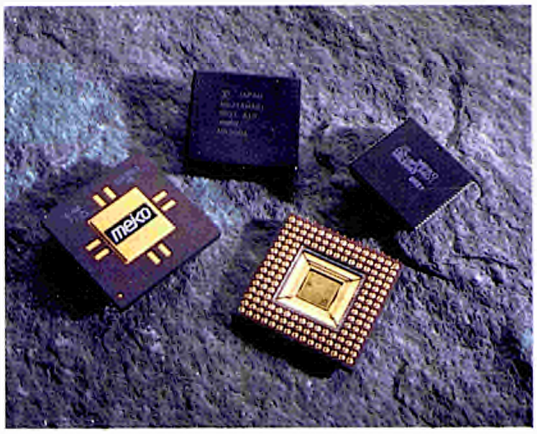
GENESIS and GPMIMD (5404), targeted primarily at scientific and engineering applications. The main exception to this general rule is found in AMUS (2716) in which a superscalar node is under development and which targets the very highest levels of computing power for numerical applications.

Providing the necessary components

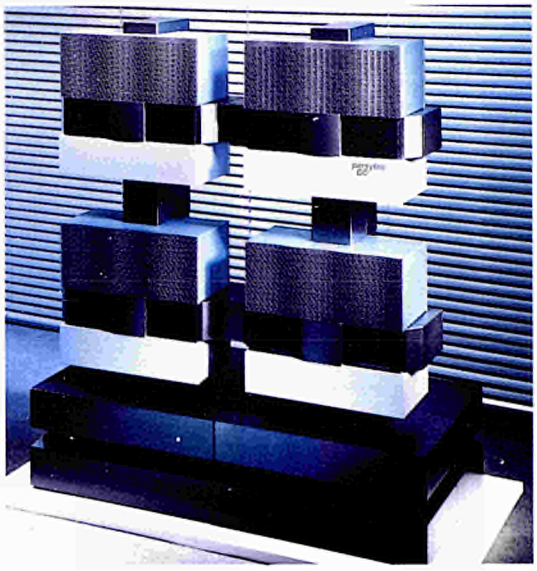
The work on this topic has been focused on components that are not likely to become available as standard for mainstream systems. In this respect, the development of ASICs for efficient communication and interconnection in tightly coupled parallel systems has been supported. In addition to the C104 chip that will be used to support future genera-

Fundamental system issues

Since the beginning of mainstream computing, the Von Neumann model has been the basic model for sequential computing. The computing community has not yet reached agreement on an equivalent abstract model for parallel computing. This is a major impediment to the achievement of application portability and scalability, and acts as a brake upon the penetration of parallel computing within a larger user community and within the body of third-party application developers. Several projects in this sub-area have been addressing issues related to computational models and in particular models for virtual shared memory.



The two foreground chips are the ELAN/ELITE high-performance interconnect chip-set partly designed by Meiko in GENESIS II (project 2702). They form key components of the new, world-beating CS2 massively parallel computer.



The massively parallel transputer-based GC computer from Parsystec developed from work in projects 2702, GENESIS II, and 2701, PUMA, has successfully overcome the practical problems of cabling up and interconnecting the processor units.

A model of computation for parallel systems, PRAM (parallel random access machine), together with what is needed to implement it in practice, has been studied by the PUMA consortium and been shown to be a viable model for implementation in future transputer-type chips and parallel systems more generally. The consortium has gone on to develop a range of efficient tools to simulate, evaluate and experiment with various types and topologies of interconnection networks. Their work has made important contributions to our understanding of how to build parallel systems. The work has already been commercially exploited in the form of the C104 chip, mentioned earlier.

The companies collaborating in EDS (2025) have developed and implemented a prototype of a 'weak-coherency' cache. This model is particularly suitable for database and decision-support applications. The model enables the information in the cache to be adapted to the types of questions the user asks, making the cache more efficient.

Portability across different types of machines was a major focus for GENESIS (2702), which successfully demonstrated this attribute through the use of PARMACS as a central programming model. This model consists of a set of macros added to Fortran. It has been implemented on a range of message-passing and shared-store systems, and is now available commercially. Contracts for its implementation on a number of European- and US-sourced high-performance systems have been won.

Work on portability is continuing, and a special interest group including key software houses and experts from universities has been set up with a view to making recommendations for standards in this area. Several meetings have already been held in collaboration with the Commission.

The Concerto computer range shown right is marketed by Meiko, Parsys and Telmat Informatique, brought together via the GPMIMD (5404) project.

Improving usability: languages and environments

The development of suitable programming languages and environments is crucial to the success of parallel systems, and significant advances have been made in this field through IPSS R&D.

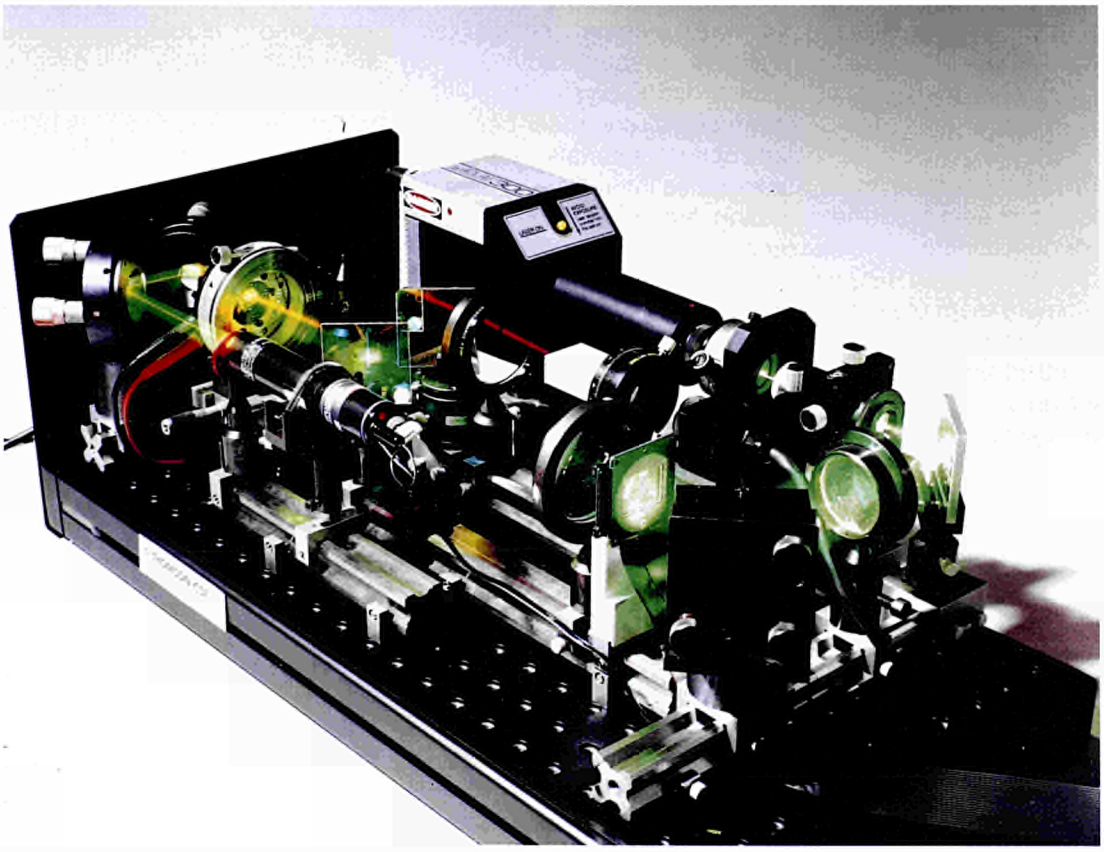
Numerical computation has received substantial attention with a particular focus on Fortran. SUPERNODE II (2528) has developed a Fortran '77 compiler which is now on alpha release for transputer systems. A

Fortran '90 compiler will soon be available. Complementing the work on languages, both SUPERNODE II and GENESIS have produced parallel numerical libraries which are now available commercially for transputer and Intel i860-based platforms. The development of these libraries was a necessary step in helping the industry to realize the potential of these platforms and represents an important European lead in this key field. In addition to the work on Fortran, the SUPERNODE II project has also given rise to a commercially available Ada compiler.

It will serve as a basis for future work in this challenging field.

Finally, the work on environments has been building on earlier results achieved in system design and engineering, focusing on tools for parallel systems.

The work on SUPERNODE II has resulted in the PCTE (Portable Common Tool Environment) being supported on transputer platforms, and the HOOD object-oriented design environment is available on platforms sup-



Pictured is the prototype optical correlator integrated at Thomson-CSF in project 2288, NAOPIA. This fully optical processor has a computational power equivalent to 100 Mops. The current size, 30 x 60 cm, will be significantly reduced when fully developed.

For the longer term, COMPARE (5399) is working on reusable compiler components to compile for many languages and different types of architectures. The work started in early 1991 and is laying the basis for exploiting the potential of parallel systems more fully through the use of a finer grain of parallelism.

Again as part of the longer-term thrust, a prototype of an automatic parallelizer, SUPERB, has been demonstrated by GENESIS. Automatic parallelizers are needed to enable systems to apply parallel processing models to problems efficiently. SUPERB is seen by many experts in the field as the best basic tool currently available for automatic parallelism.

porting the C++ and C programming languages. In addition, many of the tools produced by the GENESIS project to support the development of programmes using PARMACS will shortly be made commercially available. They include tools for performance analysis, and simulators and tools for the support of the migration of application software.

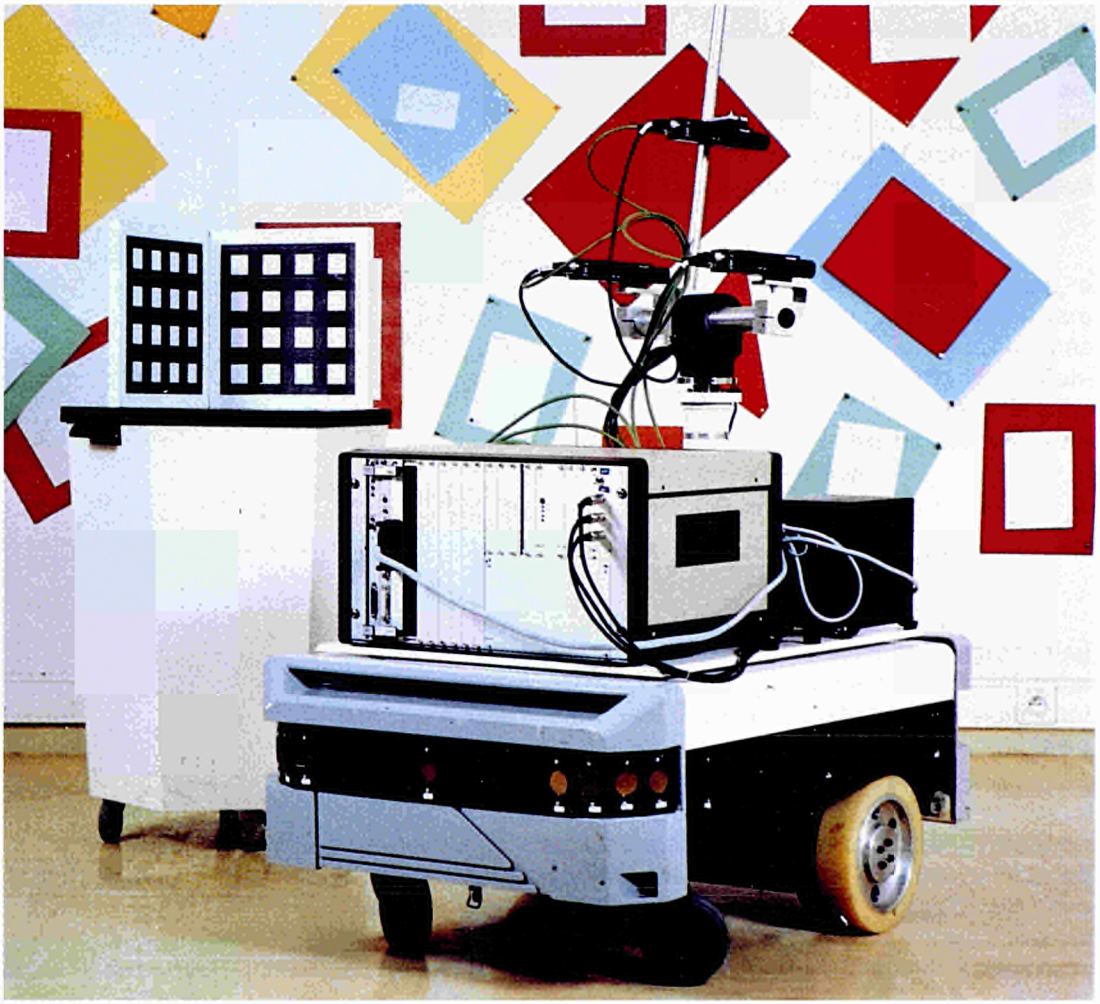
Developing new computing paradigms: optical and neural computing

Complementing the work on mainstream parallel computing, two new and promising paradigms for computation which exploit very high levels of parallelism have been in-

vestigated: optical computing and neural computing. Optical computing technology holds much promise for the future, using the intrinsically parallel qualities of light and allowing some kinds of functions to be performed extremely fast. Neural computing, based on an analogy with the networks of neurons in the human brain, is already proving its potential usefulness in experimental applications in a number of domains.

While optical computing is not yet well established, optical system architectures and optoelectronic devices are progressing fast enough to make the question of optics relevant for some specialized processing systems. Recent advances in solid-state lasers, liquid-crystal displays, spatial light modulators, computer-generated holograms and optical materials have opened up new opportunities in the field of parallel optical computing. NAOPIA (2288) is exploring industrial applications of these technologies for pattern recognition in robotic applications. The work has resulted in the optical implementation of highly parallel architectures applied to industrial sorting tasks. A prototype, easily transportable optical system that integrates laser sources, liquid-crystal spatial light modulators and real-time holographic crystals has been realized and demonstrated. With video rate correlation operations performed on images containing 10^5 pixels, the correlator has an equivalent computing power of the order of 250 million operations per second.

Neural computing is already being used in practical industrial applications. The ANNIE (2092) consortium has published a handbook containing various case studies where neural computing has been applied successfully, including non-destructive testing. PYGMALION (2059) has developed an integrated software environment for neural applications. A derived product is being marketed by the start-up company Mimetics, which specializes in neural networks. In addition, a major software component using neural net techniques is now used in a commercial OCR system (launched by Mimetics during the past year) to help disambiguate patterns. It will also serve as a test application for the silicon compiler developed in GALATEA (5293) to produce an



The mobile robot developed in DMA (project 940) employs a 3-D computer vision system for real-time analysis of scenes. It can avoid obstacles and make visual maps of what it perceives.

ASIC for OCR systems. Work in GALATEA is also in progress to produce an integrated hardware and software environment to develop neural net applications. The work includes the development of specialized chips and PCBs.

Signal processing systems

IPSS R&D on signal processing systems has concentrated on machine understanding of speech and visual signals. Direct speech understanding complements the broad range of work already undertaken in the human interface domain (described in the section on information servers and interfaces). Machine vision systems complement this work by allowing the computer to 'observe' and 'understand' complex external scenes. Both domains generally require the application of substantial computational power. Machine vision in particular has for some time exploited the capabilities of parallel computing systems.

Since the last 'Results and progress' report there has been a progressive fusion of these two major application areas and the underlying technologies required for parallel computing systems. The aim is to improve the speed with which applications in these domains can utilize the benefits now being offered by the availability of greatly increased computational power at highly economic costs. In turn, closer consideration of these key application areas helps to focus the priorities assigned to work on developing the underlying technologies, especially the technologies needed for embedded applications.

Significant advances in machine vision

A major challenge in machine vision has been the development of systems for the analysis of three-dimensional scenes in real time. Work completed in DMA (940) has made significant contributions to this field and been demonstrated in the form of a mobile vehicle that can move in different environments, avoiding obstacles and making visual maps of the scene, and in the form of an arm for industrial robots for use in object manipulation and inspection and for tool assembly. The work has embraced the full vision processing chain from image acquisition through to image understanding, and brought to realization an advanced hardware front-end system with an open architecture which allows the integration of commercial boards. In addressing some of the most challenging and computationally complex functions such as edge-detection, chaining, 3-D stereo matching, segment token tracking, etc., a set of specialized processing boards have been produced using standard forms of transmission (VMEBUS and MAXBUS) and operating, for edge-detection and chaining, at video rate. The resulting overall architecture is judged to stand comparison with the best to be found in Japan and the USA. Many of the boards designed for DMA are already representing business opportunities for the industrial partners. An example is the LINKER board from Elsag Bailey, which is connected to the videobus and is able to perform local neighbourhood image processing in real time.

A similar approach is in progress at ITMI, where the token tracker board (see above) is currently under evaluation for mobile robotics. General-purpose multi-DSP boards were produced as part of the project to meet the need for high-level vision (as needed, for example, in order to manipulate robot arms in three-dimensional space). MS2i is now using the boards in a range of proprietary industrial applications. In addition to the opportunities offered by the boards, the DMA machine itself is seen to represent a business opportunity either in full configuration or integrated with other commercial or specialized boards. Two of the industrial partners, Elsag Bailey and MS2i, are already using the DMA machine inserted into their own proprietary environment for the development of further algorithms addressing applications in support of autonomous vehicles and remote manipulation in space.

The substantial achievements of DMA are being further extended in VOILA (2502), where a number of the original DMA partners are participating. In the DMA mobile vehicle demonstrator, the autonomous vehicle was guided by largely off-board computational facilities. In contrast, the VOILA demonstrator includes computational support on the vehicle itself. The systems developed are demonstrated in a number of scenarios chosen to typify aspects of indoor environments, such as a factory or a warehouse, and outdoor environments such as roads, car parks and stockyards. Partners anticipate using the results in a range of products concerned with guidance systems for autonomous vehicles and transport systems, tele-opera-

tion applications and in remote surveillance systems.

As a complement to the work of VOILA, VIEWS (2152) is addressing issues concerned with the real-time surveillance of outdoor scenes which include moving objects in a known, structured, large area. Automatic and machine-assisted surveillance are rapidly becoming possible in a range of important public safety applications such as the monitoring of ground traffic on busy airport runways, ship movements in harbours and traffic flow at complex road junctions.

Increasing commercial opportunities for speech applications

Real progress is now apparent in meeting the critical need for robustness in speech systems as they move from the laboratory to industrial applications. Speech systems are becoming more resilient to noise and more able to deal with ambiguity. ARS (2101) has demonstrated prototypes which can work well in adverse noise conditions such as in a car or factory. These have performed well in recognizing single words spoken in a car moving in heavy traffic and even with the car window open.

A particular target for this technology is voice dialling of telephone numbers and other automotive applications. Hands-free dialling systems have become significant in the light of increasing safety legislation. Some nine million systems of this type are expected to be needed by 1995. Matra Communications and CSELT in cooperation with ITALTEL already have clear plans for exploitation.

Other companies have made further contributions to moving speech systems from the laboratory to industrial applications. Jydsk Telefon, the lead partner in the consortium working on SUNSTAR (2094) has already had some 400 users carry out an initial evaluation of three of the prototype applications developed in the project. Plans are now in hand to evaluate the prototypes on a much wider basis, involving tens of thousands of users. The application areas are PABX, abbreviated dialling and news service.

SUNDIAL (2218) has developed prototype natural language dialogue systems for English, French, German and Italian. Applications include flight enquiries and reservations, train timetable enquiries and access to electronic mail. One of the goals of the project was to integrate speech and natural language technologies. This has been achieved and has resulted in significant improvements in performance compared with using speech recognition on its own. The speaker-independent recognition technology which forms a part of the overall system has been developed to work over the telephone network. Field trials of this component are already in progress with end-users and it is planned to evaluate the complete dialogue system with potential users before the end of the project. The coordinator, Logica, is currently marketing a product called Callserver which incorporates some of the speech recognition techniques developed within SUNDIAL.

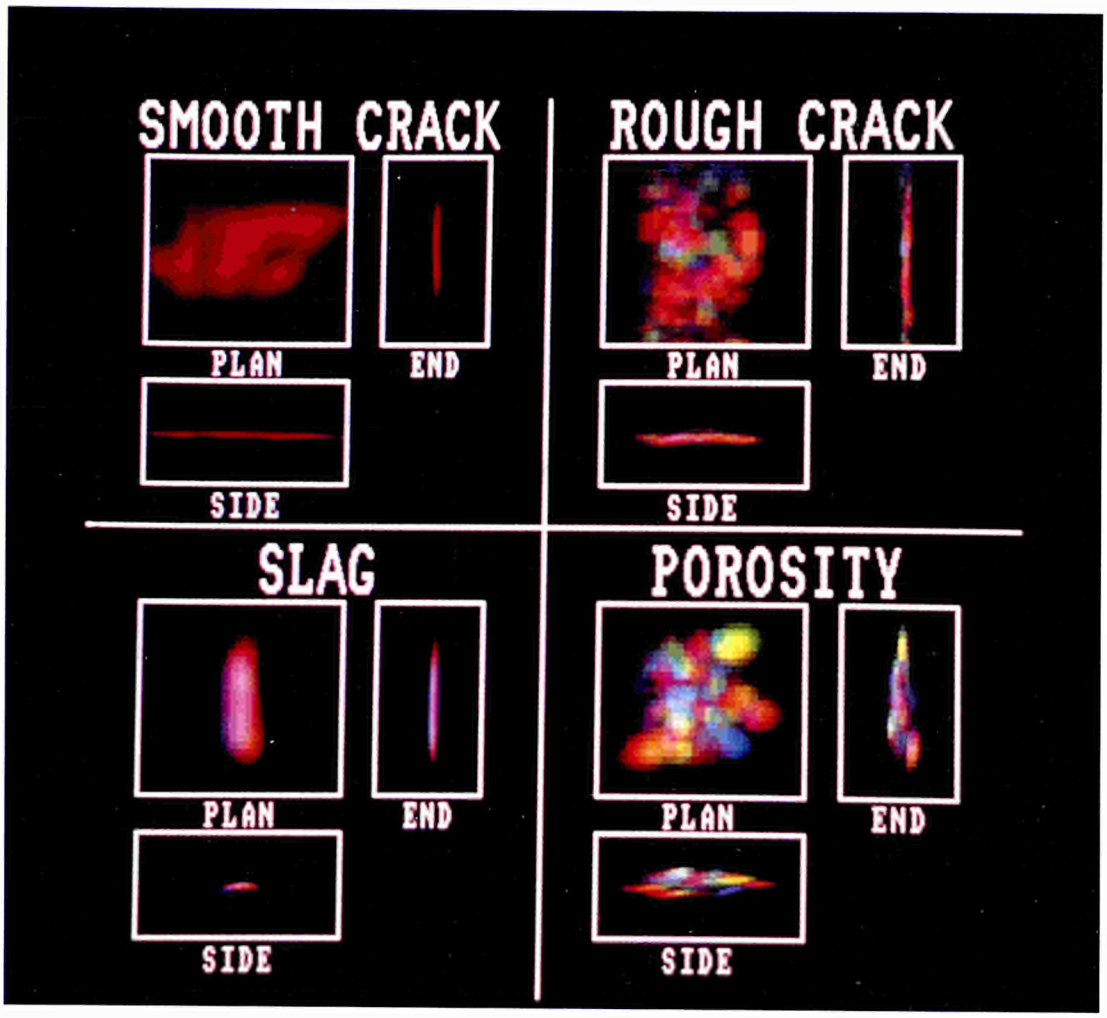
Accompanying measures

PCTE

The Portable Common Tool Environment (PCTE) was initiated as a coordinated set of eight ESPRIT projects aimed at establishing a set of open interface standards that would significantly improve the market for European CASE (computer-aided software engineering) tools and environments. This has now led to the establishment of the first public standard in the area, ECMA 149, which will be proposed as an ISO standard within the next few months. It has also led to a range of commercially available implementations which are being adopted and supported by an increasing number of both European and US workstation vendors. IBM will be adopting PCTE as its repository for its workstation market, and it is raising interest from Japanese tool suppliers and major users.

PCA

The parallel computing action (PCA) was completed in 1992 with the final workshop held in Barcelona. Launched in 1989, the PCA's aim was to help develop the expertise in advanced software needed for European industry to exploit fully advanced computer architectures based on highly parallel processor configurations. The PCA addressed this aim by assisting a substantial number of European universities and research institutions to acquire parallel computer systems. A total of 55 institutions in 11 Member States were supported in this way. Each successful institution chose its own system and negotiated its own contract with the supplier concerned. In many cases local funds were added to the Community contribution, which



Shown here are ultrasonic scanning views of each of the four main defect types found in welds: smooth or rough cracks, which are dangerous, and the more benign slag and porosity defects. The red/green/blue colour-coding fuses data collected at three different angles. Where structural integrity is important, such as in pressure vessels or piping in the process and oil industries, it is essential to identify the cracks so that they can be removed or repaired. ANNIE (project 2092) has shown how neural networks can be used to distinguish defect types automatically, so that in principle human fallibility can be avoided during the inspection process.

totalled some ECU 3.3 million. In addition, support was also provided to enable participants to attend a set of four workshops at intervals of approximately six months. These were held in Southampton (July, 1990), Ispra (December, 1990), Bonn (May, 1991) and Barcelona (March, 1992).

The PCA substantially exceeded initial expectations in adding to the very limited pool of expertise in this domain. As a result of the PCA, it can now be expected that between 1 500 and 2 000 students per year over the medium term will be exposed to parallel computing technology and thereby assisted in developing an appreciation of the benefits it offers.

ESSI

The planning for ESSI (the European systems and software initiative) has continued during the past year in readiness for its launch in early 1993. This aims to contribute significantly to the productivity and capabilities of system and software engineers by encouraging the take-up and use of modern system design and productivity techniques. Particular encouragement will be given to SMEs. The initiative is planned to cover critical testing and evaluation of advanced methods and tools, training and a range of dissemination activities.

Special interest groups

The special interest groups (SIGs) in IPSS have continued to play an active part in developing the R&D community, and, as mentioned earlier, a new SIG in the field of software portability has been formed. The SIGs currently active in IPSS now cover LISP, formal methods, metrics, European languages standards for MIMD computers, software maintenance and software portability. These groups include participants in IPSS projects and are open to other interested parties in industry, universities, research institutions and user organizations.

Commercial exploitation seminar

As part of the continuing IPSS encouragement for commercial exploitation of the R&D supported, a pilot seminar was held in Brussels in May 1992 to consider exploitation matters. A total of 28 people from 13 industrial companies attended. Presentations were given by three marketing consultants and a representative from the VALUE programme. A number of interesting concepts were discussed, including the idea of a 'technology exploitation template' comprising a description of the steps and activities needed for the preparation of an exploitation plan. The seminar was considered extremely useful by those who attended and further development of this activity to a broader set of ESPRIT projects will now be undertaken by VALUE.

Conferences

The dissemination of results through conferences and related events continues to be encouraged, and a number of successful presentations of R&D results were made during the past year.

Advanced business and home systems — peripherals

Overview

The advanced business and home systems — peripherals (ABHS-P) area of ESPRIT aims to provide vendor-neutral integrated IT systems for business and home applications suited to the needs of the 1990s. The R&D addresses a market which had a worldwide turnover of ECU 400 billion in 1990, and is forecast by IDC to grow at around 8.5% from 1990 to 1995. By the year 2000, the value of the market is expected to approach 10% of Community GDP.

The market will reflect increasing contrasts between a continued decline in some traditional core segments of the industry and a rise in other sectors that will open up new areas of opportunity. Some areas, such as multi-user computing based on mid-range and mainframe computers and traditional personal computing, will reach maturity, with a decline in the renewal of the installed base and reduced differentiation among products, except in terms of price; whilst emerging sectors (including, for example, RISC workstations, multimedia, mobile and portable computers, distributed systems software, and chips for home systems) will enjoy high growth.

The 1990s will also see a change in the role of IT in business and public administration. Productivity gains and cost reduction or containment will still be important, but the new focus for investment in IT will be based on the ability of systems and services to generate new business, increase revenue and respond faster to market requirements. There will also be greater interest in developing national and transnational systems that address the growing concerns and aspirations related to the environment. The ABHS-P area of ESPRIT is helping the European IT industry to capture its fair share of this emerging market in the face of strong competition.

Strategic product announcements, standards and market initiatives

The R&D in ABHS-P has been helping European companies to collaborate in order to develop advanced systems that can be competitive in the European and world markets. In some cases, the final products embody the fruits of several related R&D projects, each carefully planned and monitored for its value in contributing to exploitable results. The strategic announcements by Bull and other companies working in the field of distributed systems are examples of this. Bull's Distributed Computing Model, and the world-class ANSAWare system developed by the ISA consortium, have helped to put European industry in the lead in the field of distributed systems.

Underpinning such products are standardization activities. ABHS-P R&D has made significant contributions to international standards across all areas of business and home systems. A few of the many examples include the coding standards for still and moving images needed to support the emerging field of multimedia, standards for the control of Integrated Services Digital Network (ISDN) signals in business and home applications, and the open document architecture (ODA) standards for the exchange of documents in business systems.

Before products can be effectively exploited commercially, it is often necessary to develop the market infrastructure. This is particularly the case at the leading edge of technology developments and customer requirements. Two of the key successes of ABHS-P R&D in this regard are in health-care and home systems. In health-care, RICHE has made a major breakthrough in the harmonization of open information and communication

systems for health-care in Europe, improving the cost-effectiveness of advanced information systems in hospitals and providing the systems necessary to facilitate the exchange of patient information. In the case of home systems, ABHS-P R&D has helped European industry to establish a framework of standards and a European Home Systems Association (EHSA), which will enable European companies to provide competitive products. Consumers can be confident that equipment purchased from different European manufacturers will work effectively as components of an integrated home system as long as the equipment conforms to the Home Systems Specification (HSS).

Meeting customer needs

The strong market orientation of R&D in ABHS-P is reflected in the increasing involvement of user organizations in projects and in special interest groups (SIGs). SIGs bring together major manufacturers, SMEs, academic institutions, user organizations and other interested parties, encouraging the dissemination of R&D information and providing opportunities for the parties concerned to influence the direction of the work. There is increasing emphasis on the importance of market analysis in R&D proposals and as part of the projects themselves, and arrangements have been made with a leading market analysis company, IDC, to help companies working on ABHS-P R&D to gain access to market data. All-in-all, commercial success in ABHS-P will increasingly reflect 'customer pull' rather than 'technology push'.

Involving SMEs and academic institutions

SMEs and academic institutions have made important contributions to ABHS-P R&D, and their involvement continues to be actively encouraged. SMEs and academic institutions can often provide expertise in very specialized fields, and SMEs can move quickly to seize market opportunities. Of the projects and exploratory actions funded in ABHS-P under ESPRIT II and III, 107 involve SMEs, with up to 10 SMEs being involved in any one project.

Trends in advanced business systems

Advances in IT have been taking place in the context of significant political and economic changes which are continuing to impact the way in which businesses and public administrations are having to work. Both in business and in public administration, the need for harmonization is greater than ever. Organizations cannot afford to be too idiosyncratic in terms of their IT policy, but need to meet their own particular requirements within a common framework. ABHS-P R&D is supporting strategic projects aimed at helping European companies to meet particular customer needs by the tailoring of generic systems within a common framework based on open systems.

These systems represent a natural evolution in terms of:

- **Connectivity and increasing demand in terms of interoperability,** leading to increasing demands for open and distributed systems. Distributed architectures will progressively replace the traditional hierarchical ones, with computing power becoming widely disseminated within companies and to applications in the home and beyond.
- **The richness of information handled and in user-friendliness,** especially through the increasing use of graphical interfaces, multimedia presentation and multimodal user-system interaction will significantly reduce the burden of learning new applications and will help to encourage their use and accelerate their spread throughout the enterprise and beyond.
- **The autonomy of the individual,** mobile and portable computing will develop rapidly with improvements in performance, storage capacity, interface design, battery life and reliability.
- **The types of applications available** to the end-user, providing partial solutions to the software crisis through increasing the availability of standard and advanced customized packages which free users from the need to develop their own specific applications.
- **Architectures and the type of work supported,** moving from stand-alone and hierarchical architectures where users were passively connected to a mainframe, to the rise of client/server architectures, the development of groupware, and support for cooperative working at the corporate level and beyond.

This portable CD-I player from Philips is based on a prototype multimedia storage and selective retrieval system developed in the DOMESDAY (901) project and the world-standard coding system for video images (ISO 11172) developed in COMIS (2102).

Each of these lines of evolution represents a key business area for IT in terms of the opportunities for leading-edge products and systems during the 1990s. The R&D in ABHS-P is helping European industry to achieve significant results in each of them. The following are some of the highlights in terms of results achieved during the past year.

Leading the way in connectivity

World-class achievements in distributed systems

A carefully planned series of interrelated projects in distributed systems has helped the European IT industry to achieve a world-leading position in this field.

Bull's announcement of its Distributed Computing Model, based on the results of eight ESPRIT R&D projects, has helped to put the European IT industry at the forefront of developments in distributed systems and is contributing to a new liaison with Olivetti and SNI. Exploiting the results of complementary developments, APM Ltd has been established to exploit and further develop the ANSAware system developed in ISA (2267) and other projects. ANSAware enables customers to link heterogeneous hardware and software into an advanced distributed system that provides users with transparent access to applications using resources distributed throughout the system. The R&D has made a major contribution to international standards, including the ISO/ODP (ISO/JTC1/SC21/WG7) standard, and has produced a prototype of a future distributed operating system which is expected to be used increasingly in the 1990s to manage and control large numbers of computers, provide enterprise-wide services, and replace centralized or departmental services. Potential exploitation areas range from applications in all areas of business and industry, incorporating systems and services ranging from personal computers to specialist remote information services.

The availability of ANSAware compared with competitive developments and its conformance to the evolving open distributed processing (ODP) standard reinforce its strategic importance to the industry. It has been successfully sold outside as well as within Europe, most notably to NASA as the basis for the world's largest open distributed system, the Astrophysics Data System (ADS), which spans the USA coast-to-coast. NASA aims to use the system to make the results of their space projects openly available to the NASA research community worldwide. The system architecture is designed to work with every operating system and within both LAN and

WAN environments. By the end of 1991 3 500 users had been connected using Sun, HP and DEC workstations and computers running operating systems including MS-DOS, HP-UX, SunOS, Unix, VMS and Ultrix, each with ANSAware installed. Over the next two years the system is expected to grow to over 100 000 users. According to the NASA administration, the system represents 'the dawn of a new age of information systems architecture and utility'.

Ensuring that European industry can maintain and even improve its lead in this key area, CAP-Gemini, Bull, Siemens and other companies are incorporating results from these and other projects in further system developments (e.g. in HARNESS, 5279), helping to develop a unified European approach to distributed systems. The work has already contributed to a basis for new products, including the AMADEUS environment being marketed by Iona Technologies.

Advances in business communications

As business systems become larger and more complex, increasing demands are put on the underlying communications subsystems in terms of available bandwidth, flexibility of use of bandwidth, security and other factors. This effect is amplified by the movement towards increasingly sophisticated applications, including multimedia applications and applications supporting cooperative working. As part of ABHS-P R&D, leading companies together with SMEs and research institutions have collaborated in the definition of a multifaceted and coherent work programme for business communications R&D. The results are helping European companies to provide competitive solutions to customers' needs for both local-area and metropolitan-area systems, including systems which support very large numbers of users using a highly heterogeneous range of hardware and software.

A market study carried out in DAMS (2146) has indicated a considerable demand both in Europe and elsewhere over the next few years for systems which will enable customers to handle both circuit-switched and packet-switched data and to cope with widely varying bandwidth demands. Users of such systems will be able to benefit by having access to a wider range of services, and more advanced services (including multimedia services), without any noticeable increase in problems associated with traffic congestion. Responding to this opportunity, the consortium has developed the components needed for such a system, giving European industry an important base of technical achievement in this key area.

Where the demands on bandwidth are particularly exacting, it may be necessary to move to ultra-wideband communications. Prototype components necessary for this have been developed in UCOL (249 and 2054), giving European industry a world lead in this important field. The consortium was the first in the world to demonstrate end-to-end communication using coherent optical techniques. In complementary work on high-speed LANs and B-ISDN, OSI 95 (5341) is making proposals to the relevant standardization bodies aimed at revising the OSI reference model from layer 2 upwards to take account of new requirements and the new communications environment. This work has contributed to a number of products, including the Estelle Development Toolset developed mainly by Bull and INT. Olivetti and other companies are using the results in prototype developments.

Prototype components needed for European solutions to business needs in the field of larger-scale networks, including metropolitan-area networks, have been developed and are being integrated in MAXI (5193). The R&D is helping the companies involved to develop turn-key communication systems, network products, chip-sets, high-speed communication servers, improved communication protocols for systems, and network management systems and services. Companies involved in MAXI and related R&D in ABHS-P have signed a joint venture agreement to exploit their results.

Interconnection of networks is becoming a key requirement in many business applications and ABHS-P R&D is helping European companies to provide competitive products in this field. For example, 3-Net and Systems Wizards in collaboration with University College, London, have developed two products, BANDMAN and InterChange, based on the results of their work in PROOF (2404), which are aimed at supporting the interconnection of ethernet LANs to primary rate ISDN. In terms of their technical specifications, both BANDMAN and InterChange are world firsts, putting the producers in a competitive position both in Europe and worldwide.

In some environments physical communication links are not feasible, and other forms of

communication are needed. Ship-to-shore communication is one such example, and in this field a number of commercializable results from work in ICI (2058) were demonstrated at the 1991 ESPRIT conference exhibition. ICI uses long-range radio communications to support fax and data transmissions, providing a practical alternative to satellite communications. Its communications speed and data integrity make it a unique system. Individual commercial results include a high frequency (HF) radio modem (for which there is no known competitive product in the same low-price range), an HF radio communications protocol, software to automatically predict appropriate frequency and signal-to-noise ratio, and a channel simulator to test HF modems under replicable conditions.

European products in EDI

The market for electronic data interchange (EDI) has been estimated to be growing at a rate of 40% per year, and in response to this opportunity, Bull, Nixdorf and other companies are using the results from several ABHS-P R&D projects to develop a generic software platform which will enable computer applications running on different computers to communicate with one another using EDI messages sent over X.400 networks (CHALENGE, 5322). The work supports the development of EDI services and complements that being done in the TEDIS programme. The results are being piloted in several European countries and are helping the companies concerned to offer competitive European products offering advanced EDI services.

World firsts in multimedia

A key improvement in the systems of the 1990s compared with those of the 1980s, from the user's point of view, will be the range of information that the systems can handle. Products are already appearing on the market which support moving video, still images, voice, sound and graphics as well as conventional text and data. These products are 'multimedia' but are merely the forerunners of what is to come. The market for the new systems is enormous. Firstly, multimedia represents a natural evolution of personal computing, so the new products will address the 'substitution market' for today's business desktop PCs. Secondly, it opens up possibilities for a range of new applications (such as public 'multimedia kiosks' providing information and services in department stores, libraries, railway stations and other public places). Thirdly, it presents significant opportunities for applications in the home (which has already been the target for 'multimedia encyclopaedias' and other products). As consumers become more aware of the new services which can be provided using digital systems, and increasingly demanding in terms of the quality they require, so there will be increasing merging of traditional applications such as television with computer-based applications.

The ABHS-P R&D in this area is helping the industry to define and cooperate in the carrying out of strategic projects which will ensure that European industry takes its fair share of this emerging market, estimated by Inteco to be about USD 12 billion in Europe alone in 1994. Significant achievements have already been

The commercial potential of the results achieved by Philips and other partners in the early DOMESDAY (project 901) R&D is now being realized in CD-I products being released by Philips, such as this mass-market player.

made in the ABHS-P R&D which give the European companies concerned world leadership in important respects.

Major product announcements

The commercial potential of the results achieved by Philips and partners in the early DOMESDAY (901) R&D is now being realized in the commercial product launches associated with the Philips CD-I (compact disc interactive) system, which was launched in the USA in October 1991 and in Europe in 1992. With dozens of titles already launched, CD-I is spearheading a completely new industry in the field of business and public information as well as home entertainment. It represents potentially the most significant major innovation in the field since videorecording and is heralding a new era in electronic publishing.

World leaders in true-colour image systems

As CD-I and other systems needed to support multimedia come to the market, so the demand for information in multimedia format grows. A key aspect of this is the demand for high-quality, true-colour images, important in a wide range of multimedia applications. This is a field in which ABHS-P R&D has already helped European companies to establish world leadership. Building on results reported last year, Brameur, the Dorner Institut, Telecom Paris, the National Gallery and other partners in VASARI (2649) have made a further breakthrough in capturing very high resolution images by combining the technique of 'multiband scanning' with 'mosaicing', resulting in electronic images that exceed the physical resolution of the camera used to take the initial pictures. A wide range of applications are foreseen for the results, with the initial application being in the lucrative visual arts field.

A complementary line of R&D has been pursued in MASCOT (2103). Their results include a world-first complete digital camera system, software for manipulating the images in a desktop publishing environment, and ink-jet print technology, including special inks. The inks alone represent an important market in their own right, and the complete system represents a significant achievement in the field of desktop publishing.

Developing the necessary standards

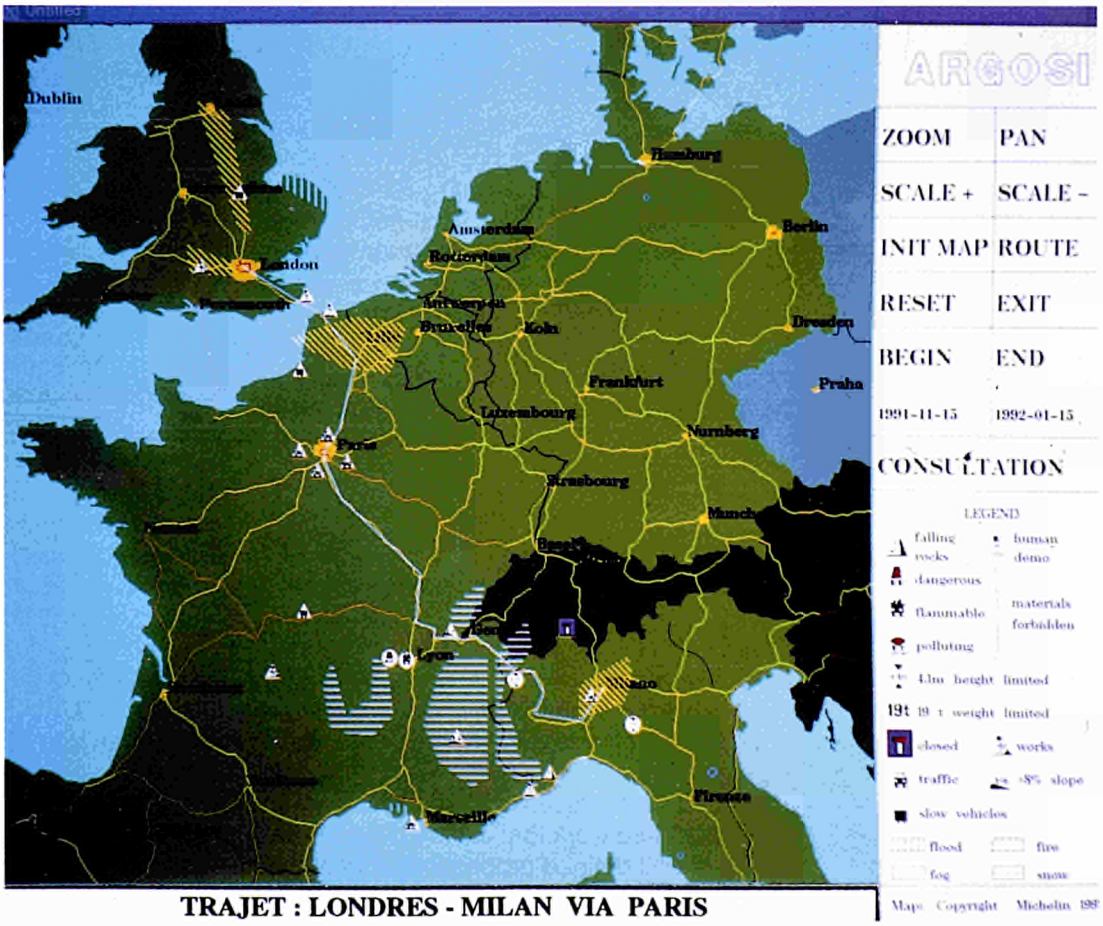
As graphical information increases in importance in business applications, so the need to be able to access and edit such information remotely becomes more important. An example of this was shown in a demonstration by Thomson-CSF at the 1991 ESPRIT conference exhibition showing how road freight operators could obtain graphical information on likely transport difficulties for various routes through Europe using live communication of graphical data stored on different systems in several European countries. The ARGOSI (2463) R&D has already contributed to international standards, including FTAM (file transfer access and management), CGM (computer graphics metafile) and CGI (computer graphics interface). With regard to products, Thomson-CSF has ported an FTAM product with CGM-FTAM document types to the French CETIA workstation and upgraded the Tecsiel FTAM product to manage CGM-FTAM-type documents. The results of the work have been widely disseminated and demonstrated at several other international conferences.

Ahead of the market in workstations

The development and delivery of multimedia applications depends upon the availability of suitable workstations. A series of related ABHS-P workstation projects has been carried out by leading European companies in a step-by-step approach to helping European industry catch up with foreign competitors in this lucrative market. The R&D has already helped European companies to enhance their workstation products, and to position themselves to take a share of the 1990s market for multimedia workstations. In this field, the R&D is coming to fruition in MULTIWORKS (2713).

The MULTIWORKS R&D is being undertaken by a consortium comprising some of the most prominent European computer manufacturers such as Olivetti, Bull, BNR Europe, AEG Elektrokom and Philips. Building on the results achieved under a range of earlier workstation projects, MULTIWORKS is developing a family of multimedia workstations, including both authoring and delivery systems. The key results of the R&D became available during 1992, two years before the expected development of a high-volume market. In this way ABHS-P R&D has helped position key European companies

Results achieved by Thomson-CSF and partners in ARGOSI (project 2463) mean that users can have access to up-to-the-minute images held in databases distributed throughout the European Community. In this example, the images provide information about weather conditions, road works, traffic congestion and other information needed by businesses to plan their transport of freight as efficiently as possible from one Member State to another.



TRAJET : LONDRES - MILAN VIA PARIS

ready to compete effectively for the new market. The MULTIWORKS consortium has identified six areas where their results can be exploited: workstations, basic hardware components, hardware add-ons, operating systems, knowledge engineering tools and hypermedia.

The experience and results achieved by Acorn Computers in MULTIWORKS is helping the company to maintain a leadership position in this field, including the setting-up of a joint-venture company with Apple Computer and VLSI Technology. The three companies formed Advanced RISC Machines (ARM) in 1990, focusing on high-performance, low-cost, low power consumption 32-bit RISC processors for embedded control, computing, digital signal processing and portable applications. During 1992, ARM announced its first major success for the ARM 610 processor: its incorporation as the core processor in the Newton 'personal assistant' product line from Apple. The first Newton products are pen-based electronic notepads that intelligently assist the user in capturing, organizing and communicating ideas and information.

Complementary lines of R&D are providing the basis for products which can capitalize on the advanced workstations and networks to which they are connected. For example, KIM (exploratory action 5638) is researching the feasibility of a graphical user-interface that can facilitate user access to a diverse range of multimedia or other databases in centralized or distributed systems. An early prototype of the KIM system has been customized for the European Space Agency in Frascati, where it is being used to help define the requirements for a larger query system. In related work, TOOTSI (2109) has defined a user-friendly common interface to a range of information services and has incorporated this in an early product, TOTO. Work on linking document production to databases in SUPERDOC (2170) has helped the companies concerned to launch an innovative product, ENGRAFO, which runs on a variety of different platforms. Developments such as these are helping European companies to present a credible range of European products for business users of advanced workstations.

Integrated enterprise-wide systems

Advances in technology and specific applications, whilst technically challenging, are not ends in themselves but means of improving the integration of the various different functions of an enterprise so that it can operate more effectively and efficiently as a whole. The R&D in ABHS-P has been helping European companies to develop a base for competitive European products to meet the need for integration and harmonization at three levels: the workgroup, the enterprise and the Community.

The workgroup

PANDA (5432) has developed a combined workflow/exception-handling plus case-handling/workstep system for the integrated handling of dossiers or folders relating to cases. The key characteristic of the system is its ability to improve the efficiency with which dossiers such as insurance claims are managed and processed. The focus is on well-structured work that can be described in terms of well-defined procedures, and in this respect PANDA complements the earlier MIAS (2684) system, which supports managers and professionals working in less structured contexts. The PANDA and MIAS results together form the basis for a new generation of office communication products.

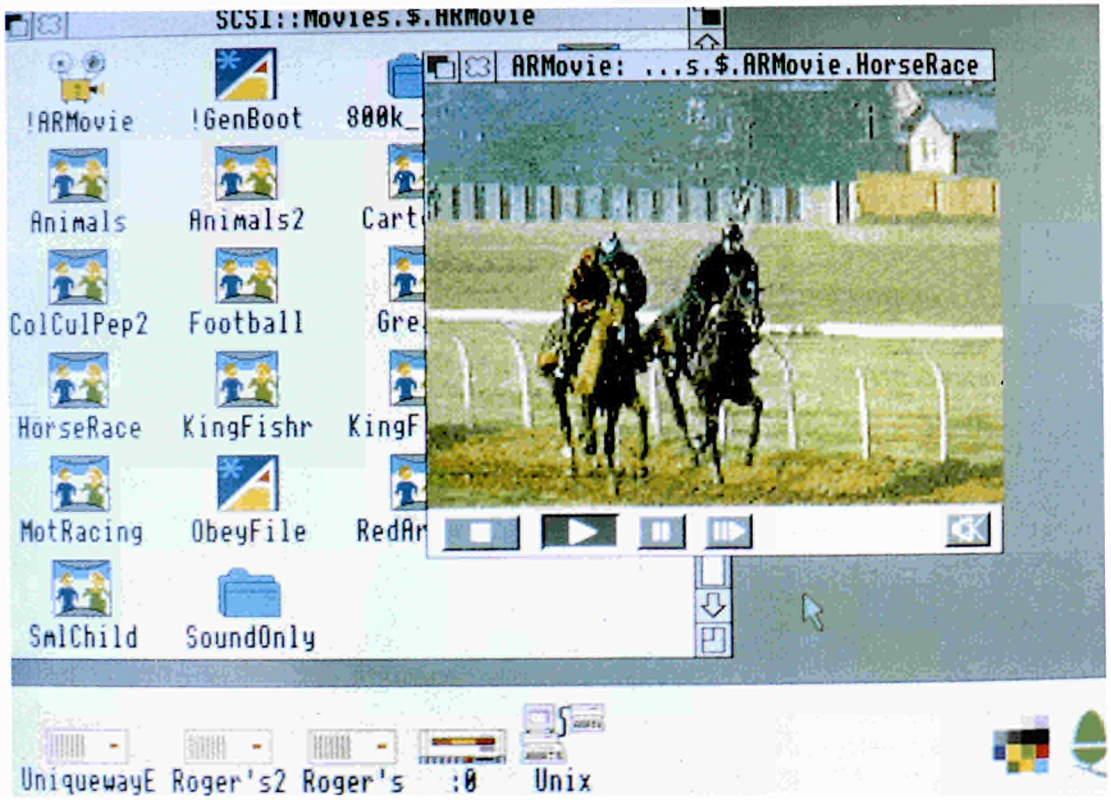
Emerging as a key element in IT support to the workgroup is the need for efficient personal information management, including use of a diary, address lists and other facilities. One of the early products to be launched in this field based on ABHS-P R&D is the Triumph-Adler Personal Information Manager. Both this and the EuroCoop Activity Coordination Tool-kit (both resulting from EUROCOOP, 5303) were presented at the Cebit '92.

The enterprise level

Providing support at the level of the individual workgroup is important but needs to be seen within the broader context of support to the enterprise as a whole, supporting the integration of different workgroups and functions across different organizational divisions and physical sites. Several ABHS-P projects have examined the needs of various types of organization and have developed generic solutions that can be tailored to fit the particular contexts. These generic solutions are being demonstrated in working applications within user organizations participating in the research. The following examples illustrate the kind of results being achieved in this area.

European hospital information systems. In RICHE (2221), Staf, Bull, IMS, the UK National Health Service and other partners have been working with hospitals throughout the European Community to develop an integrated European approach to hospital information systems. Previously, where such systems existed at all, each had been developed locally. This was expensive and meant that data generated in one system could not easily be transferred and used in another. Alternatives to local development were available from non-European sources but were developed with a different, non-European health environment in mind. The RICHE consortium has worked with a large number of major European hospitals and hospital administrations, including the UK's National Health Service, to develop an agreed set of standards to which European systems will be built. A RICHE special interest group has been established, and results are being validated with users in various countries including France, Italy, England and the Netherlands. During the past year, working prototype systems have been established in several domains including planning of patient care, daily activity management, nursing care and medical care. This represents a coordinated European approach to hospital information systems that is in advance of any competitive approach in the world.

European retailing after 1992. The R&D in EUROSHOP (5346) has already enabled SNI to incorporate a wireless connection between points-of-sale and a server into its product range. The wireless connection was presented at Cebit '92. In another aspect of the R&D, El Corte Ingles has developed a software package which can accept all the Spanish payment cards, allowing them to be used for electronic payment of goods through an integrated system. SNI and Sligos have founded a company, ERFIS, to market results from the R&D, and the system has already been installed in almost 100 stores in a Spanish fashion chain. The companies involved in the R&D have also established a special interest group and a retail application platform group (RAP). Results have been disseminated through a workshop on customer-computer interaction held at the



A multimedia screen incorporating full-motion video produced by Acorn, based on the results of MULTIWORKS (projects 2105/2713).

Fourth International Conference on Human-Computer Interaction (Stuttgart, 1991).

Other application areas. Generic European solutions for integrated systems are also being developed across a broad range of other application areas including, among others, financial management, technical in-house publishing, mobile working and large-scale public events. These have been carefully selected for their usefulness in providing the industry with a breadth of experience appropriate to the diversity of applications for which customers are seeking IT solutions. In the case of financial management, a leading-edge system using neural networks to forecast exchange rates was demonstrated at the ESPRIT 1991 conference exhibition by FOES (5653). SPRITE (2001) has developed a prototype integrated in-house publishing system offering greater integration at lower cost than any known competitor. In the case of mobile working, ELO (2382) is developing a system to integrate information and communication technology functions at both the hardware and software levels under a single user-interface. The result will be a highly task-oriented 'elusive office system' supporting mobile workers in their activity planning and communication activities. The ELO support-ware package addresses issues concerning the introduction and use of technology in organizations, including training, user-acceptance and other issues. In the case of large-scale public events, the R&D has focused primarily on the need for security. MORESYS (5470) has developed a 'hands-free' access control system for buildings and other areas. It was used in the main building in Albertville during the 1991 Winter Olympic Games. People requiring access to the building were given badges to wear which permitted or barred access to particular areas by controlling gates according to the system program and data stored on the badges. The system is also permanently installed in a major building in Paris, and is also being tested on ski-lifts in several Spanish ski resorts.

Working in a multilingual community

The work of individual workgroups within enterprises, and of enterprises themselves, needs increasingly to be considered within the context of global markets and, in Europe, in the context of the multilingual European Community. The diversity of natural languages that need to be considered in designing, producing, marketing and supporting products and services poses a challenge to enterprises that can significantly affect their competitiveness.

A forex (foreign exchange) trading room: customers switching money from one currency to another can gain or lose substantial sums depending on the accuracy of their forecasts. Results achieved by Concept Logiciels Expert and partners applying the latest developments in neural network technologies in FOES (exploratory action 5653) have been shown to improve the accuracy of exchange rate forecasts significantly.

TWB (2315) has made a significant contribution to reducing this problem by developing a 'translator's workbench', demonstrated at the ESPRIT 1991 conference exhibition. The system provides a set of tools to support the professional translator in the pre-translation, translation and post-translation processes involved in document translation. The system is aimed primarily at supporting the growing demand for technical and commercial translation but many of the tools also meet a need for improved multilingual secretarial support. The results of the R&D are enabling the European IT industry to gain a competitive edge in specially designed systems for supporting secretarial work. These systems are likely to become increasingly important in the European Community of the 1990s and beyond as barriers to the free movement of people and goods are progressively removed, with a concomitant increase in the exchange of business information in different European languages. Several modules have already been marketed by Triumph Adler, L-Cube, UPC and the University of Surrey, and are used in the translation department at Mercedes-Benz.

Advanced tools for supporting the system life-cycle

A key part of the ABHS-P R&D has been aimed at developing the advanced tools needed by European IT companies and user organi-

zations to support the system life-cycle, from early concept stages through building of the system to implementation, administration, maintenance and ongoing evolution.

Strategy and planning

The need to raise customers' awareness of the potential of IT applications and to provide a framework for planning applications has been addressed in IT-USE (2144), which uses multimedia technology to present the results of research and experience in a way that can help user organizations plan effectively for IT. In a complementary line of development, ACIBS-D (5444) has developed a computer-based planning tool to help user organizations highlight issues involved in integrating heterogeneous systems and to align their plans with their business objectives.

The picture shows how the badge system developed in MORESYS (project 5470) allows hands-free access control to, in this case, a ski-lift. The reader is at top left.

To ensure that advanced system developments can take due account of their wider implications for society and the quality of life, a set of software tools for developing scenarios describing the likely impacts of different IT developments has been developed in QLIS (5374). The work created considerable interest at the Fourth International Conference on Human-Computer Interaction in Stuttgart in 1991, and three of the largest industrial companies in Europe (Ferruzzi, Fiat and SNI) are committed to using the tools. The work on QLIS helped Cap Gemini Sogeti to understand software development and management needs when introducing process modelling and enactment technology, and in this way helped in the development of Process Weaver (mentioned below), one of the first products on the market targeting this technology. Complementary R&D is being conducted on the needs of particular domains such as IT systems in the context of urban planning (HERMES, 5405).

Tools for application developers

The key work on tools for application developers is being done in the development of an integrated tool-kit in ITHACA (2705). Commercial exploitation of ITHACA's results by the industrial partners has already begun: of particular note is the release by SNI in July 1992 of COOL, an object-oriented language designed for application programming. COOL is meant to play the same role in the object-oriented world as COBOL has played in traditional business systems. Bull has started marketing the ITHACA-Go graphic objects package through OEM channels, and is also marketing a workflow product, FlowWorks. Other exploitation has taken the form of using the ITHACA tools to develop applications for clients in banking, finance and public administration. The R&D has also continued to contribute to international standards, mainly through the international Object Management Group (OMG).

An important aspect of application development is quality control. In the case of large, geographically widespread companies, or a consortium of different companies, this may require reconciling the need for standardization across the organization as a whole with local flexibility. The results of HECTOR (2082) have enabled Cap Gemini Sogeti to develop and implement for in-house use an organization-wide quality control system, PERFORM. PERFORM focuses on standards for management and management of system development whilst allowing for local variation and creativity. The R&D has also supported the development of Process Weaver, a product for modelling the software development process and supporting its implementation. Process Weaver is being used on a test-case basis in three different working environments (by Cap Gemini Sogeti professionals, engineering students of the Université de Grenoble, and the space shuttle software development team in Houston).

Tools for system administration

As business systems become more complex, so do the demands on system administration. TOBIAS (2294) is helping to meet this need in work on an object-oriented tool-kit for system administration in distributed systems, aimed especially at a heterogeneous Unix and PCTE environment. In a complementary line of development, ISA-DEMON (5199) is developing a prototype of a commercial product for graphically monitoring a distributed system or application. The work is nearing completion and a presentation of some of the results was made to the European special interest group in distributed systems management at Imperial College, London, in July 1992. Strong interest has been signalled from the American market.

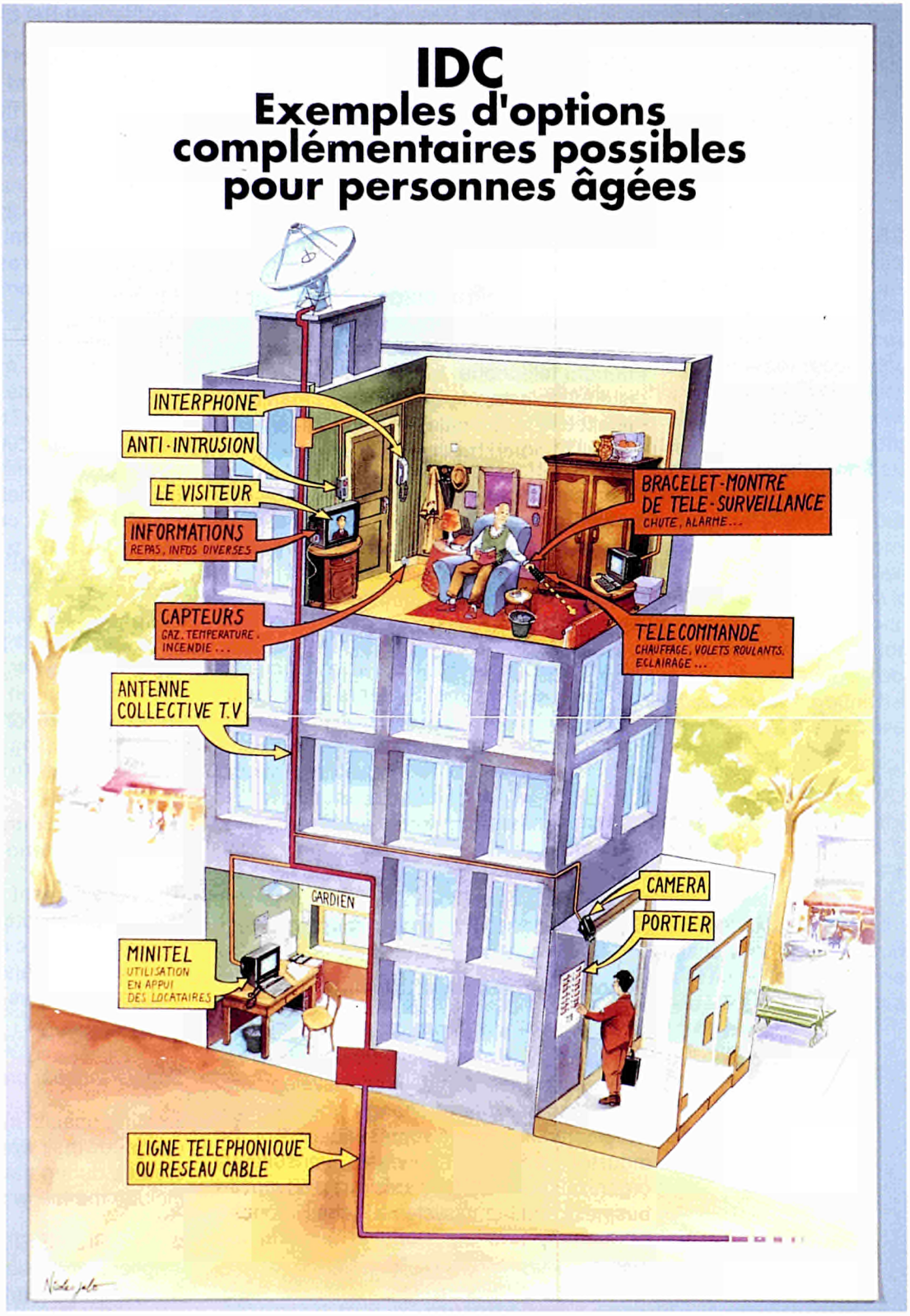
Home systems

It has already begun to appear in homes in various ways, and this trend will continue during the 1990s. The major difference will be that integrated systems supporting a wide range of functions will become much more common. Integrated home systems and systems for buildings will provide benefits during the 1990s in terms of energy saving, effective communication, emergency management and safety. Other important target areas include entertainment, teleshopping and health-care. The systems will be complex, but the incorporation of user-friendly controls will enable the user to become accustomed to increasingly sophisticated equipment that will bring subtle but significant improvements to the quality of life. Visitors to the 1991 ESPRIT conference exhibition were able to enter a demonstration home showing some of the key features of integrated home systems, based on concepts incorporated into the proposed HSS developed with support from ABHS-P R&D. An exhibition and conference devoted to home systems for the disabled was held in Chambery, in conjunction with the 1991 Winter Olympics and Para Olympics.

Home systems represent a major opportunity for the European IT industry in the coming decade and the key European players (the big competitor companies) have been well coordinated under the ESPRIT programme as part of the ABHS-P R&D (especially in HOME, 2431, further developed in IIH, 5448), enabling European industry to catch up with the Japanese and Americans and now take a leading position. The standards which

The hands-free access-control badge system developed in MORESYS (5470) used to control access to a ski-lift.

An illustration of how the quality of life for the elderly could be enhanced through the use of integrated home systems supporting a wide range of functions. Research into home systems is well coordinated in the ESPRIT programme, especially in the HOME (2431) and IIH (5448) projects.



have emerged from this work (embodied in the proposed HSS) have been well supported by the industry and have already been submitted to the appropriate standardization bodies including ISO, IEC, CENELEC and other interested bodies.

The R&D has provided a good basis for commercial exploitation by the companies involved. For example, it has enabled SGS-Thomson Microelectronics and Philips Microelectronics to collaborate on the integrated circuits needed to use the mains as the basis for a

local area network serving the home, so the cost of installing special cabling can be avoided. Philips has developed the necessary protocol handlers whilst Thomson has developed the power line modems. The integrated circuit chips are being used by a consortium installing home automation products in 20 000 homes in France. The system will be used initially for security and energy management applications. In future it will be able to offer additional services such as PSTN/ISDN gateways, opening up the possibility of remote meter-reading, building-management functions and value-added services to be provided through telephone lines or the electricity distribution network. The potential market for the circuits is estimated to be of the order of several hundred thousand units in 1993.

Other contributions to product developments during the past year have included a user-interface simulator and infra-red communication system (developed in HIVE, 5140) which Bang & Olufsen are using in their product developments.

A key milestone has been the establishment of the European Home Systems Association (EHSA), set up by the partners in the ABHS-P R&D to provide continuity for home systems activities across a broad industrial platform. The EHSA will help manufacturers take the steps needed to bring home systems products to the market.

Accompanying measures

Encouraging strategic thinking

The occasion of the 1991 ESPRIT conference was used as an opportunity for a special session on 'market, competitors, development, future: dimensions of change and strategic developments', where representatives of the industry and independent consultancy organizations described a vision for advanced business and home systems in the European Community and the world at large in the 1990s.

Encouraging market awareness

Reflecting the strong emphasis on market orientation in the ABHS-P R&D, the Commission has made arrangements with a leading marketing research company, IDC, to facilitate access to market information by companies working on ABHS-P projects.

Facilitating the industrialization of results

The main focus of the ABHS-P consortia working in the second phase of the ESPRIT programme should now be on the industrialization of their results and on turning into market benefits the technological innovation and know-how they have developed. In order to provide help in this, especially to SMEs, a meeting was jointly sponsored with DG XVIII (credits and investments) and the DG XIII VALUE programme to put technological innovators in contact with investors interested in supporting high technology enterprises at various stages of the development of innovative products. The meeting was held in Delft in April 1992 and included presentations as well as opportunities for representatives of SMEs to meet with members of the Commission and financial partners in the Eurotech Capital Network on an individual basis.

Participants in ABHS-P R&D have been encouraged to take up opportunities presented by the VALUE programme in other ways as well, and this has proved to be of benefit during the past year. For example, VALUE has taken a key role in helping to launch the OPC (see below) and in helping specific projects, such as helping the start-up partners in MORESYS (5470) to prepare for rapid growth.

Encouraging European industry associations and consortia

The development of strong industry associations and consortia committed to European standards can be an important factor in helping to stimulate and direct a new market area. Two key examples in the ABHS-P area are as follows.

Special interest groups

Existing special interest groups (SIGs) have continued their work and new ones have been created during the past year. Current groups include the following:

- The RICHE SIG provides a focus for suppliers and users in the field of hospital systems to work together on developing a common, unified approach to systems capable of meeting the needs of European hospitals.
- The distributed systems SIG aims to encourage and facilitate cooperation between IT companies and customers in the field of distributed systems.

- During the past year, a new group has been formed in the field of European retailing in order to ensure that the industry cooperation developed during the R&D on EUROSHOP (5346) will continue beyond the project itself and facilitate the development of exploitation and strategic industry actions. The SIG includes IT users from the retail area and related areas such as banking and transport. The group is especially concerned with defining the demands for the use of IT up the year 2000. A second group, the EUROSHOP retail application group (RAP) has been formed to specify technical solutions and scenarios according to the requirements identified by the SIG. The RAP group includes companies from sectors such as consumer electronics and telecommunications as well as specialized SMEs.

- The European Home Systems Association (EHSA), formed initially as a special interest group, has received strong support from the industry and is evolving into a potentially significant association in the field of European home systems.

- The Open Phoenix Consortium (OPC) was formed during 1992 to exploit the results of the ABHS-P R&D in the field of workstations. Using an innovative process, the OPC will solicit technology from the industry and will deliver heterogeneous open computing technologies. The environment and portfolio of technologies will be fed by results from all the workstation R&D projects. The OPC is structured so that members have the maximum possible participation in shaping the future of a European heterogeneous open computing environment. The VALUE programme has strongly contributed to helping the OPC to analyse and define its business plan and to launch its activities. It is now fully operational in France, Germany and Spain.

Disseminating results

The companies participating in ABHS-P R&D are encouraged to disseminate their results as widely as possible within constraints imposed by the need to protect commercial exploitation possibilities. Companies and their research partners have generally responded very positively to this encouragement, which may typically generate dozens of publications and conference papers, with demonstrations of prototypes and other results at several exhibitions. Some of the key examples during the past year have been referred to in this chapter, although they are by no means comprehensive. The ESPRIT conference and exhibition in Brussels and the Cebit exhibition in Hanover have been among the events particularly well supported. Further information about publications and exhibitions can be obtained from the individual projects through the contact points given in the project synopses.

Videos

Some of the companies participating in the ABHS-P R&D are making use of videos to disseminate information about their work. For example, SNI presented two different PC-based digital video animations about the strategy and exploitation of results from EUROSHOP (5346). The video is permanently on show in the demonstration room at the SNI self-service centre in Paderborn.

Computer-integrated manufacturing and engineering

Overview

The challenge facing manufacturing industry

The EC manufacturing and engineering industries comprise the second-largest sector in the Community economy after the services sector (to which manufacturing operations also make a substantial contribution). They face unprecedented challenge and opportunity during the next decade for a variety of reasons.

With the coming establishment of the internal market of 340 million consumers, industrial restructuring can be expected to continue and the pace of mergers and acquisitions will accelerate. Japan, the world's most efficient manufacturing economy, will take advantage of the opportunity in several market sectors, and EC manufacturers will therefore have to more than match their products on quality, price, suitability and time to market. In some cases, strategic alliances with non-EC partners will offer the best chance for survival and growth.

The resulting management and organizational change, in which accountability is devolved to cost centres, profit centres and strategic business units, will require new forms of technological support. For example, advanced IT will be required to link geographically distributed production centres and to provide the means to supervise and control dispersed operations so that they may be directed effectively towards the overall goals of the enterprise.

The pace of product innovation is likely to increase as manufacturers seek to gain competitive advantage by introducing novel features that differentiate their products from the rest of the market. Increased interaction will be required between R&D, product design, production and marketing teams in order to reduce time to market. The management of information and IT will be key enabling elements in both facilitating management for change and supporting a multi-disciplinary approach to design and production.

There are two aspects to innovation: the innovation itself, and its application to some useful purpose. It is essential to pay as much attention to the latter as to the former. A significant challenge facing industry within the European Community during the 1990s will be to absorb new technology and to apply it strategically and imaginatively to achieve significant improvements and developments in business enterprise before the competition does so. For this reason a key issue is application awareness and technology transfer.

Responding to political priorities

Political changes in the republics of the former USSR and in Eastern Europe will lead to the development of a number of new market economies. The demand for adequate supplies of a range of consumer goods and the need for a better distribution structure will require rapid modernization in the manufacturing and construction industries and in the food and agriculture sectors. This will result in the opening-up of many new trade opportunities.

Reduction in defence spending by Western democracies as a result of the dissolution of the Warsaw Pact will lead to increased availability of financial and human resources for non-military production and to increasing emphasis on putting advanced technology to peaceful uses.

Legislation to protect the quality of the environment that is now in place requires the effective monitoring and control of industrial

processes and manufacturing plant, and the development of products and processes that are more environmentally-friendly. It is estimated that the demand for information technology for the environment in the European Community is now more than ECU 2 billion per year and will grow at a rate of 20% per year during the next few years. To this must be added the demand in Eastern Europe and the former USSR brought about by the need to restructure industry, clean up existing processes and reclaim areas laid waste by pollution.

In the process of improving cohesion between the most prosperous and the less favoured regions of the Community, the manufacturing sector is seen to be of key importance. The early application of computer-integrated manufacturing and engineering (CIME) developments is crucial to the survival of the manufacturing sector in these regions in order to enable them to compete on equal terms with efficient and productive manufacturers of high-quality goods, both within and outside the Community.

Emerging enabling technologies

By the mid-1990s a number of emerging information technologies will be sufficiently mature to play a significant role in engineering design and manufacture, provided that management understands their potential for improving the business enterprise. For example, high-speed digital data transmission networks and the ability to store, access, rapidly process and distribute large quantities of complex information will have major implications on how an enterprise is organized. It will become much easier for project-based consortia to be formed for particular purposes. Multimedia and video imaging techniques enable information to be communicated much more imaginatively between the individual operator and the computer, between different functions within an enterprise, and between different enterprises.

Architecture and communications

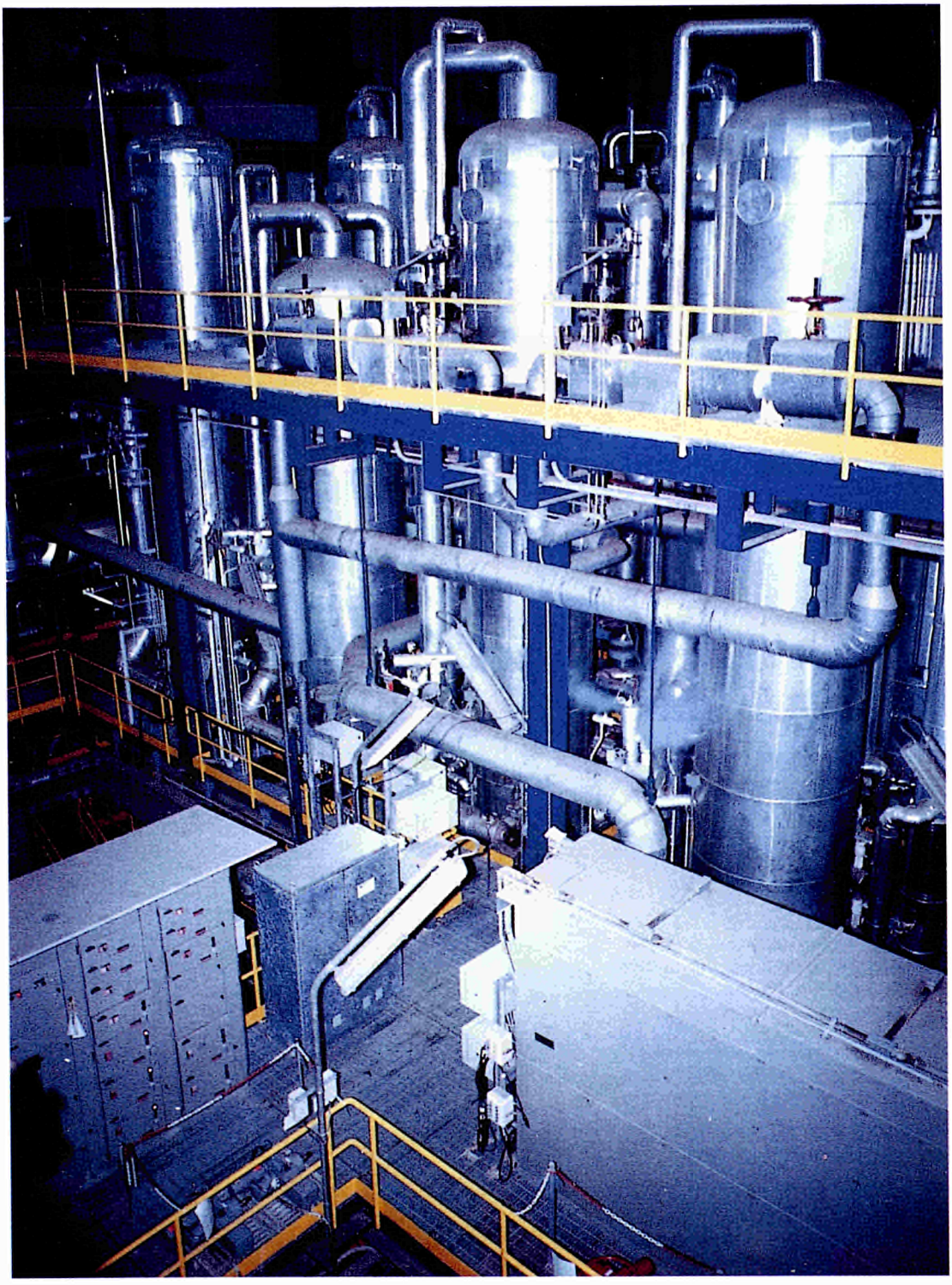
A fully integrated manufacturing environment requires open systems with sufficient functionality to provide a high degree of flexibility to users. A number of projects have been supported that make a contribution to standardization and product development.

One of the major cost elements in manufacturing plant is the cost of interconnecting the various sensors, computing and control elements that enable the plant to operate. These connections are greatly simplified by using a fieldbus: a single connection to the fieldbus is sufficient, with the routeing of information from one device to another taking place under the control of a computer. DIAS (2172) has developed the concept of integrating control, maintenance and management subsystems into one. The elements to be integrated are intelligent actuators and sensors, the maintenance system, process control, and the human-machine interface.

The first prototypes of the integrated system have, or are being, installed at three industrial sites for operational tests and demonstration: generating stations in Italy (ENEL) and France (EDF), and a chemical plant (Montefibre). The ENEL installation is at Piombino, where DIAS is used to control one of two lines of high-pressure feedheaters supplying one of the four 320 MW turbo-generators. The basic principle of a feedheating system is to preheat condensed water in a line of heat exchangers, with steam bled off from the steam turbine, before feeding it into the boiler. This improves the overall efficiency of the steam cycle. The DIAS system replaces all the operating and control apparatus on the feedheaters involved, and enables on/off actuators, modulating actuators, a flow sensor, level sensors and temperature sensors to communicate with upper-level subsystems by means of the fieldbus. The DIAS system provides more consistent, validated and integrated information than the system it replaces, and control and instrumentation wiring is greatly simplified.

DIAS has successfully shown that fieldbus technology works in a very arduous environment. However, before fieldbus products can be put on the market, much work still needs to be done on fieldbus standardization. DIAS has shown the importance of developing a means of standardizing the description of component functions: the standard description method employed allows the development of interoperable devices which are easily integrated into the system.

The FICIM (5206) project pools the fieldbus knowledge and experience of major European vendors, users and academic institutes from seven different countries. The project focuses attention on advancing fieldbus stan-



The efficient generation of electricity depends on the optimum control of the steam cycle. This line of feedheaters, in which steam bled from the turbine heats boiler feedwater, is now controlled by the DIAS (project 2172) system of distributed intelligent actuators and sensors.

dardization in a number of different areas: chemical plants, energy production, off-shore oil production, assembly lines, manufacturing cells and machine tools. The fieldbus implementation guide is now publicly available. A demonstration linking field devices such as sensors, actuators, input/output racks and local controllers with higher-level automation systems will be demonstrated in the FICIM-Namur plant in November 1992.

Trends in manufacturing and information technology

Since the beginning of the industrial revolution, manufacturing has moved through three stages: craft production, where skilled workers using simple, flexible tools, made exactly what the customer required; mass pro-

fessionals designed and engineered the product and large numbers of semi-skilled or unskilled workers produced standard components in large volumes from expensive dedicated machines; and now 'lean' production, where the advantages of craft and mass production are combined using teams of multi-skilled employees and highly flexible manufacturing processes to produce both volume and variety at low cost.

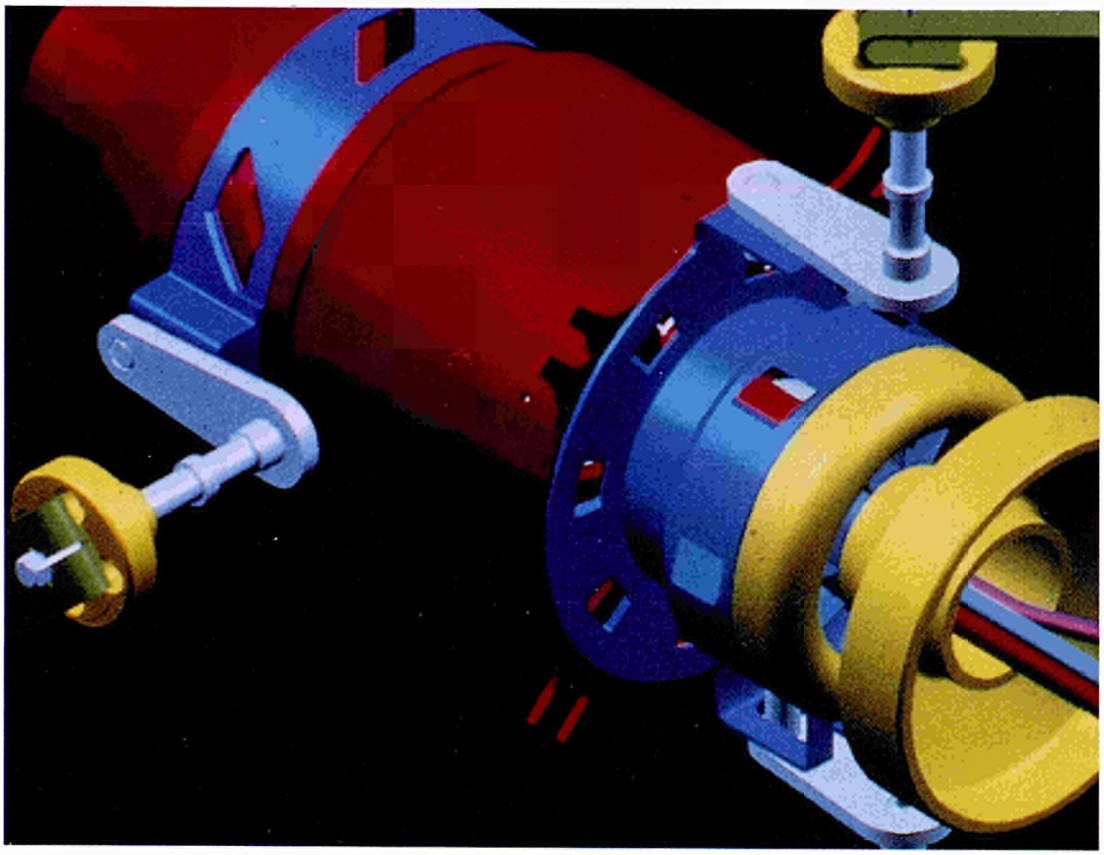
Lean production uses less of everything compared with mass production: less human effort, less development time, less manufacturing space, less investment in tools, and less waste and pollution. It results in fewer defects, a higher-quality product, and a greater variety of products to meet different needs and requirements. To apply lean techniques effectively requires leadership, teamwork, communication, target-setting and simultaneous engineering. Such techniques require less time for developing new products and putting them into production, and the lean producer can absorb new products without having a major impact on either productivity or quality. Lean design, coupled with efficient product development, enables a rapid expansion in product range and more frequent product renewal.

The assembly of products is an exercise in materials logistics and is dependent upon having good supply chain management. Lean producers assign whole component assemblies to their main suppliers, buying in complete assemblies and sub-assemblies, rather than buying in individual parts and then assembling in-house. This approach needs a good steady relationship with the suppliers concerned and a very efficient and highly automated ordering system. The passing of design information between assembler and supplier and down the line to sub-suppliers needs specialized IT support if the integrity of geometric data is to be guaranteed.

Increasingly, it is necessary to examine manufacturing systems within the broader context of the environmental impact of product and process. The effect of developments in IT is to enable the extension of the field of control of industrial systems. Water, air and soil monitoring systems and control systems using a variety of optimization techniques offer considerable potential for the use of IT in areas such as data acquisition, processing, communications, storage, processing, analysis and presentation, together with its application in industrial and agricultural operations. More far-sighted industrial operators have already realized that pollution associated with production means unnecessary waste and loss, and are using IT to achieve a greater degree of economy in

In the Bayer AG Brunseuttel chemical plant in Germany, a FICIM fieldbus (developed in project 5206) will improve the links between field devices (such as sensors) and higher-level automation systems.

manufacture and thereby gain a strategic advantage over their more wasteful competitors. To meet the increasing public pressure for clean manufacturing requires consideration of environmental effects at all stages of manufacture, in use and during disposal.



The results of CADEX (project 2195) help different CAD systems to exchange geometric or finite element model data.

Clearly here IT has a significant role to play.

Product design

A major contribution to improving competitiveness in the manufacturing process is the provision of the means for exchanging design and engineering data within the single enterprise, between a contractor and subcontractors, and between contractors and clients. CADEX (2195) has produced a data exchange tool-kit that is now available at low cost to companies for the development of STEP processors. Vendors in the CADEX project have started developing their own products based on the results of the project.

The increasing level of technical sophistication and the growing competitiveness of an increasingly open world market force engineering companies to provide more competitive products in a shorter time. This affects the whole company, especially the design office. Providing competitive products in the required time-scale can only be achieved through the cooperation of several design engineers working simultaneously on the same project. Current CAD technology does not support concurrent working, and much effort is wasted in manual coordination of the work and, in particular, verifying the consistency of design decisions made in parallel by several designers. The use of design standards and standard parts throughout the design of a product can substantially reduce production costs and make the company more competitive. A CAD system for concurrent design must therefore encourage the use of design standards and standard components by making the relevant information readily available to designers in a manner which is obvious to them and which does not require the use of the kind of complex system commands that interrupt the creative design process. CACID (5168) is tackling these issues by developing and implementing a pre-production prototype CAD system that supports concurrent engineering design activities. CACID integrates standard parts into the design process, with the possibility of adding company specific standard parts. The project is improving current CAD technology by adapting and augmenting it to suit the practical needs of SMEs.

Management and control of industrial processes

Designers of complex large-scale industrial plant must accommodate many different requirements and constraints. At present the problems of chemical process design, design and tuning of regulators and controllers, optimization, instrumentation engineering, etc., are addressed one at a time. However, to design safe, easily controllable plant that is efficient in terms of capital and operating costs requires an integrated approach that brings together advanced tools from different engineering fields.

The EPIC (2090) project is developing a workbench (an integrated design framework) that provides methods, techniques and tools to support the preliminary design steps of continuous processes. The workbench prototype has been tested out on part of the fluid catalytic cracker unit of Motor Oil Hellas. Case studies have included the redesign of the regulatory control system and applying optimizing control to the existing unit. The effect of changes to the process have also been examined. The results of these case studies have ensured that EPIC's participants will continue collaboration beyond the end of the project to develop competitive market products.

The management and control of production systems require a high degree of fault tolerance. In addition there is a need to exchange formalized descriptions of products and processes between manufacturers and the suppliers of components and manufacturing equipment. Besides agreement on standardized product models, appropriate protocols are required for transmission of data and the information needed to control the flow of goods from one plant to another at the right time. Current work aims at the development of methods, tools, interfaces and architectures which facilitate the exchange of technical and commercial data between independent organizations working in a distributed manufacturing environment. This work is closely related to developments in the field of EDI (electronic data interchange).

The involvement of Pirelli in ESPRIT dates back to 1985. Two projects have already been concluded (932 and 2434), and one is in its final stage (5114, DIREK). These activities currently involve eight different Pirelli tyre factories within five Community Member States (plus Turkey), the tyre sector headquarters in Milano, and Pirelli Informatica, the IT company of the Pirelli Group. Nine systems have been developed and installed for the manufacturing area and are today running on a routine basis, as shown in the diagram below.

The approach adopted by Pirelli in the development of such systems is based on the selection of one or more pilot factories combined with the setting-up of international, multisite working groups who deal with each project from start to finish. This results in systems which are fully consistent with customer needs and represent a fairly broad cross-section of technologies, thus enabling the easy implementation of the system in other sites. Internal exploitation of project results throughout the whole Pirelli Group, including both tyre and cable production, is of key importance to the Pirelli strategy.

This approach has already proven successful in several projects, leading to significant and measurable benefits, such as increased productivity, more timely reactions to shop-floor perturbations, reduction of out-of-stock situations, reduced levels of scrap and rework, higher job satisfaction, and a better understanding of factory performance.

Pirelli's successful involvement in ESPRIT is attributed to the use of a total project management approach, which provides the fully committed participation of the shop-floor through to the highest level of corporate management. This has ultimately been achieved thanks to the close consistency between ESPRIT objectives and Pirelli's CIM and IT development strategies. The main benefits and trade-offs include reduction of the product introduction time, shorter, more reliable delivery lead times, reduced costs, lower stocks, and improved product reliability

CIM for multisupplier operations

Although there are examples of companies that successfully manage their supply chains, there has, until recently, been little documentation or understanding of how their success can be replicated. A significant result in CMSO (2277) has been the identification of the need for companies to manage affairs beyond their immediate supplier and customer relationships. This has led to the

The fluid catalytic cracker unit of Motor Oil Hellas in Greece, where the process plant design workbench developed in EPIC (2090) has been evaluated.

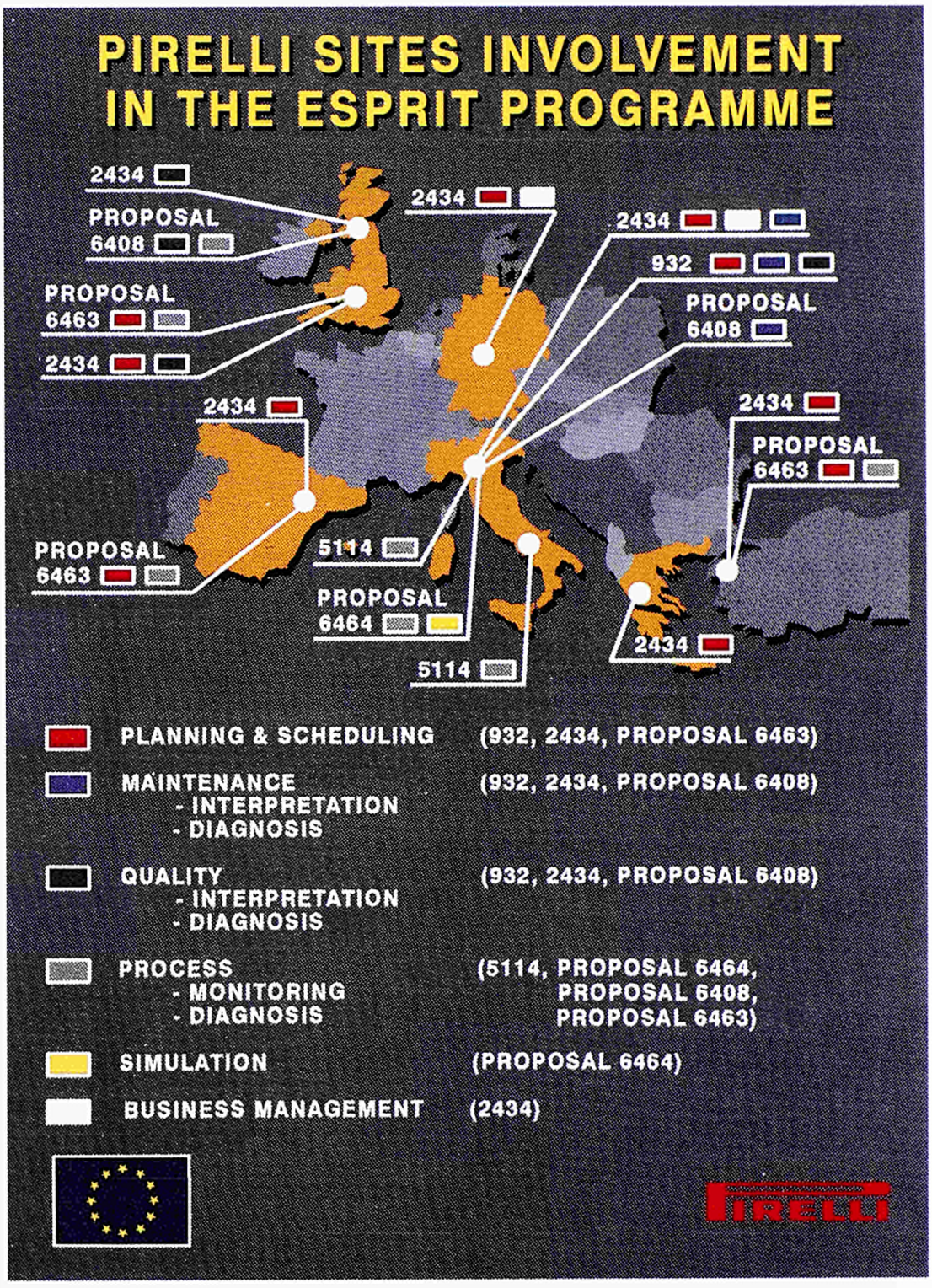
development of a supply-chain methodology that enables organizations to map their supply networks and to evaluate the possibilities for simplifying and improving them. The methodology has been applied to compare manufacturing chains for different products in different countries in the car industry. The principles are obviously applicable to other industries.

'One-of-a-kind' production

'One-of-a-kind' production encompasses sectors such as shipbuilding, aircraft and satellite assembly, large civil engineering projects and process plant construction. Here products are often designed to a customer's specification, and each is unique or almost so. The product may comprise a large number of product elements, each of which is a complex product in its own right. Manufacture may involve an extensive network of contractors and subcontractors and call for a high level of project management, with thousands of work-packages needing to be controlled. The products are expected to have a long life (in some cases decades), and this requires the management of large databases of product information for design, manufacture, assembly, commissioning, maintenance, repair and decommissioning purposes.

ROCOCO (2439) has developed a reference architecture for 'one-of-a-kind' production on construction sites such as those found in key sectors such as the process and power plant industries. The findings have been demonstrated in a Bremer Vulcan shipyard where the production problems in manufacture and assembly of pipework are representative of the shipbuilding industry. Many ship systems have large amounts of pipework, and the production, tracking and installation of pipework presents major problems to the shipbuilder and, if not properly controlled, can add significant cost and time delays to the project. Major results from ROCOCO include an improved user-interface management tool, a jobcard interface terminal for harsh workshop or construction site use, a gateway computer to connect IT tools for marking components and capturing data to host systems, punch- and paint-marking equipment, improved computer vision equipment for data capture and identification, software for calculating work content to support planning, scheduling and cost estimating, and a scheduling tool to support consultancy, planning and scheduling.

Pirelli has extensively contributed to and benefited from the ESPRIT CIME programme. Activities currently involve eight different tyre factories, the tyre sector headquarters, and Pirelli Informatica. Nine management and control systems have been developed and installed for the manufacturing area based on the results of projects 932, 2434 and 5114.



CIME investment

It has long been apparent that SMEs are not installing CIME solutions in anything like the numbers expected, perhaps because they do not see how CIME can support their business objectives. The CIMPLE (5424) project set out to communicate the value of CIME solutions to SMEs by developing a set of tools that would first define the CIME requirements of an SME and, second, propose specific CIME solutions that support those requirements. A subset of the CIMPLE tools, the fast track modelling (FTM) toolset, allows the user to quickly build

a model of the business enterprise. Using the model, the business objectives can then be defined and rated so that the primary objectives of the enterprise are identified as priority goals for CIME support. This allows the specification of a set of generic CIME tools of proven value in the support of the business objectives of an SME in a particular class of enterprise. This generic specification of requirements can then be converted into an invitation to tender that can be sent out to CIME vendors. A measure of the project's success is that the industrial partners are continuing their cooperation in order to turn FTM into a commercial product.

Machine tool industry

The Community's machine tool industry, mainly comprising SMEs, is of great strategic importance, supplying critical technology to engineering industries and exporting more than a third of its output outside the Community. It accounts for 35% of world production and has a positive trade balance. However, the Community's share of the world market is declining, whereas Japan and other Far Eastern countries' market share is increasing.

The Community's machine tool manufacturers are typically small compared with their rivals. Japanese output is typically three and a half times that of European companies because they subcontract a greater proportion of their work, concentrating on final assembly. The small size of European firms has led the industry to develop custom-built and specialist machines. This concentration on market niches has to be balanced by being able to integrate machines within a CIM environment in which the client mixes and matches machines from different sources to meet particular requirements. The strategic use of an open systems approach by clients and suppliers would support the integration of machine tools, robots and mechanical-handling equipment into flexible manufacturing cells.

The mainstream targets and priority objectives for machine tools under ESPRIT are to:

- integrate machine tools with open manufacturing environments using the enhanced integration capabilities of a machine tool architecture;
- implement a concurrent engineering approach in the design and production of machine tools by means of closed-loop information management;
- improve overall machine tool accuracy while reducing the associated cost;
- increase machine tool availability by improving the reliability of machine tool components using fault-tolerant control of functionality, and improving productivity by using CAD/CAM data management techniques.

In the new ESPRIT III set of projects, there are 24 participants belonging to the machine tool industry. Eleven are machine tool manufacturers and 13 are machine tool user/vendor companies of which 14 are SMEs. An interesting approach to collaboration is being pursued in the SINTOMA (6118) project. The partnership includes IDEKO, a group comprising eight small Basque machine tool manufacturing companies. The group is exploiting the technologies developed in the project over the full spectrum of machine tools manufactured by its members.

Automotive sector

As a leading-edge user of information technology and communications, the automotive industry stimulates and contributes to important new technological developments and provides outlets for innovative products.

With an increasingly complex end-product, car manufacturers and component suppliers are becoming dependent on IT-based design tools. Software is being developed for dynamic structural analyses that integrates fatigue analysis and acoustic radiation prediction with vibrational analysis, with the extraction of geometric data for other calculations based on finite element analysis. Initially, the exchange of data between design engineers, whether within one company or located at supplier sites, was restricted to geometric information. Now data exchange covers a broad range of product information including material properties, guidelines for use, methods of assembly and product costs.

Integrated circuits and embedded software are widely used in automobiles. There is also a trend towards systems integration. Elec-

tronic control units will act as intelligent computer systems, receiving and transmitting data to and from the automatic braking system, the transmission system, the suspension system, check panels, etc.

Industrial competitiveness depends on effective supply networks. For instance, in car assembly, more than 500 suppliers may deliver more than 10 000 different car parts, and this complexity must be controlled. Material, transport and handling costs are 10 to 20% of the total costs of car assembly, and material shortages in the assembly lines restrict output and add to costs. Keeping stocks is expensive and does not guarantee that parts are available. Because short delivery time, flexibility and preciseness of the material flow from the suppliers to the assembly line are critical to being competitive, it is essential to monitor and control the material flow from suppliers to the assembly line during production at the suppliers, transportation, the various material receiving and distribution stages, and up to the point where components arrive on the production line.

CMSO (2277) is improving the competitiveness of the European automotive industry through the application and development of methods, tools interfaces and architectures which facilitate the exchange of technical and commercial data between independent organizations working together in a manufacturing or distribution environment. This work is important because whereas in the Japanese automotive industry vehicle manufacturers and their major suppliers are often members of the same corporate 'family' and in close geographical proximity, the European equivalent comprises distinct and independent companies, within independent supply and distribution chains, each of which has its own corporate objectives. The main working areas of the project are the domain of interorganizational business processes within the logistic chain, the required logistics applications, and the integration of the underlying technologies.

Robotics and shop-floor systems

The purpose of TRIOS (2017) is to advance the state of the art in high-speed 3-D inspection systems. Two fields are being addressed: the inspection of advanced printed circuit boards, thick film circuits and die frames; and the precise, high-speed inspection of assemblies, such as surface-mounted devices, fibre-optic components, high-density connectors, and electro-optical and electromechanical subsystems.

The VIMP (2091) project has developed a non-contact inspection system for components manufactured in an FMS cell, based on real-time computer vision, that can measure to an accuracy of 10 to 100 microns. It enables the inspection of components on-line, reducing inspection time and increasing the rate of production. The system generates a reference image from data stored in the CAD system database and compares this with an image of the actual component.

A first prototype of the VIMP system was demonstrated at the 1991 ESPRIT conference exhibition. The demonstration showed the transfer of product model data using STEP; a planning system for inspection tasks; a simulation for optical data; a vision system oriented towards metrology; and a high-precision scanner carrying the acquisition and lighting systems.

The quality requirements of many metal-finishing processes such as grinding, deburring and polishing are strict and demand a high degree of human skill and attention. The work is strenuous, noisy, dirty and uninteresting. Workers are exposed to hazardous environments and to machine vibration. Automating such processes will lead to lower production costs, higher production and more uniform product quality. The ICI (2640) project has developed a prototype robot grinding cell, capable of a wide range of finishing tasks, comprising a grinding robot, tools, the vision system, the inspection robot and the cell manager. The demonstration grinding cell has been in operation in one of the factories of Metalworks of Attica, Greece, since January 1992.

The project represents a significant advance on the state of the art in an area where market needs are well defined. Zenon (GR) is commercializing the cell and will bring it to market before the end of 1992. The product will comprise a robot grinding cell and a robot inspection cell, either of which can be sold separately or with the coordinating software to unite the two into a combined grinding and inspection unit.

The ARMS (2637) project is specifying and developing a prototype robotic system for assembling components in the automotive and domestic appliance industries. The project addresses issues such as making off-line programming of complex tasks easier by using advanced graphical simulation tools, improving the speed and accuracy of the manipulator, developing special control algorithms for compliant motion using force and torque sensors, and improving the integration of sensors with the control systems. In mid-1992 the prototype manipulator, controller, off-line programming and the simulation packages were integrated and demonstrated in two experimental cells, one in the car industry and the other in the domestic appliance industry.

Application awareness and technology transfer

CIM-Europe

CIM-Europe, now in its eighth year, continued its role in disseminating information regarding the progress achievements and results of CIME, both to the CIM R&D community and to manufacturing industry. 1991/92 was characterized by a continued emphasis on public events (the annual conference and many workshops) and the launch of several new CIM-Europe interest groups, which now actively involve about 200 industrialists and researchers.

The highlight of 1992 was the eighth annual conference, with around 250 delegates, which was held in Birmingham, UK on 27 to 29 May and co-hosted by the DTI (UK Department of Trade and Industry). Over 50 presentations were given by world-leading experts, which placed particular emphasis on presenting the results of finished or ongoing ESPRIT CIME projects.

During 1991/92 special workshops and tutorials were held on model-based predictive control (Ghent), multisupplier operations (Stuttgart), strategies for implementing CIM (Valencia) and results of ESPRIT CIME projects (Bilbao).

Eight CIM-Europe interest groups are now operational, covering topics such as:

- change and innovation management
- product data technology
- identification systems and security
- user-interface development environments
- European manufacturing systems
- open CIM architectures
- CIM in the process industry
- computer-integrated design of industrial control systems.

The output of the interest groups includes overviews of the current state of the art, discussion papers on future research directions, and descriptions of experiences in introducing CIM technologies.

International collaboration

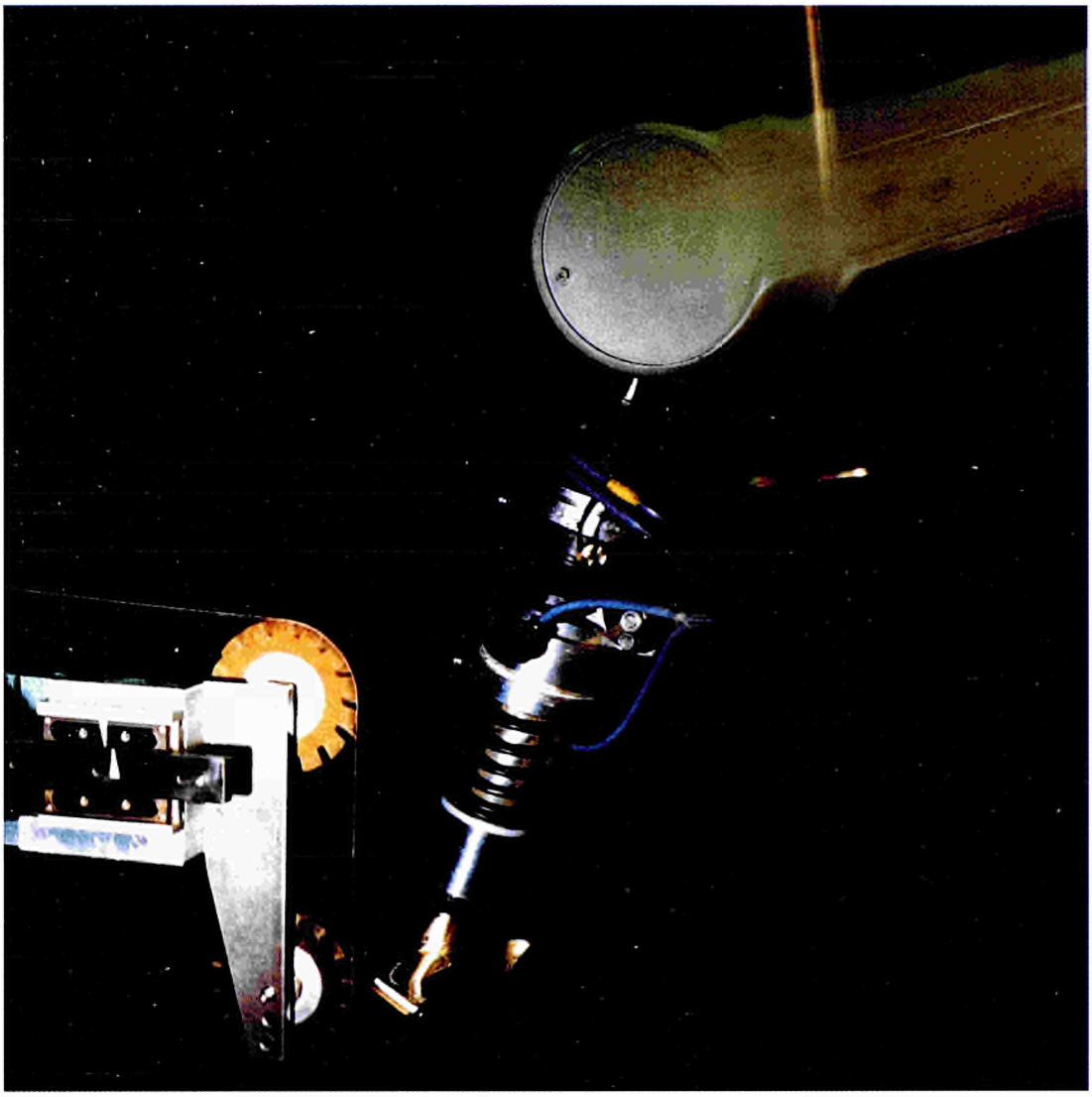
Intelligent manufacturing systems (IMS) feasibility study

In mid-1992 the operational framework for an international feasibility study on advanced manufacturing was agreed by high-level representatives of the industrial and research communities of Europe (the European Community and five EFTA countries), Japan, the USA, Canada and Australia. ESPRIT's CIME division is providing the European secretariat. The feasibility study is designed to examine the prospects for setting up a full-scale programme in this field, where it is felt that international collaboration could help improve manufacturing operations, many of which are increasingly global in scale. The proposed intelligent manufacturing systems (IMS) initiative would bring together researchers from industry and academia, initially drawn from the regions participating in the feasibility study. The study itself will get under way with a limited number of R&D test-case projects early next year. The test-cases are designed to determine if a full-scale IMS programme will be workable in practice, and to assess whether it would be likely to result in an equitable balance of contributions and benefits: the programme will not go ahead unless the prospects for achieving this are demonstrably sound.

The first European information event linked to the feasibility study operations was an IMS planning workshop, which took place in parallel with the 1992 CIM-Europe conference.

US/EC collaboration

Collaborative prenormative research activities are in the process of formation in five areas: product data-sharing, enterprise integration, production planning and control, industrial communications, and open distributed processing.



Pictured is the demonstration grinding cell developed in ICI (project 2640) in operation in one of the factories of Metalworks of Attica in Greece. The cell is being commercialized by Zenon.

Basic research

Overview

The year 1991/92 for basic research marks a watershed — the completion of actions started from the first call for proposals in 1989 and the recommendations for funding further work from a second call made in October 1991. Almost all the 61 actions and 13 working groups launched as a result of the first call for proposals in 1989 were completed, and 108 new projects, working groups and networks of excellence were initiated. The new projects and working groups are split roughly 60/40 between those continuing existing lines of work and novel research topics. About 75% of the proposals made in response to the first basic research call came from organizations new to the ESPRIT programme. The latest call for proposals again attracted a large number of newcomers. The proportion of new projects with industry participation has risen to 36%, up from 24% in the original actions, and includes a significant number of small and medium-sized enterprises.

An evaluation of the three pilot networks of excellence set up last year (3701 ELSNET, 3702 CABERNET and 3703 COMPULOG-NET) has clearly demonstrated the benefits gained by the institutions involved: formulating research strategies, coordinating research proposals and creating links with industry have all been facilitated for participants. These three original networks have now been extended, with additional members, into a second phase, and six new networks set up. In addition, the enthusiasm of the pilot research and industry participants has led to a widening of the role of networks to include activities such as joint ventures with industry and liaison with venture capitalists.

The VLSI design action, launched in 1989 to increase the number of students trained in VLSI techniques, has substantially exceeded expectations and has been extended for three years.

Objectives

The original aim of basic research in the ESPRIT programme was to support collaborative fundamental research in areas with a clear potential for eventual industrial use and impact (see Box 1).

The aim now is to prioritize and channel support to activities with a concrete, tangible application in at least the medium to long term (five to 10 years' time). The new priority themes (see Box 2) are intended to ensure continuity with ongoing basic research actions while introducing new research orientations with a clear potential for industrial breakthroughs.

Industrial applications, especially of research techniques, may of course emerge over a much shorter time-scale: for example, EPIOPTICS (3177) has already attracted the sustained interest of major semiconductor companies, and commercial use has already been made of results from TOPP (3260).

Eventual industrial use is facilitated by establishing methods for transferring basic research results downstream into precompetitive research or industrial development. The most effective method has proved to be the movement of people from academic research into industry, and such shifts have occurred in PROMPT (3109) and SPEC (3096), among others. The roughly 1 000 doctoral and post-doctoral students supported at any one time — accounting for a third of the basic research budget — make a significant contribution to this process.

Box 1: Basic research objectives

Objectives	■ Collaborative fundamental research ■ Support of long-term industrial goals
Selection criteria	■ Likelihood of industrial application ■ Clearly upstream from competitive R&D ■ Value-added through European collaboration
Broad areas	■ Computer science ■ Cognitive science ■ Microelectronics (microsystems, compound semiconductors, optoelectronics)

The stimulus of contact with different disciplines and methods is often the springboard for innovative research, and this is fostered in basic research by working groups and the networks of excellence. Working groups provide a forum for researchers in a common topic area to present papers and discuss their methods and results. Funding supports short scientific visits, workshops and conferences aimed at improving the systematic exchange of information between teams working on a common theme and so building up and then maintaining research momentum. Such groups have been very productive in publishing their proceedings in the past year: for example, COMPASS (3264) has published a survey of algebraic methods of programming, and WOIT (3199) the proceedings of a conference on state-of-the-art optics and optical computing (see the bibliography on p. 111).

Networks of excellence

Networks of excellence embody the principle of self-determination for the research community. A network contains a group of academic and industry research teams that share common long-term goals and have agreed to coordinate their research and training policies. To achieve these goals the network must have a critical mass of top-level researchers with the necessary skills and be equipped with a suitable communications and management infrastructure. Networks of excellence complement working groups: they provide a stable environment for broad interdisciplinary work that often crosses current research boundaries.

The core of the network concept is that network members draw up a strategy for achieving their long-term goals by formulating ac-

Box 2: Basic research themes

Area 1: Speech and natural language, human-computer interaction, computer-integrated manufacturing, robotics (sensing and control), computer vision, neural networks and neuroscience, adaptive signal processing, machine learning, knowledge engineering, uncertainty management.

Area 2: Logics and logic programming, symbolic computation, databases and information retrieval, distributed systems (reliability and dependability), algorithms, parallel computing and architectures, theories for concurrency and real-time specification and verification.

Area 3: Alternative semiconductor materials, devices and process steps, algorithms for design methods for circuits and digital optical systems, multilayered materials for silicon-compatible optoelectronics, nanoelectronics (including organic polymers and crystals), new concepts and materials for optical devices and optical computing, high-temperature superconductivity (low-current applications).

tions that make use of their different skills. Their complementary contributions improve the relevance and focus of research proposals, encourage the sharing of research tools, and foster agreement on standards. The resources of a network are ideally accessible from any of its nodes, not only to its members, but to industry and governmental bodies as well. By this means researchers are brought into closer contact with their markets, and innovative industrial enterprises gain access to the research necessary to sustain and develop their activities. In locations where a centre of excellence is not feasible, it is often possible to set up a network node: this attracts young researchers and so counters the drain of resources from regions that do not have a strong history of research. The provision of training is strengthened by using network skills and infrastructural resources to prepare new course material and offer extensive facilities to doctoral students.

illustrate, NEXUS (7212), the multifunctional microsystems network, will build on Europe's lead in the top-down approach to designing complete microsystems technology for volume and specialized markets, ranging from the automotive industry to health-care. This requires the integration of different methods, techniques and materials from CMOS technology to robotics. Standardization activities and strong industrial participation will be key to the success of this network. A total of nine networks were selected for Community support, three of which are the original pilot networks, which will continue reinforced with new members.

As networks become established, their communications and management needs grow, and standard high-speed networks will be required for the communications framework. Work on the technical standards, interfaces and a source of funds for implementation is already under way. The networks have the potential for spinning off innovative commercial enterprises, and measures will be taken to attract the venture capital required. This process will be encouraged by a comprehensive publicity campaign.

Box 3: Networks of excellence

High-temperature electronics — HITEN (6107)
Organic materials for electronics — NEOME (6280)
Language and speech — ELSNET (6295)
Distributed computer systems architectures — CABERNET (6361)
Multimedia information systems — IDOMENEUS (6606)
Machine learning — ML (7115)
Multifunctional microsystems — NEXUS (7217)
Computational logic — COMPULOG-NET II (7230)
Mesoscopic systems — PHANTOMS (7360)

Three pilot networks of excellence were set up in 1991 to test these ideas: speech and natural language, ELSNET (3701), with 25 founder-members; distributed computing systems architecture, CABERNET (3702), with 20 members; and computational logic, COMPULOG-NET (3703), with 52 members. Researchers embraced the network idea with enthusiasm: they made the necessary management arrangements for the three pilot networks, surveyed their network's resources, embarked on joint postgraduate training and mobility programmes, devised industrial affiliation schemes and summer schools, set up standards for network communications and research tools, and began the process of defining a research strategy and appropriate funding methods.

The success of the three pilot networks has generated proposals for new networks spanning interdisciplinary research (see Box 3). To

Results and evolving themes

Speech and natural language

The long-term aim of this work is to model the complete physical and cognitive chain from speech to understanding, with the end-goal of achieving direct, natural language oral communication with information processing systems and devices. Research on multilingual systems is of particular interest in a Community with nine major languages and a host of others. The ACCOR (3279) action

tackled the relationship between articulatory processes and acoustic output in English, French, German and Italian, by identifying the language-independent physiological characteristics of speech production and relating these to phonological rules. Lexicons in these languages were built with methods of labelling the data and modelling its use. The prototype multichannel speech workstation constructed is now commercially available. The ACCOR II working group (7098) seeks to further this by modelling the brain's representation of speech and its manifestation in speech output. Two more speech projects have been launched: SPEECH MAPS (6975), which seeks to map the transformation from articulatory to acoustic information, and WERNICKE (6847), which aims to design a speech recognition system using artificial neural networks and hidden Markov modelling.

The natural language lexical database produced in the ACQUILEX (3030) action has been adopted by the Cambridge University Press for a pilot implementation of a dictionary. The database includes methods for structuring hierarchies of semantically related entries and previewing typesetting on screens. ACQUILEX 2 (7315) aims to extend this to large multilingual dictionary databases; the consortium includes several publishers. The partners in DYANA (3175) worked on phonological systems, word ordering, and computer systems for developing and testing grammars. The grammar system has been modified for use by an industrial customer (Sharp Laboratories Europe) and further work is being jointly funded by Aérospatiale (F). DYANA II (6852) will extend this by examining natural language information states and semantics, developing grammar architectures and demonstrating their utility.

The work of both ACQUILEX and DYANA was presented in November 1991 at the Symposium on natural language and speech. The VOX (6298) working group, which has strong links with ACCOR and SPEECH MAPS, is a new forum for research into speech databases, and DANDELION (6665) is addressing the development of a language-independent theory of discourse.

The task groups in the ELSNET (3701) network of excellence have been extremely active. Network resources have been surveyed, and an integrated PhD programme established. A work programme has been drawn up that focuses on three medium-term tasks: unrestricted text-to-speech, multilingual access to text material and spoken language information systems. These building-blocks will be used for a fourth longer-term task, interpretation for face-to-face interaction. In addition, initial standards for network communications have been established. Publications so far include a survey and a book on the analysis and synthesis of speech.

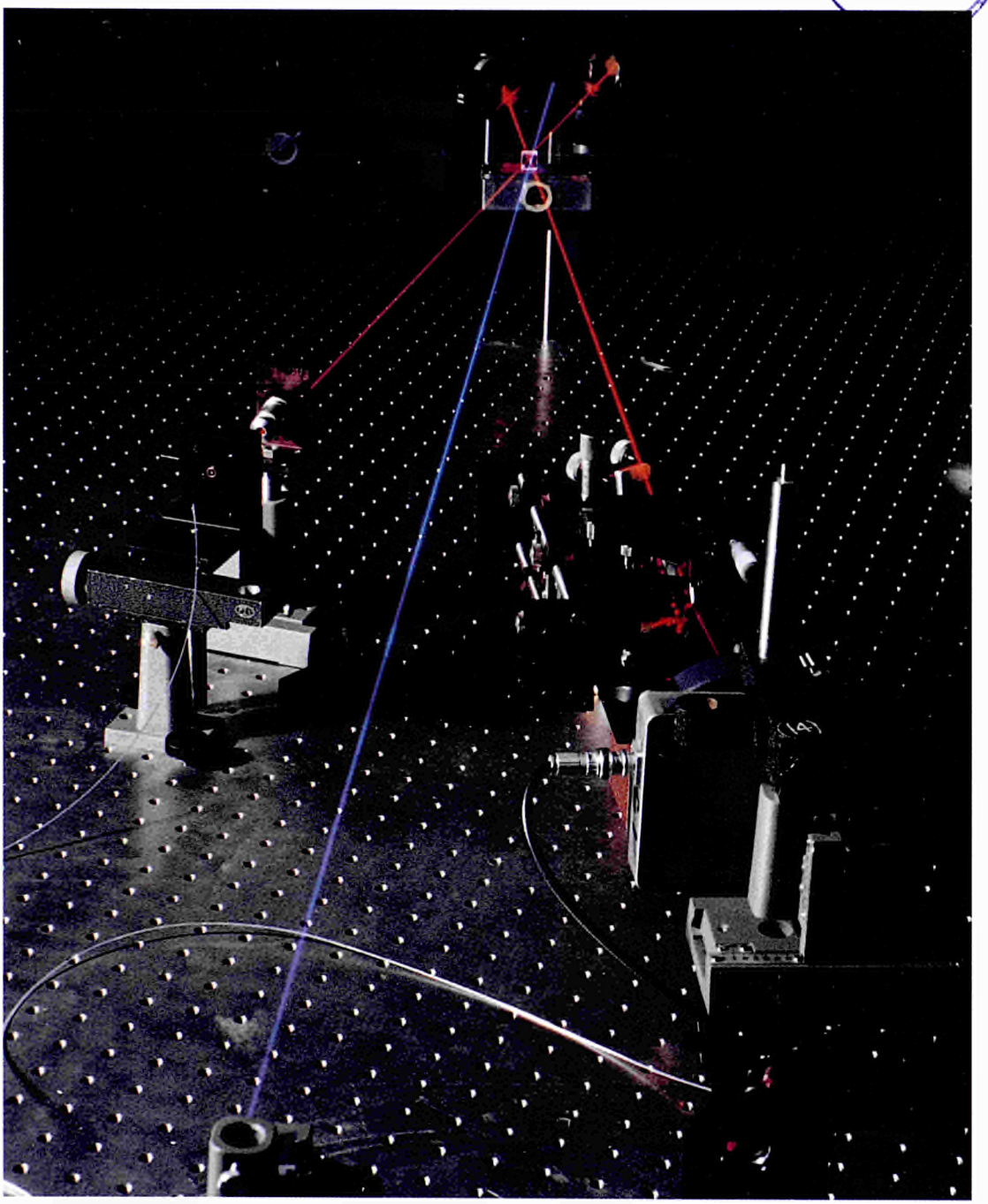
Human-computer interaction

The main aim of research in this area is to produce generalized predictive models of the interaction between humans and advanced systems and of the interactions between system users themselves. To this end, MOHAWC (3105) developed a taxonomy to make possible the systematic integration of results from different studies. The consortium conducted field and laboratory studies of human operators in areas such as medical diagnosis, nuclear power plants and aircraft pilots. The results include models drawn from control theory, time studies and simulations which have led to important conceptual developments and an understanding of decision making in work teams.

Agent notations for the theoretical modelling of interactive graphical systems were developed by AMODEUS (3066). These are being further developed in the continuation project AMODEUS II (7040), by extending the factors integrated into the design process model. Work has started in the new projects GRACE (6296) on the selection and combination of media, COMIC (6225) on a theoretical basis for computer-supported cooperative work (CSCW), and in SCATIS (6358) (whose consortium includes two commercial enterprises) on engineering aspects of virtual reality systems.

Computer-integrated manufacturing

The factory of the future action, FOF (3143), developed an integrated reference model of one-of-a-kind production, which contains all important known relationships and facts about production management. No particular line of approach is unanimously recognized as the most valuable by the CIME community, and consequently no new proposal was selected for funding. However, two working groups have been set up, containing a cross-section of the CIME community and including the members of the FOF consortium, with the intention of providing a more unified view of



A spin-off from NOROS (3186) makes use of a famous 'action at a distance' paradox postulated by Einstein, Podolski and Rosen in the 1930. A one-photon-per-bit communications system uses pairs of photons which are quantum-mechanically entangled — i.e., the state of one photon determines the state of the other. A patent has been obtained for the secure encoded communications system based on this principle.

the field and a broader basis for proposals in the future. They will consider the complementary areas of CIME modelling and prototyping.

Robotics

Basic research in robotics is focusing on the establishment of a theoretical framework for integrating the sensory and manipulatory aspects of the field. A very large number of disciplines contribute towards this objective, ranging from engineering to neurophysiology. Analogical representations of visual scenes were used by SUBSYM (3234) as a basis for planning and monitoring sensorimotor actions and generalizing them into classes for instructing robots. A camera/robot workstation was constructed to validate the results. To improve the flexibility and reliability of robots, FIRST (3274) examined the integration of sensing, planning and control functions. New algorithms for computing the visual properties of objects were developed (to be published by Springer Verlag), and an efficient method for planning the direction of flow in complex dynamic environments is being developed by SECOND (6769). In contrast, MUCOM (3149) built simulations of brain/eye

operations based on the measurement of eye movements and histological techniques. The continuation project MUCOM II (6615) is studying sensing and control in animals, and PROMOTION (6546) is examining motion planning.

Computer vision

A general-purpose vision system is the long-term aim of computer-vision research, with work concentrating on reducing the task-specificity of particular systems and broadening their applicability in the real-world domain. In March 1992 the VAP action (3038) demonstrated the world's first integrated vision system capable of recognizing and focusing on moving objects. The system features an active (moving) robot camera head, real-time image-processing hardware, and software capable of stereo image tracking and grouping, 3-D scene modelling, object recognition and symbolic reasoning. A distributed software architecture operating at 10 frames a second makes possible the exploitation of simple reflex actions for controlling attention. VAP has developed a range of three camera heads with different response times and accuracy specifications, and specialized hardware for image processing. VAP II (7108) will develop the system further.

The three new projects in this area are INSIGHT II (6019), building on the results of INSIGHT (3001) and aiming at an understanding of vision at the computational level, based on multidisciplinary studies combining mathematics, neurophysiology and psychophysics; VIVA (6448), focusing on the investigation of viewpoint-invariant geometric properties; and NAT (7130), examining image processing, with particular emphasis on image sequence analysis.

Neural networks and neuroscience

Useful insights can be gained by emulating the massive parallelism inherent in biological systems. NERVES (3049) studied the question of selecting suitable neural architectures and algorithms for applications such as the visual processing of text. ELENA-NERVES (6891) is continuing the work by studying synaptic adaptation and designing neural net hardware and algorithms. SSS (6961) is developing models of biological systems using an approach based on electronic engineering, physics, physiology and neurobiology. The aim is to identify salient features of visual and acoustic sense-organs for use in designing sensors for vehicles.

Symbolic machine learning

The representation of knowledge in a computer must include the means of applying it, and ECOLES (3059) concentrated on integrating machine learning and logic programming. The resulting inductive logic programming (ILP) systems develop predicate descriptions from examples and background knowledge. Cost-effective application areas for ILP include drug design, finite element mesh analysis, prediction of aspects of protein structures, and fault diagnosis rules for satellite repair and maintenance. The work will be taken further by ILP (6020), where the objective is to produce a unified theoretical framework for inductive logical programming. The new B-LEARN II (7274) project continues the theme of the working group on vision (3352), looking at the integration of learning strategies for robot control.

Knowledge engineering and representation

Research in this area is concerned with endowing machines with reasoning power and structured knowledge-bases, turning them into 'intelligent agents'. Legal reasoning, founded on well-ordered sets of precepts and rules, would appear to be suitable for computer representation, offering the long-term prospect of a decision-support system for legal practitioners. However, the 'Foundations of legal reasoning' working group (3152) found that even with limited legal topics there were difficulties with the multi-dimensional structure of the law.

To illustrate the problem: if Mrs V is a recently widowed woman whose husband has paid pension contributions then she is entitled to a pension; but if the reason for Mr V's death is that he was unlawfully stabbed by Mrs V then another, more general, rule comes into effect. An attempt to formalize the situation in deontic terms leads to a paradox which requires non-monotonic logic to resolve (see Box 4).

The group generated a number of pilot legal expert systems for English contract law, Italian matrimonial law and Italian students' benefits, and Scottish intestate succession. The results have been used by Machine Intelligence Ltd (UK), the coordinator, in the ABHS-P exploratory action ALDUS (5636), which in-

Box 4: Legal reasoning

The general aim of the 'Foundations of legal reasoning' working group (3152) was to identify the appropriate role of informatics in legal reasoning, and to tackle some fundamental theoretical problems that need to be resolved before legal decision-support, or 'expert' systems, can be used effectively in legal practice. For example: Mrs V is a recently widowed woman whose husband paid his due contributions throughout their married life, and who now, on his death, claims her right to a widow's pension. By the applicable legal rules it appears that she is of course entitled to it. However, the reason for Mr V's death is that he was unlawfully stabbed by Mrs V. She is now denied her pension, on the grounds of a general legal principle that, the rules notwithstanding, 'no person shall profit by his wrong'. Can a formalization of the law handle such a case?

We can formalize this situation as follows:

1. **If Mr V dies, then it ought to be that Mrs V receives a pension.**
2. **It ought to be that if Mr V does not die, then Mrs V does not receive a pension.**
3. **It ought to be that Mrs V does not stab Mr V.**
4. **If Mrs V stabs Mr V, he dies.**
5. **If Mrs V does not stab Mr V, he does not die.**
6. **Mrs V stabs Mr V.**

In deontic logic, the following inferences are valid:

(i) P is true.
If P, then it ought to be that Q.
Therefore, it ought to be that Q.

(ii) It ought to be that P.
If P, then Q.
Therefore, it ought to be that Q.

(iii) It ought to be that P.
It ought to be that if P, then Q.
Therefore, it ought to be that Q.

Now from 4 and 6 it follows that:

7. **Mr V dies.**
And from 1 and 7 it follows, by virtue of (i), that:
8. **it ought to be that Mrs V receives a pension.**
But from 3 and 5 it follows, by virtue of (ii), that:
9. **it ought to be that Mr V does not die.**
And from 2 and 9 it follows, by virtue of (iii), that:
10. **it ought to be that Mrs V does not receive a pension.**

The problem is how to formally reconcile 8 with 10.

vestigated the feasibility and marketability of a system for drawing up sales contracts.

Systems capable of reasoning were studied by MEDLAR (3125),which developed new algorithms appropriate for dealing with the various logics required for reasoning. The work is being continued in MEDLAR II (6471). The new project NATURE (6353) will address the central problems of requirements engineering: requirements capture, the representation of functional and non-functional requirements, and the transformation from informal expressions (natural language,

graphics, etc.) into formal semantics. It will also study the reuse of such requirements models and their usage for systems integration.

Logics and logic programming

Among many other outstanding results in category theory, CLICS (3003) produced a proof for a theory in category logic first formulated in 1976 — the mathematics of concepts and structures. New formalisms were also produced for experimental implementation in domain and type theories, semantics, linear logics and concurrency. Its successor, CLICS II (6811), will extend this work. In a related area, SEMANTIQUE (3124) used partial evaluation and abstract interpretation methods to express the semantics of programs and generate specialized software from generic solutions (for example, the production of specialized aircraft navigation systems from general systems). This offers the prospect reducing the amount of work required in maintaining and modifying programs, and a new SEMANTIQUE working group (6809) will coordinate research in this area.

Formal proofs and development methods play an increasing role in the design of correct software. The LF project (3245) developed and tested five proof systems using type theory for specifications, programs and proofs. TYPES (6353) and GENTZEN (7232) are continuing work on theorem-proving, and the automation of mathematical reasoning.

Programming parallel and distributed systems presents special problems, while graphic representations are attractive because of the intuitive insights they can convey. Both the COMPUGRAPH working group (3299) and the SEMAGRAPH action (3074) have confirmed and developed graph representations as an efficient basis for implementing parallel programs, and SEMAGRAPH produced experimental parallel implementations on transputers. The complementary work of both actions is being continued in the form of working groups: SEMAGRAPH (6345) on the theory of graph rewriting, and COMPUGRAPH (7183) on graph grammars.

Since its inception the members of the COMPASS working group (3264) have published over 300 papers on algebraic methods for system specification and produced a valuable survey and bibliography of the subject. The group is continuing as COMPASS (6112).

The pilot network of excellence in computational logic, COMPULOG-NET (3703), has been very active, and is continuing, as reported above, as COMPULOG-NET II (7230). This network spans constraint programming, programming languages (including parallel and concurrent implementations) and aspects of other basic research themes, such as knowledge representation. COMPULOG-NET's work on the tractability of concept description languages won the IJCAI Best Scientific Paper Award (Sydney 1991) and has considerable practical potential for the design of deductive object-oriented databases. The Gödel language developed in COMPULOG (3012) will be used as a common basis for work by researchers in the network.

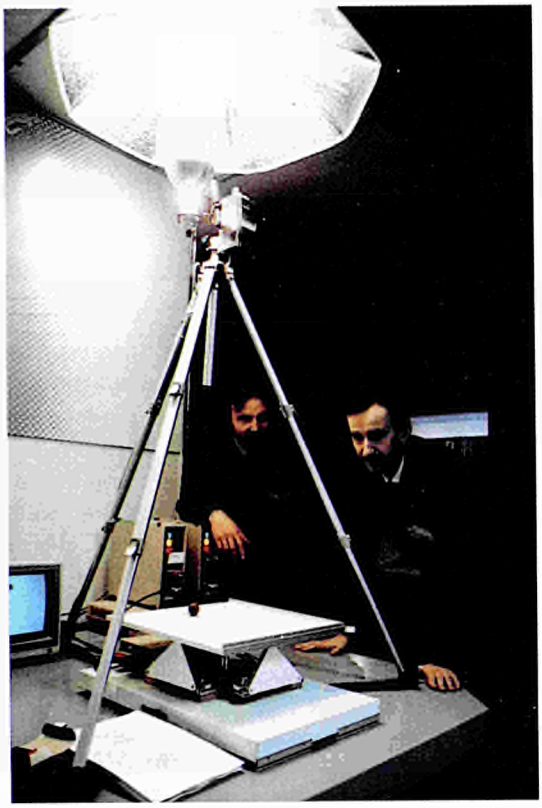
Databases, information retrieval and multimedia

Rapid growth in the use of databases has exposed weaknesses in areas such as query languages, bulk data access and multimedia. The goal of this theme is to meet the requirements of a wider range of applications including CAD/CAM or geographic databases, data and procedures integrated by object-oriented modelling

In this area FIDE (3070) examined the inconsistencies between programming languages, databases and operating systems. The consortium developed a systematic approach for use by database language programmers for determining appropriate type systems and selecting the best technology for persistent stores, and for programmers to improve the design of their database applications. Prototypes were used to assist the design of a large health-care system. FIDE II (6309) is developing an integrated environment for such data-intensive systems.

Geographical information systems involve large volumes of data with a long life-span. The working group BASIC GOODS (3191) examined database requirements in this area and developed prototype extensions to the relational model and object-oriented data-modelling approach to improve ease of use and rapidity of response. These results have been documented as the proceedings of a workshop published in the basic research series. The experimental and theoretical work in spatial data-management stemming from BASIC GOODS is being taken further by the

AMUSING project (6881), and the MIRO working group (6576) has been set up to examine information systems handling multimedia.



An experiment carried out in PDCS (3092) to test the dependability concepts developed in the action consists of a ball on a plane that can be tilted by servo-motors. The video camera observing the ball controls the servo-motors; the aim is to tilt the plane so that the ball rolls along a circular path without falling off despite mechanical (to the ball), optical (to the camera) or electronic (to the controlling computer system) interference.

Distributed systems, reliability and dependability

The dependability of large distributed systems is a critical issue in applications such as electronic funds transfer, but few tools are available to assist designers of dependable systems. The PDCS action (3092) developed methods for measuring and predicting the dependability of systems and of specifying and designing for dependability. PDCS II (6362) aims to make these methods even more cost-effective and predictable. Another project, BROADCAST (6360), is refining principles for designing and implementing very large distributed computer systems containing millions of nodes.

Appropriately CABERNET (3702), the pilot network of excellence in distributed computing systems architectures, has taken the lead in network communications and set up standard file server hardware and software for the transmission of files between network nodes in six countries. The network has four industrial partners, two of whom are participating in other ESPRIT projects. A strategic framework for distributed computing research has been defined around six topics: algorithms, operating systems and kernels, programming support environments and languages dependability, high-speed networks and multimedia systems and real-time systems.

Algorithms, the key to effective computation

The feasibility and efficiency of a computational task is determined by the algorithm chosen. The ALCOM action (3075) brought together researchers to identify good algorithms, study their complexity and set up an algorithm library. Its continuation, ALCOM II (7141), is accompanied by RAND (7097), a working group on randomized algorithms whose members comprise most of the leading European researchers in this area, while QMIPS (7269) is constructing quantitative models of algorithms for parallel systems.

Concurrency, real-time specification and verification

Europe has a world lead in formal approaches and theories for developing and improving the quality of concurrent and real-time systems. Finite state theory is valuable in the production of many real-time computer systems, but the solution space required to specify and verify the system greatly exceeds practical memory limits. SPEC (3096) developed 'on-the-fly' techniques for testing such systems as their solution spaces are expanded, together with executable formalisms for specification. These methods are now being used by Bull (F) to test their real-time systems. Other systems, such as those using natural numbers, are not best represented by finite-state systems, and here SPEC took up the work of DESCARTES (IPSS project 937) on the verification of interface refinement (such as the change from synchronous to asynchronous interfaces). Using temporal logic, SPEC has developed, for the first time, a method for interface refinement verification in its most general form.

The PROCOS action (3104) has developed tools for proving the correctness of real-time systems that are being used by the Danish National Railway for checking automatic signalling systems. PROCOS II (7071) extends this work to provide an integrated and rigorous framework for the design process, while PROMOTOR (7082) is examining an innovative approach to modelling the software process.

Box 5: From fundamental research to industrial application

In 1991 Siemens (D) granted an R&D contract to Professor W. Richter's group at the Institut für Festkörperphysik der TU Berlin, which participated in EPIOPTIC, to assess the potential of reflection anistropy spectroscopy (RAS) as a non-destructive technique for orienting silicon wafers with an angular resolution of better than 0.1°. RAS, developed in EPIOPTIC (3177), easily achieved this resolution for Si (110). For other wafer orientations, such as (100), the wafers need to be prepared by a special etching procedure to produce the surface anistropy required. A patent application (P 4127704.4) has now been filed covering the use of RAS for this industrial application.

Advanced materials, devices and processes

The interest shown by industry in this area is demonstrated by its use of results from the first basic research actions and its participation in the second call for proposals. EPIOPTIC (3177) pioneered *in-situ* methods of monitoring the growth of thin films using light beams, and developed a method, using scattering phenomena, which detects single atomic layers. One of the procedures devised by EPIOPTIC has already been used by Siemens (D) for the fast and accurate orientation of silicon wafers (see Box 5).

The new project EASI (6878) is extending the techniques employed by EPIOPTIC to new materials and methods.

The need to study atomic impurities and irregularities in depositions on silicon surfaces led the PROMPT action (3109) to build a research-scale linear cluster tool for ultra-high vacuum (UHV) semiconductor processing. The ion-beam scattering, residual gas analysis and scanning tunnelling microscopy (STM) facilities fitted enable all stages of the oxidation step to be controlled. The STM can discern individual atoms on the surface of the high-quality MOS building blocks fabricated. Industry has participated in PROMPT's workshops, and as a result a small spin-off company has been founded selling STM and ion-beam analysis techniques (see Box 6).

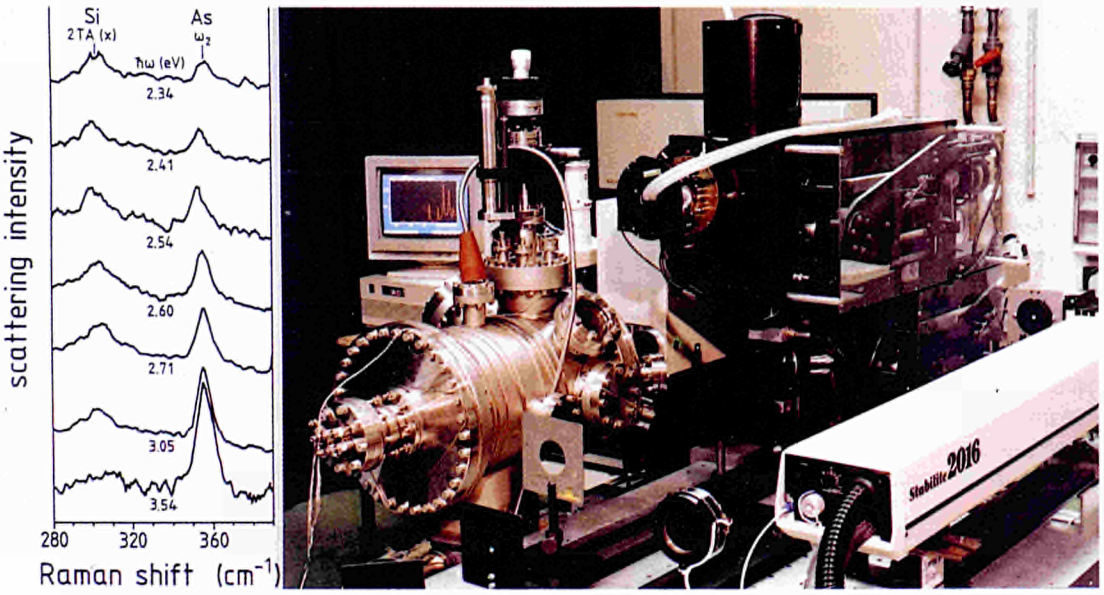
The new projects ASSIST (6108) and EASI (6878) are working on *in-situ* non-destructive diagnostic techniques for surface and interface structures using STM and a variety of complementary optical probe techniques respectively.

Designing complex circuits and digital optical systems

As VLSI improves and silicon chips become denser and more complex, the problem of verifying their design grows increasingly difficult. The CHARME action (3216) designed analytical verification methods for each stage of chip design and used them to verify a modem chip containing 32 000 transistors — the largest totally verified chip in the world. The techniques were also used to identify and correct problems in a chip design system, CATHEDRAL, developed for industry by the microelectronics SPRITE project (2260). CHARME II (6018) is carrying on this work. The chips used in signal processing in video, robotic and telecommunications applications require very efficient algorithms for their design. NANA (3280) devised and tested a number of new parallel algorithms of different types and investigated the memory management techniques required. SGS-Thomson (F/I) will be using the systematic design methods developed. The work continues in NANA II (6632).

Materials for silicon-compatible optoelectronics

Tailoring the optical properties of multilayer materials such as silicon/germanium superlattices and diamond or diamond-like multilayers will have a strong impact on the viability of silicon-based optoelectronics. Their successful exploitation will lead to the production of improved silicon-compatible photodetectors, diodes and optical fibre links necessary for the next generation of telecommunications systems. The SLS action (3174) has made a new Si/Ge semiconductor with novel optical emission and absorption properties. This is the first time that fibre-optic devices have been integrated with electronic



Shown is equipment used in EPIOPTIC (action 3177) for the non-destructive, high-resolution optical characterization of materials used in information technology devices. See Box 5 for the industrial application of one of the action's results.

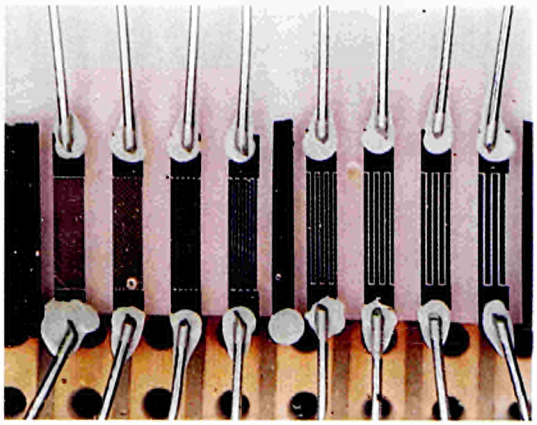
driver circuits. One of the applications envisaged is a light-emitting and receiving device on a silicon chip for use in optical and interchip coupling.

Nanotechnology and molecular electronics

With the mastery of very precise epitaxial growth and lateral patterning techniques, new phenomena in semiconductors can be observed that are directly attributable to electrons behaving as waves rather than particles. An approach based on quantum physics is more helpful in understanding devices whose critical dimensions are less than 0.1 micron (one ten-millionth of a metre). If successful, this could result in novel optoelectronic and electronic devices (such as microcavity lasers, photodetectors and modulators, and single-electron electrometers) as small as 0.01 microns (10 nanometres) compared to the 0.1 micron theoretical limit of current technology. The study of these quantum effects and the devices in which they arise has become known as nanoelectronics, and their application, nanotechnology. Physicists are also trying to improve on the performance of the familiar silicon microchip by looking at other semiconducting materials. Some of the

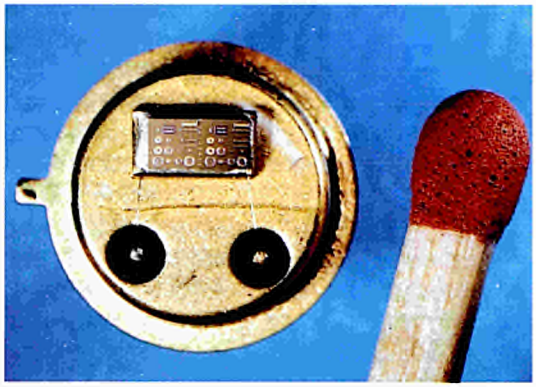
Box 6: Basic research fuels industrial innovation

East Coast Scientific Ltd, or ECS, is an excellent British example of an industrial enterprise capitalizing on concepts and prototypes developed in basic research projects. ECS was recently formed to transfer the experience gained by Cambridge University's STM (scanning tunnelling microscopy) research group during their participation in the PROMPT (3109) action to commercial instrumentation. PROMPT, involving AEA Technology (UK), IMEC vzw (B) and Cambridge University (UK), developed a research-scale linear cluster tool for ultra-high vacuum (UHV) semiconductor processing. Building on the know-how developed, ECS specializes in the development of one-off instruments for unusual applications, and provides a service to other firms that lack the experience needed to develop novel instrumentation quickly and at a reasonable cost. An example is the design of a combined scanning electron (SEM)/STM instrument for retro-fitting to an existing MBE system manufactured by Vacuum Generators. This will be used for atomic resolution studies of thin-film growth mechanisms. ECS's activities are also a fine example of ESPRIT basic research's contribution to ensuring, through training and work experience, the future availability of high-calibre scientists and engineers: the managing director of ECS participated in PROMPT as a graduate student.



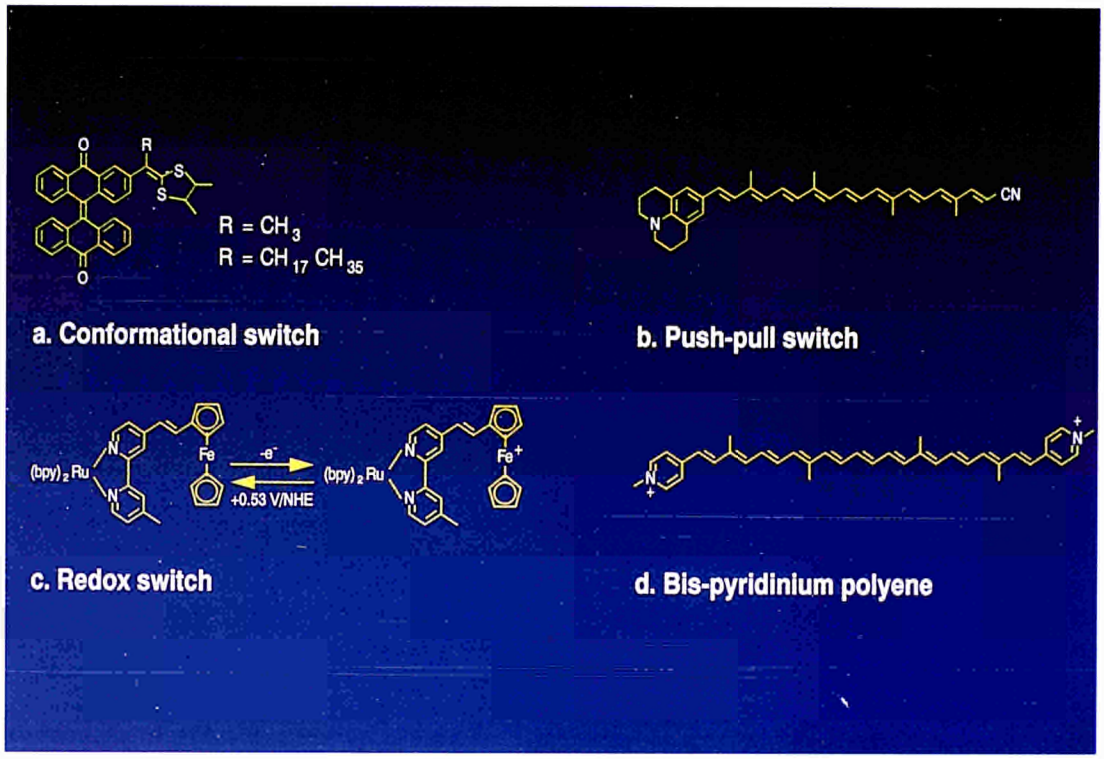
A polymer wire developed in OLDS (3200). Eight molecular layers, shown in pink, have been deposited on to pairs of interdigitated metallic electrodes of varying gaps. Each layer contains the polymeric wires. Photoelectrons travel along the wires and can be detected as an electrode current.

most promising of these are gallium arsenide (GaAs) and other related compounds formed from elements in groups III and V of the periodic table. Devices based on this so-called group of 'III-V' compounds have tremendous potential because they combine low power consumption with fast operating speeds. GaAs itself is especially important, together with InP, in optical applications, such as semiconductor lasers, where silicon cannot be used.



Pictured is a new silicon/germanium strained layer superlattice (SLS) diode chip produced by the SLS (3174) action. The device is made out of alternating layers of Si and Ge grown by molecular beam epitaxy on an Si substrate. The chip can be integrated with current silicon IC technology.

A substantial body of work has already taken place within ESPRIT basic research aimed at understanding the physical principles involved and developing the fabrication tools needed to study the optical and electronic properties of III-Vs at the nanometre scale. NANOFET (3042) has achieved the fabrication of the smallest field-effect transistor (FET) in the world (25 nm gatelength) with submicron ('nanometric') resolution. LATMIC (3043) has produced a lateral superlattice defined by a gate with a comb-like electrode for controlling electron flow. The quantum dot structures, which include 20 nm diameter dots on 50 nm spacings and quantum 'wires' as small as 20 nm wide, have eventual applications in producing narrow bandwidth (and hence higher data-transmission rate) semiconductor lasers for use in optical fibre telecommunications. LATMIC II (6536) is seeking to use these results in switching devices and memories. Under certain conditions, electrons are no longer wave-scattered by impurities, but behave more like ricocheting billiard balls. Exploiting this phenomenon, NANSEV (3133) has successfully demonstrated the principles of



Molecular switches developed in MOLSWITCH (action 3314), which has examined organic materials with potential transistor-like switching properties for use in microelectronics.

ballistic transport devices, such as steerable electron beams that can act as switches, and quantum point contacts and quantum wire waveguides for communication between devices.

These actions, together with others in this area of basic research, have demonstrated many of the techniques needed for making nanometre-scale structures that could be used to store and process information. The work is continuing in SOLDES (7260), investigating a novel approach to the direct growth of nanostructures via self-organizing atomic structures; PARTNERS (7193), aiming to produce high-speed devices operating on quantum mechanical tunnelling principles; NANOPT (6719), working on optical devices such as narrow-linewidth lasers with narrowed linewidths.

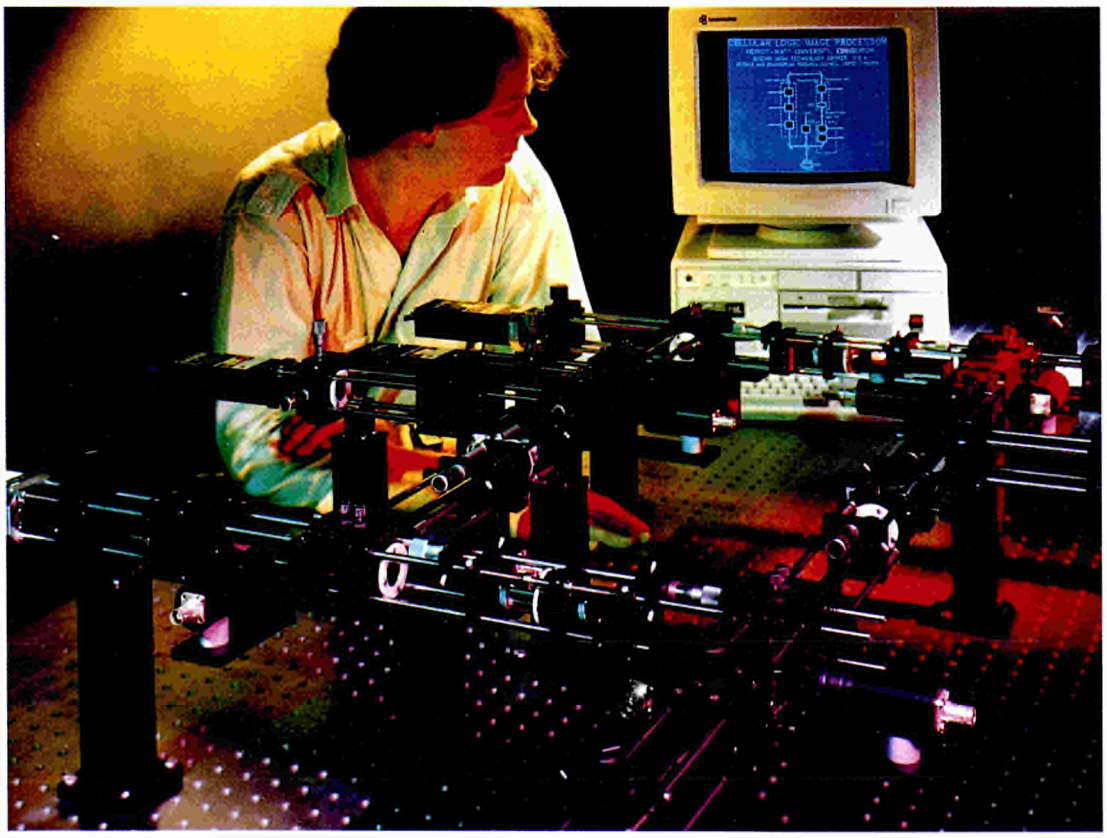
Alternatively, nanostructures can be realized by designing and synthesizing suitable organic molecules. OLDS (3200) has developed scanning near-field optical microscopy and STM as new tools for storing and retrieving information at the nanometre scale. The action studied and characterized two kinds of organic molecules: conjugated (i.e. those with electron-transport properties), to be used for molecular 'wiring', and liped molecules (i.e. those with defined dipole moments) for representing information.

Despite the fundamental nature of work on nanostructures, the results of MOLSWITCH (3314) have already been commercially exploited, with four Danish companies collaborating with the coordinator, the Centre for Interdisciplinary Studies of Molecular Interactions (CISMI) at the University of Copenhagen, on techniques for the imaging of molecules adsorbed on solid substrates. Lithographic techniques are also being developed for processing molecular monolayers by applying electrical pulses at preset positions to initiate cleavage or synthesis reactions.

Two new projects, TOPFIT (7282) and PROTIOS (7238), focus on molecular electronics.

Optical communications and computing

Progress in optical computing relies, amongst other things, on the synthesis and characterization of suitable materials for constructing optoelectronic components. FOCUS (3180) has constructed the first optical memory device using transparent silicon substrates to enable them to be packed into 3-D arrays. The proceedings from the WOIT



The working group WOIT (3199) recently held an exciting workshop on optical computing, whose proceedings are to be published in the Basic research *series by Springer-Verlag. The picture shows a demonstration of the potential of massively parallel digital optical computing concepts from the laboratories of the coordinator, Heriot-Watt University.*

working group (3199) conference held in December 1991 produced a state-of-the-art reference book in optical computing which has been published by Springer in the *Basic research* series.

New projects in this area include QUINTEC (6934), working on the engineering of quantum optical devices; TONICS (7118), which addresses the storage of information in laser modes, and EOLIS (7228), which is investigating the recently discovered phenomenon of the emission of red light from porous silicon. POPAM (6863) on holographic memories and PHOTONS (7070) on surface-emitting lasers are concerned with novel optical computing effects.

High-temperature superconductivity

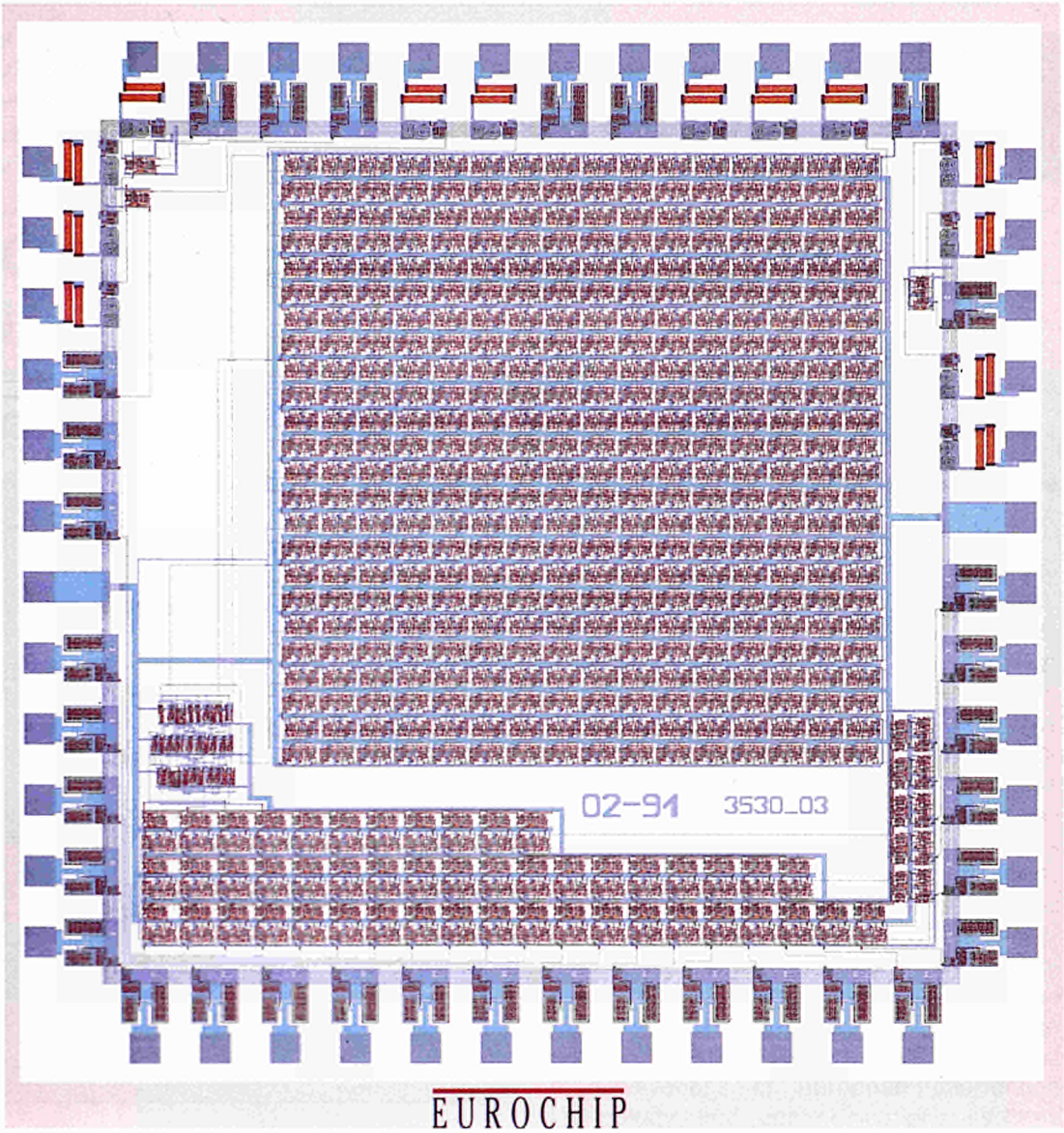
The ultimate goal of research into the high-temperature superconductivity phenomenon is the production of very low-power, ultrafast processing systems, while shorter-term objectives are focused on applications such as microwave components, magnetic field sensors (SQUIDS) and signal processing circuits. In the last few years the physical properties, theory and models of different classes of high-temperature superconductors have been thoroughly investigated, and a number of deposition techniques for high-quality thin films have become available. To accelerate the search for a unified theory, HTSC (3014) organized a series of four international workshops to bring together experimentalists and theoreticians. The original basic research actions in this field concentrated on materials characterization, with SUPRADYNAMICS (3327) and DIRTYSUPRA (3146) producing phase diagrams for YBaCuO compounds and observing the effects of impurities. Looking at practical aspects, SUPERMICA (6113) is studying the microwave losses in superconducting films, and X-BAND-SRO (6625) on a new hybrid device, a superconductor resonator coupled to a GaAs HEMT that operates at 12 GHz for microwave communications. The new HTSC-GBJ (7100) project is studying grain boundary junctions.

EUROCHIP, the VLSI design training action

The first VLSI design training action (3700) is now drawing to a close, having greatly surpassed its original targets. By mid-1992 more than 5 000 students, 500 more than the targeted number, had been trained in VLSI design skills at approximately 120 academic institutions, more than tripling the number previously trained annually. Using the latest computer design programs and workstations, at least 1 000 VLSI designs had been made, of which some 600 had been fabricated to state-of-the-art levels at the five European foundries involved. Workstations, test equipment and design software for the universities are selected in the light of a number of criteria, such as user requirements, factory compatibility and international standards. Central procurement enables professional-quality computer programs to be offered at a fraction of their market price. Universities can therefore afford to buy this highly expensive software, and can choose the tools which best meet their needs and then integrate them with their existing computer equipment. The action's contribution to postgraduate as well as undergraduate training is well illustrated by the over 2 000 internal and external reports already produced, including about 1 000 undergraduate reports, 800 at master's level, and nearly 200 PhD theses. The provision of design facilities for training purposes and access to manufacturing prototypes has opened the way for chip production by academia, and the action's budget has been augmented several times over by the institutions involved from their own resources. An annual workshop is held where successful student projects are honoured, and a design catalogue is now available, providing off-the-shelf solutions for industry. The second phase of the action, EUROCHIP (6573), is now getting under way. Involvement will be extended to a larger number of universities and polytechnics, and any recognized higher training institution in the Community, EFTA or Central and Eastern Europe that is considering entering this area will have the opportunity of easy access to the service. EUROCHIP will collaborate closely with two new working groups: ROC (7053), which focuses on the specific requirements of research institutes, and MEDCHIP (7307), which addresses the particular VLSI design training needs of Greece, southern Italy, Portugal and Spain.

Basic research — a European catalyst

The research results of the first basic research actions include advances in topics as diverse



VLSI design training: this circuit is an automatically generated digital filter designed by A. Keady of the NMRC, Cork, under the VLSI design training action (3700/6573). It was fabricated at the MIETEC-Alcatel foundry, one of five involved in the action.

as organic superconductors, semiconductors for optoelectronics, laser communications systems and category theory. Direct industrial exploitation of research results and techniques has taken place in areas ranging from robotics through chip fabrication to program verification. It is increasingly recognized that successful innovation, which is at the heart of industrial competitiveness, is based on a complex and increasingly faster-moving feedback loop. We have moved on from the time when it took 20 to 30 years before a basic research result found its way into the development mainstream and eventually ended up as an industrial application. What took decades has now been compressed into years. At the same time, basic research is more and more acknowledged as an activity that nurtures the high-calibre scientists and engineers needed throughout industry. It is now evident that even though the industrial goals keep shifting, these cannot be attained without adequate support for basic research and, most importantly, the interlinking of basic research activities with those that are closer to the industrial innovation process.

The interdisciplinary nature of basic research, the mobility of human research resources and the coordinating role of networks of excellence are all factors which put basic research in the mainstream of European collaboration.

Open microprocessor systems initiative

Background

The goal of the open microprocessor systems initiative (OMI) is to bring the open systems concept to the level of on-chip microprocessor systems and their associated software. This is being done by creating a framework and standards for an open and licensable library of macrocells, and by providing macrocells of a number of existing processors, new processors and other on-chip functions. The open applications software needed to integrate these components into on-chip systems is also being made available. OMI is launching 20 projects in 1992 covering overall coordination and standards, the provision of microprocessor and other macrocells, software and tools, applications feasibility studies, and the dissemination of OMI results.

Microprocessors and their associated software form the intelligence of electronic systems. Increasingly critical throughout industry, their uses range from sophisticated control systems for aerospace, robotics, industrial control and telecommunications, to mobile telephones, office automation, consumer electronics and automobiles. These are examples of embedded applications. Microprocessors are also the key component of general-purpose programmable systems covering the wide range of computers from supercomputers to notebook PCs. Intelligent systems are becoming increasingly important in securing environmental and social benefits, such as pollution control, access control, health-care and aids for the disabled. As the 1990s progress embedded systems are expected to overtake general purpose computers as the predominant application of microprocessors. This is particularly the case in Europe.

The US semiconductor industry currently dominates the world microprocessor market. Two companies, Intel and Motorola, have shaped the development of the market through their complex instruction set architectures (CISC). In 1991 they sold 98% by volume of microprocessors used worldwide in computers priced less than ECU 20 000 (*Business Week*, 30 March 1992). As a result of their position, these companies no longer make their technology available under licence. Overall, in embedded systems and general purpose computers, Europe is more than 80% dependent upon foreign microprocessor technology, and its use is only growing at half the world rate. This not only represents an adverse trade balance, but indicates impaired responsiveness of European information technology and communications systems suppliers to technological and market opportunities. The weakness of the European generic software industry has been related to the lack of a strong local microprocessor industry. In addition it is hard in Europe to form the strategic alliances necessary to exploit new processor developments as soon as they become available, and to influence new designs.

In the CISC architectures developed in the 1970s, 80% of actual processing was carried out by just 20% of the instructions. During the 1980s technology improvements made it possible to develop alternative 'reduced instruction set' architectures (RISC) which achieve extremely fast processing by optimization for the reduced set of instructions that performs 80% of the work, and using combinations of those instructions to perform the remaining 20%. While CISC architectures

remain dominant, designers of novel RISC architectures have made significant inroads into certain market segments. The share of RISC is expected to grow considerably during the first half of the decade. It is in the RISC domain that indigenous, European strengths lie, especially in embedded and parallel systems (the Inmos transputer), and very low-power microprocessors (ARM). These strengths are recognized worldwide, with a high proportion of such products being exported.

Application-specific microprocessors, known as digital signal processors (DSP) are also increasingly important in the market. DSP chips are the most complex mathematical processing engines created in silicon, and can be 10 times as powerful as general purpose microprocessors. They are optimized to translate specific continuously varying analog signals (e.g. voice and images) into digital form. US manufactures control more than 85% of the market, but European companies have a good technical position especially in telecommunications. DSPs are being used in digital HDTV, multimedia computers, videophones, and all kinds of consumer products from the digital personal communicator to the silent vacuum cleaner.

Until recently, intelligent systems were made up of different component chips such as microprocessors, memory management units, caches, random-access memory and application-specific integrated circuits, mounted on printed circuit boards. It is now possible to produce single-chip systems integrating the above functions, provided in standard macrocell form. Macrocells allow the mixing and matching of components on chip, so that custom silicon can easily be produced attuned to specific processing applications (e.g. car pollution control, portable telephony, simulators, etc.). This level of integration presents both significant opportunities and threats for systems builders. On-chip integration introduces important advantages of cost, size, flexibility, power consumption, speed and development time. However, if processor manufacturers with closed architectures control the process of on-chip integration, dependence of systems builders upon them is very much increased. This dependence can be avoided, and the advantages obtained, if component architectures are openly licensed and the macrocells from which on-chip systems are built are conformant to open standards.

Software is vital to the application of such single-chip systems in advanced products. The essential software elements are operating systems, able to control the operation of complex, heterogeneous, distributed on- and off-chip functions, and software portability mechanisms, allowing existing and new generic and applications-specific software to be easily moved between processors of different architectures. Currently such considerations are most important for general-purpose computer systems, since embedded systems software is still usually custom made. The distinction between general-purpose computers and embedded systems is likely to blur as integration, and sophistication, including parallelism, increase. An example is single-chip multimedia workstations which will not be very different from digital HDTV. Generic software is expected to become more important in the embedded system domain during the 1990s.

A great deal therefore depends on improving the European position for both embedded systems and general-purpose computing over the next decade. Strategic interests in open microprocessor systems unite systems builders with innovative developers of RISC processors, including not only Inmos and ARM, but also those US companies (e.g. Sun and MIPS), who have adopted an open strategy for their processor architectures, as well as their licensees. Several European silicon manufacturers have licensed one or other of the US RISC architectures. The advantages of the open approach for systems integrators are local, flexible choice of supply, and the chance to build close links with microprocessor vendors. Technology suppliers, including software houses, gain benefits by pooling resources, as well as access to a wider range of applications. They can concentrate on adding value to their offerings. An open approach is therefore vital to the expansion of both the production and use of microprocessors in Europe.

OMI technology

The goal of the open microprocessor systems initiative (OMI) is to extend the open systems concept, well known in computer systems and telecommunications, to on-chip microprocessor systems and their associated software. A framework and standards for an open, licensable, library of macrocells will be

provided, as well as conformant macrocells of a number of available processors, new processors and other on-chip functions. Emphasis is given to the applications software needed to integrate these components into on-chip systems. Portability of applications software between processors based on different microprocessor architectures is a key consideration, especially for introducing a new microprocessor into the market. New processor architectures are very difficult for users to adopt, particularly in general-purpose computing, if existing applications cannot run on them. OMI standards for applications software portability therefore underpin an evolutionary and migratory approach, allowing Europe to capitalize on its existing strengths and commitments, and to introduce easily new hardware and software technology.

Microprocessors and their associated software form the intelligence of electronic systems. Uses range from sophisticated control systems for aerospace, robotics, industrial control and telecommunications, to mobile telephones, office automation, consumer electronics and automobiles. Microprocessors are also the key component of general-purpose programmable systems covering the wide range of computers from supercomputers to notebook PCs. Intelligent systems are becoming increasingly important in securing environmental and social benefits, such as pollution control, access control, health-care and aids for the disabled.

The planning for OMI was industrially led by a task force set up by the ESPRIT Advisory Board, chaired by Professor P. Aigrain, chief scientific adviser to the chairman of Thomson. The task force agreed that OMI must be not only technically but institutionally open, to take advantage of the best technology available anywhere. The initiative will apply and build on the results of previous and current work in all areas of ESPRIT, in other European programmes, and worldwide, to facilitate the development of complete open microprocessor systems. OMI is committed to adopting established and emerging international standards, both formal and *de facto*, aiming to produce new standards only where no suitable standard exists. Any new standards required will be proposed to the relevant standards authorities.

OMI is driven by the needs of systems integrators, the users of microprocessor systems. From the start of the initiative in 1992 there has been significant interaction between the technical projects and users, through both applications demonstrators within projects and applications studies in a number of market segments. It is anticipated that in the next stage of OMI, a number of applications pilots will be implemented, based on this initial work. Areas covered are home systems, aerospace, workstations, vision systems and robotics, high-performance computing, automotive control, process control, mobile and portable systems, electronic musical instruments and toys, telecommunications and multimedia. Users will work closely with the technology projects to ensure that their requirements are taken into account at all stages. The intention is to build confidence, seed the industry to ensure early industrial take-up in a broad field of applications, and help systems manufacturers to

build the stronger links with their customers which are essential if they are to use OMI to increase their share of a growing market.

An exploratory project OMI-MAP (5386) was started in 1990 by ESPRIT advanced business and home systems. As a result of this and a series of workshops with both suppliers and users, the first call for the open microprocessor systems initiative was launched in October 1991. OMI launched 20 projects in 1992, including an overall coordination and standards project, projects to provide microprocessor and other macrocells, software and tools projects, applications feasibility studies, and a supporting dissemination activity. Each technology project is self-contained, with important results for European industry, independent of the success of other OMI projects. It is the aim of the initiative to closely coordinate projects so as to obtain significant added value for users and suppliers through the interoperability of individual results.

The Eurocell library and interfaces (ELI)

OMI microprocessor projects each contribute elements of the OMI macrocell library, ELI (Eurocell library and interfaces). These interworking components are planned to be accessible under commercial terms to all systems integrators. A major task of the overall industrial coordination of the initiative is to plan the eventual exploitation of ELI and to set up mechanisms for conformance testing and licensing, taking into account the intellectual property rights of participants. This work is being defined in the first year of the initiative.

ELI standards are the main consideration of STANDARDS (7267). The standards adopted and developed are expected to become the strategic standards for on-chip integration for the 1990s. New standards under discussion relate to on-chip interconnection, behavioural and definition languages for macrocells, and standards for macrocell testing and debugging. All will be tested for conformance using formal techniques. OMI standards for the interoperable macrocells library framework come from IDPS (2270 in ESPRIT microelectronics). OMI-MAP (5386 in ESPRIT advanced business and home systems) has initiated work on the standard for on-chip transfer of data between processors with different data representations. This work is being carried forward and extended within the STANDARDS project.

Microprocessors in ELI

Projects which will contribute to ELI include DE (6909) and TMP (7250). These projects build on recognized European strengths in embedded control and low-power RISC. DE, building on ARM technology, is implementing 32-bit RISC processors as macrocells in deeply embedded control, that is, within highly-integrated chips also containing many application specific macrocells. Very low-power implementations are an overall goal. The results will be demonstrated in portable musical instruments and telephony. TMP applies on-chip integration to the requirements of the telecommunications industry. The transputer line is being transformed as macrocells and integrated with application-specific cells for use in switched multimegabit data services equipment.

SUN/SPARC and MIPS RISC processor architectures will be made available as ELI macrocells through SMILE (6142) and MMI (6258) respectively. MMI aims to provide basic building blocks for modular microprocessor implementations, based on the MIPS R3000. Extensions to the MIPS R4000 architecture for high performance and low power, are also being developed. The results will be demonstrated in programmable systems, including low-power, portable workstations, high-end workstations and database servers. SMILE is targeted principally at on-chip integration of the SPARC core with generic and application-specific macrocells for two main application areas: high-volume, low-cost multimedia terminals and real-time embedded systems for industrial control.

Efforts on the new, next-generation, post-RISC architectures begun in OMI-MAP (5386 in ABHS) and AMUS (2716 in IPSS) are being brought together and extended in HORN (7249). HORN aims to provide, for the second half of the 1990s, very high-performance, low-power, general-purpose microprocessors and other macrocells for a broad range of applications including high-performance workstations and servers, power-efficient low-cost portable systems, high-performance parallel computing, and high-performance embedded multiprocessing systems.

The STANDARDS project aims principally at on-chip integration through standards for macrocells. HIC (7252) is developing the next generation of high-performance serial communications for heterogeneous microprocessor interconnect, for use on-board, in backplanes, and between cabinets. It will provide macrocells supporting the HIC serial link technology in the Eurocell library, and will demonstrate use between different processor architectures. The HIC consortium will work closely with international standards organizations, aiming to influence future standards in this area.

User advantages in portable applications are increasingly driving the search for power efficiency. EXACT (6143) aims to contribute to solving the energy dissipation problem by using asynchronous circuits (i.e. circuits without a system clock). Correctness is guaranteed by the use of formal methods and techniques. The asynchronous approach is not new, but has only recently become viable in microprocessors, and could lead to a breakthrough in low-power processing. A spin-off will be the reduced use of batteries, a significant pollution hazard.

System simulation and test

Successful exploitation of the Eurocell library requires tools to completely design and test on-chip integrated systems. Existing tools are being used wherever possible, including results from JESSI CAD-Frame (5802 in ESPRIT microelectronics). Workshops have been started by DEBUG (7325) to define exactly which specific new tools are required to design, simulate and test on-chip systems based on ELI, including tools for modelling hardware/software tradeoffs. DEBUG will specify and later provide the tools.

Representative workloads, known as benchmarks, are used in the evaluation of processing systems. Existing benchmarks have been designed primarily for general-purpose single-processor computers, particularly mainframes and to some extent vector processors. A new generation of support tools will be necessary for embedded control and real-time applications. The BENCHMARK project (6271) is characterizing typical embedded application workloads and establishing benchmarks for embedded control and multiprocessor systems. These will be used for the

Pocket computers: the Newton 'personal assistant', an all-in-one portable electronic notebook, word processor, fax machine and computer recently launched by Apple, is based on a reduced instruction set (RISC) microprocessor chip developed in ESPRIT. The ARM 610 offers the performance of an up-market personal computer combined with low cost and low power consumption. These characteristics make the ARM chip ideal for portable products made in large volumes, such as small consumer electronic devices. The ARM was developed by Acorn, the UK technology division of Olivetti, and is based principally on results from MULTIWORKS (2105) and OMI-MAP (5386).

evaluation of the performance of different OMI processor design alternatives.

Systems software

OUVERTURE (6603) and HARMONY (7253) are complementary operating systems projects within OMI, extending the European Chorus microkernel technology, a combined result of a number of ESPRIT projects in ABHS and IPSS. HARMONY will adapt Chorus to provide a distributed real-time operating system for transputers. OUVERTURE will add value to an open, market-standard operating system, Unix system V release 4. Benefits foreseen derive from improved partitioning and modularity, which will reduce the complexity of porting to new processor architectures (an important consideration for OMI, particularly for general-purpose computing applications, but later also for embedded control). OUVERTURE will increase the productivity of software developers through the use of simple standard components and reusable code. It will provide better support for distributed computing architectures and client-server computing, and it will extend the operating system for the emerging markets in real-time, parallel and multimedia systems.

Applications portability

Early availability of applications software is essential to the acceptance of innovative microprocessors. Portability of existing applications can be facilitated by the use of a virtual binary interface (VBI), an intermediate code into which applications software written in many different high-level languages can be compiled (using a producer). The VBI representation can, in a subsequent stage, be converted once to run on any specific microprocessor and operating system combination (using an installer). To be of value the software market must accept and use a standard VBI. A VBI developed partly in OMI-MAP (5386) has been adopted by the Open Software Foundation worldwide as the basis of its architecture-neutral distribution format (ANDF). Applications portability for OMI will be provided by GLUE (6062), which is developing complete ANDF-based language support, coordinated with the operating system and microprocessor library work. Extensions to ANDF for heterogeneous microprocessor interoperability and for emerging applications in parallel processing will be developed in GLUE, submitted to the OMI standards review process, and subsequently submitted to OSF and other standards bodies for adoption.

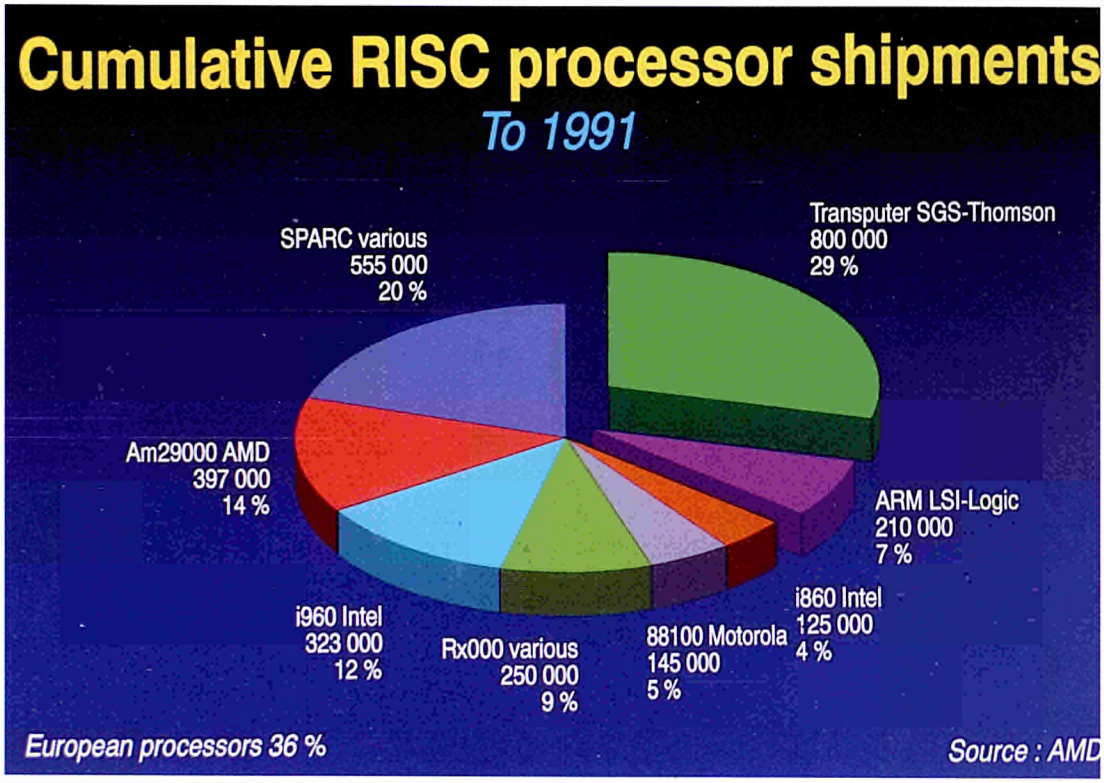
OMI applications

Applications demonstrators, as described in the microprocessor projects above, provide an important source of user input. Additionally a range of applications feasibility studies have started within the initiative, some of which may lead to full applications pilots later. From the outset, regular workshops are being held to develop common perspectives between technologists and users in the systems industries.

An important feature of the applications feasibility studies is the involvement of industry in defining requirements for systems in their respective product sectors. For example, Zanussi and Balay are involved in DOMUS (6060), which will define the user requirements for the domestic white-goods sector (washing-machines etc.). The project liaises closely with the home systems work being undertaken in ESPRIT ABHS projects HOME (2431) and IIH (5448). In the automotive area, BMW and Volkswagen are working with Motorola in FAST (6666) to define the integrated microprocessor chips required to enable the automotive industry to meet European anti-pollution legislation.

GEC and Bertin are involved in ARCHIE (project 7283), a workstation project developing virtual reality interfaces for applications with high social impact such as air-traffic-control and care of the disabled. ARCHIE is investigating how OMI technology can allow improvements in flexibility of design, performance, and compactness. MOVE (6084) is a feasibility study for an open modular vision environment. It will identify classes of industrial applications of computer vision, for example advanced robotics, for which there are software solutions, but which require OMI integrated chips to become economically viable.

In OPUS (6610), ILVA and others are specifying the requirements to OMI for reduced complexity, set-up and maintenance costs of industrial automation. MBB and Thomson, advised by the European Space Agency, are working together in DIPSAP (6347), a feasibi-



RISC processor sales figures: the demand and range of applications are growing rapidly.

lity study to define requirements for radiation-hardened digital signal processors for use in the aerospace and nuclear industries.

OMI dissemination

Dissemination is the third precompetitive component, together with technology and user applications, required to give OMI the basis of future successful exploitation in the market.

OMIDIS (6175) will promote the information flow on which success depends. This dissemination activity includes promoting communication among the projects of the initiative and raising the awareness of systems companies worldwide regarding OMI alternatives, standards, and their future commercial viability.

Workshops and conferences are scheduled to encourage the close cooperation of technologists and the user industries (consumer electronics, automotive, computer, aerospace, manufacturing, telecommunications, etc.). The promotion of software standards (e.g. ANDF) to the software industry is an area of emphasis. Of particular importance is the early dissemination and training in OMI technologies to undergraduate and graduate students in the universities, and dissemination of OMI in regions of Europe not yet strong in the microprocessor systems industry.

Information exchange system — research networking

Overview

Further improvements were achieved in the last year concerning communications facilities for European researchers in general, and for participants in the ESPRIT programme in particular.

Research networking has to rely on facilities provided both at the national and European levels. The progressive development of national research networks, such as DFN (German research network), JANET (joint academic network, UK), SURFnet (NL), GARR (I), RENATER (F), IRIS (E) and similar initiatives in other European countries (sometimes still in their infancy), form the basis on which European-wide research networking can be built.

In ESPRIT, two main lines of support are being pursued to strengthen the research networking components at the European level. These relate to:

- the cooperation and interconnection of the national research networks, as undertaken in the context of COSINE and RARE;
- pilot projects with specific targets, such as IXI and Y-NET.

Some further activities relating to European research networking have also been promoted, such as the ECFRN (European Consultative Forum of Research Networking).

The initiatives funded under ESPRIT have been coordinated with corresponding activities relating to computer networks funded under the VALUE programme.

It should be noted that the electronic mail and computer-conferencing service EuroKom, which started as a pilot project under ESPRIT some years ago, now provides its services on a commercial basis. Many ESPRIT participants use this service, particularly its group communications facilities.

COSINE and its subprojects

COSINE has made considerable progress in the last year. The establishment of the COSINE project management unit (CPMU) provided the focus for the subprojects which will lead to operational services for the European research community. Several of these subprojects are now providing service on a pilot basis. These include:

PARADISE

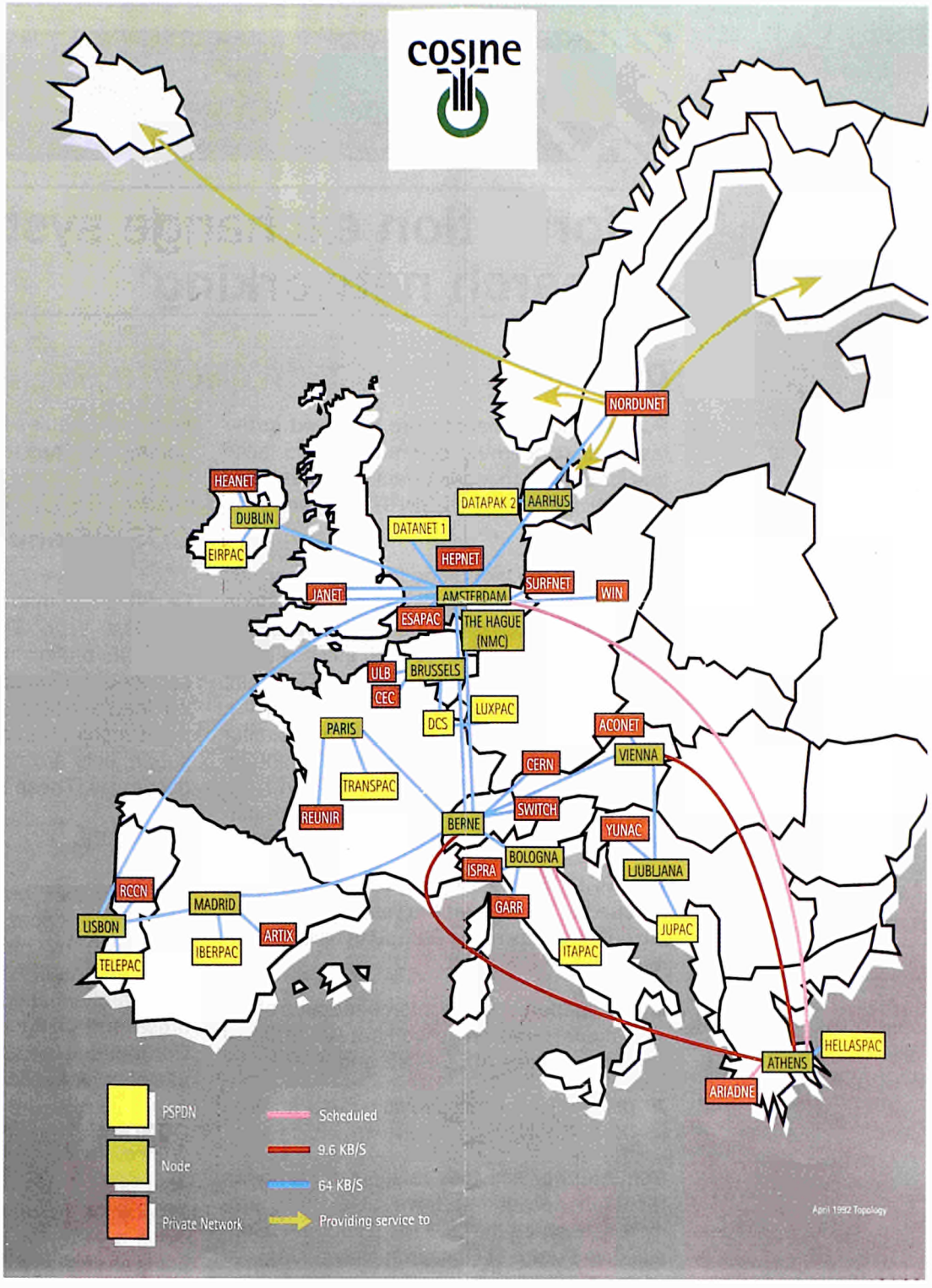
The PARADISE project provides international directory services through linking national directories by means of the international X.500 standard. As an example, this enables a researcher based in Athens to obtain the address and contact points of a colleague in Dortmund. It is a valuable support tool for the use of other services such as electronic mail.

CONCISE

This project has established an information service for the research community that provides a wide range of information covering fields as diverse as forthcoming seminars and conferences and reports on special interest groups in Europe.

COSINE provides gateways between Europe and North America for electronic mail and file transfers. It is developing 'virtual terminal' software, which will allow users to exploit the full capabilities of their terminals when making use of services from a wide range of providers using a variety of potentially incompat-

The COSINE network.



ible equipment, hence improving the market for such services. COSINE has identified a number of problems in providing high-quality services based on the collective efforts of independently managed organizations, and has launched subprojects aimed at the coordination of electronic mail services in Europe, the management of connected electronic networks, and the general problem of defining and monitoring quality of service.

Other COSINE activities have focused on enlarging the use of electronic communications by targeting support on special interest groups, and at improving the security of com-

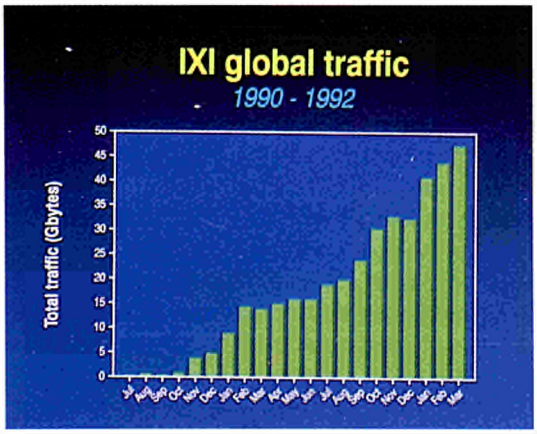
munication by applying security mechanisms to existing standard services.

RARE

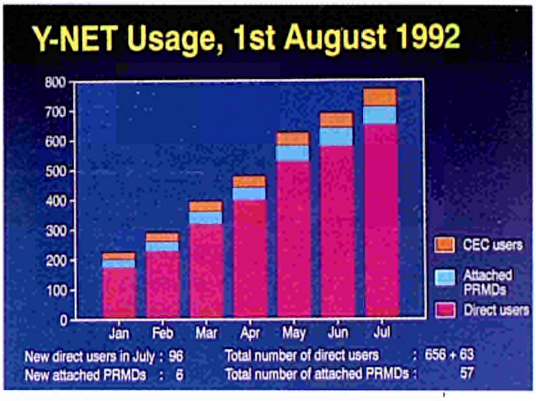
The RARE (réseaux associés pour la recherche européenne) association aims at harmonizing the existing research networks at European level. Some recent initiatives of RARE were supported by ESPRIT. These include the international symposium on high-speed networking organized by RARE in Brussels in 1991, and studies and technical specifications of RARE working groups. Other initiatives of RARE have been strongly encouraged, such as the planning of an 'operational unit' to manage research networking at the European level.

IXI

The usage of IXI, the European X.25 backbone for the R&D community, has further increased (see below). The present phase of IXI provides 64 kbit/s access speed. IXI connects 20 public and private X.25 networks in the Community Member States and EFTA countries. It also provides direct connections to specific organizations (such as JRC, CERN, EuroKom and the CEC).



An initiative is under way to extend the IXI backbone to countries in Central and Eastern Europe (partly funded by the PHARE programme).



European 2 Mbit/s pilot backbone

Preparations in cooperation with the most advanced national research networks have been undertaken to launch a pilot backbone operation at 2 Mbit/s. The participation in this pilot is based on existing or emerging 2 Mbit/s pilots of the national research networks, connected through the international backbone. The plan is to operate the pilot in a way that a multi-protocol service is provided to the national research networks. A first phase with the initial participation of six countries is expected to start in the second half of 1992.

Y-NET

The ESPRIT Y-NET project became operational at the end of 1991. Y-NET is a pilot project for the provision of OSI services based on heterogeneous equipment from Bull, Olivetti and SNI. European-wide electronic mail pilot services are currently provided for R&D in Europe through X.400 systems operated in the Member States. Teleo Spa has been contracted to manage the whole project, and has in turn subcontracted the operations and user support of the national Y-NET nodes to suitable organizations.

The Y-NET national nodes communicate via the IXI network, and are interconnected with the mail networks of national research networks. Gateways to non-OSI electronic mail services are also provided. The Y-NET pilot services are particularly targeted towards users without in-house OSI experience (for example, SMEs), and a national help-desk service is also provided. The introduction of further OSI services is foreseen in the next phase of the project.

ECFRN

The European Consultative Forum of Research Networking (ECFRN), an initiative of persons responsible for research networking in Europe at national and international level, has also been encouraged and supported. ECFRN addresses the evolution of research networking beyond the end of the COSINE project with a view to define and develop improved technical and organizational structures at the European level. A planning document, 'Computer networking for European researchers — the challenges ahead', which can be obtained from ESPRIT, identifies an urgent need for better coordination in this domain by national and European administrations, the introduction of central management for European research networking, and increased backbone facilities.

VALUE

The research network initiatives sponsored by ESPRIT have been closely coordinated with corresponding initiatives sponsored under VALUE in subprogramme II. VALUE initiatives address improved security in OSI communications, an improved X.400 basis for national networks participating in the COSINE message handling systems (MHS) project, and a wider usage of directory X.500 communications in the European research community.

Awareness activities

Encouraging participation

DG XIII plays a very active role in alerting European academia and industry to forthcoming calls for ESPRIT proposals and in assisting potential participants to prepare proposals that stand the best chance of success. In 1991/92, for example:

The 1991 **work programme** and complementary background material were prepared after consultations involving the convening of industrial working groups and experts' workshops and on the basis of guidance and advice from the ESPRIT Advisory Board and Information Technology Committee. An **information package** was prepared containing an overview of the programme, specifications of the form proposals should take, the evaluation and selection criteria employed, detailed notes on contract conditions, and descriptions of consortia-forming mechanisms. In mid-1991 over 25 000 copies were mailed or otherwise distributed, together with the work programme and background material, in support of the autumn 1991 call.

- Fifteen **national information days,** with around 2 500 attendees in total, were held during 1991 in Community and EFTA Member States to help make potential participants aware of the rationale and content of the work programme and the call for proposals. Four **international proposers' days** were organized in Brussels, where over 1 500 participants were given detailed information on each work area and provided with every opportunity to identify potential partners via posters, noticeboards, the use of the Eurocontact database, and the provision of venues for formal and informal meetings. A particular aim of these events was to ensure that information about ESPRIT was efficiently transmitted to the more outlying regions of the Community in order to give them an equal opportunity of participating in the programme.

- As in previous years, DG XIII was greatly assisted in disseminating information about ESPRIT by the **national contact points (NCPs)** established in every Community and EFTA Member State to provide a permanent and visible local presence for ESPRIT. NCPs maintain stocks of ESPRIT publications, provide early notice of calls for proposals, assist potential and actual participants, participate in information days, and administer local versions of the Eurocontact database. The Euroguichets, established to promote access, especially for smaller companies, to Community programmes in general, are another important source of ESPRIT information. **ESPRIT Clubs,** set up in 1991 in France, Spain, Greece, Italy, Denmark, Germany, and the UK under the auspices of local trade, professional or governmental bodies, continue to disseminate information about the programme.

- Potential programme participants were also reached by numerous **articles** and **information notes** written for a wide range of specialist journals, and via the Commission's quarterly *XIII Magazine* and *XIII News Review.*

Promoting contacts and disseminating results

DG XIII also takes an active part in promoting contact between ESPRIT participants. Now that such communications have been established for several years, a European IT community has become firmly established. One outcome of this effort is that a great deal of information exchange now takes place within this community without the Commission's explicit involvement, as shown by the in-

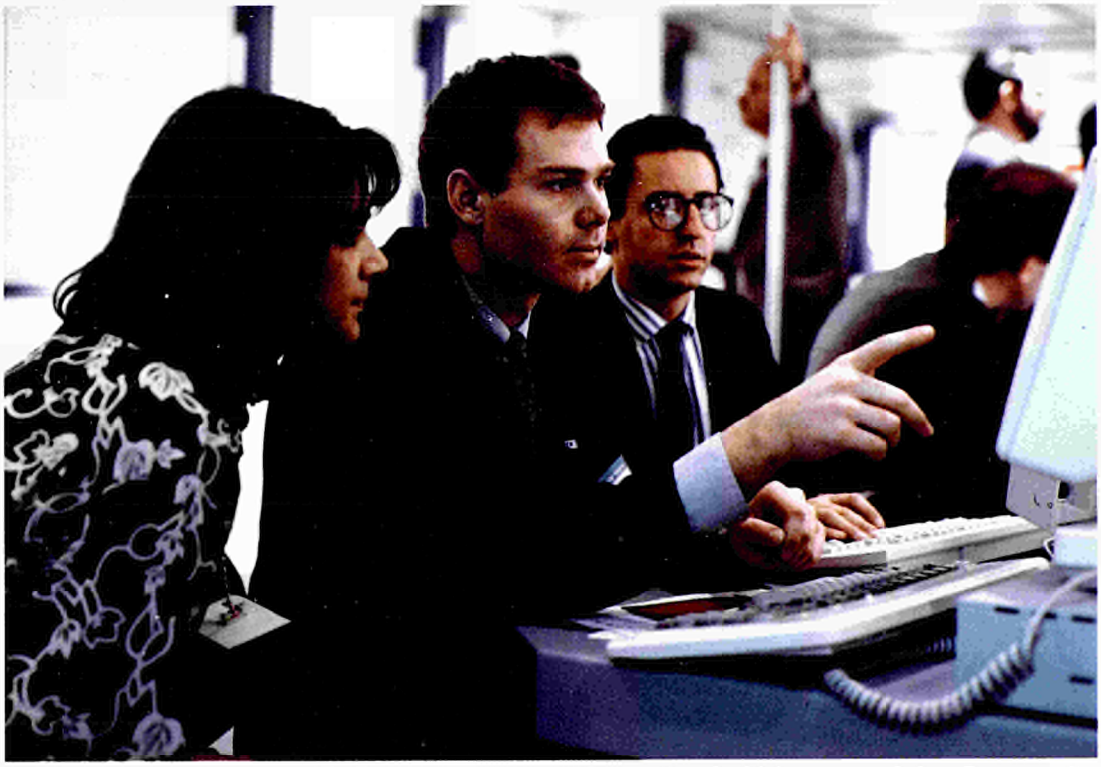
creasing number of European conferences and interest groups set up in the last few years.

The transfer of R&D results into actual use is of prime importance to ESPRIT participants and the European IT industry, and the Commission makes special efforts to provide a supportive framework for technology transfer. The basis for both fostering contacts between participants and publicizing results is provided by the events and services described below.

The seventh **ESPRIT conference and exhibition,** the major annual public event of the ESPRIT programme, was held in Brussels on 25 to 29 November 1991, attracting more than 3 500 participants.

The conference, first held in 1984, addresses both policy and technical issues. Policy is the subject of the day-long **IT Forum,** where leading European decision-makers discuss broad strategic issues of importance to the future of IT in Europe. The technical issues concern the dissemination of results, the cross-fertilization of ideas, and the catalysis of contacts between programme participants. The first three days of the conference are usually devoted to technical sessions, with over 120 presentations including descriptions of important results, panels discussing topics of general interest, and workshops on specific issues. A major feature of the conference week is the **exhibition** of ESPRIT results, which in 1991 featured 125 projects (up from 100 in 1990) involving more than 300 companies. The demonstrations, backed up by a comprehensive exhibition guide made up of **technical fact-sheets,** range from intermediate findings through to industrial prototypes, and in 1991 included impressive results from all areas of the programme.

In addition, the ESPRIT programme is presented at numerous **conferences, workshops** and **seminars** throughout the Community and abroad. With the programme's high profile in the IT community, presentations on ESPRIT are invited for most of the relevant conferences worldwide, and it is common for contributions from ESPRIT project participants to dominate European events. The Commission has exhibited ESPRIT at numerous technology conferences in the past 12 months, held in most of the Community Member States and also in several EFTA countries. The Commission also encourages and sponsors presentations at technical conferences by project consortium representatives.



The 1991 ESPRIT conference exhibition, open to the public for the first time, featured a record 125 projects involving more than 300 companies. The ESPRIT conference continues to function as a leading forum where researchers can learn of the latest results, keep abreast of leading-edge IT developments, share experiences and discuss issues of common concern.

Special interest groups (SIGs) provide an extremely important communications medium between projects with common interests and between projects and industry. Most run autonomously with DGX III support, and publish a variety of newsletters and reports. The current groups are briefly

described, together with their contact points, in the next chapter.

ESPRIT information

The most general and widely used description of ESPRIT projects and their results is contained in the **project synopses.** The multi-volume set contains summary descriptions covering, in each case, a project's objectives, progress, results, and commercial prospects, and giving details of participating organizations, contact points, start date and duration. A master index and list of participants is included. The synopses were completely revised for the October 1991 edition to update, in particular, the 107 new projects and 43 exploratory actions selected for funding following the 1990 ESPRIT II call for proposals. By the autumn of 1992 over 100 000 volumes will have been distributed at various events, by direct mailshot, and in response to enquiries. The next full edition, available in October 1992, will include descriptions of the new ESPRIT III projects. The synopses are also available as an electronic database via the Eurokom service and on the Cordis database.

The **Proteas database** on Cordis has been comprehensively updated with results from ESPRIT projects. Major reports on the final results of ESPRIT projects are increasingly disseminated in the form of **monographs,** and in the past year a good dozen have been published by Springer-Verlag and others. Information is also provided via *XIII News Review,* the supplement to *XIII Magazine,* which covers the activities and programmes supported by DG XIII. This ESPRIT **'Results and progress' report** itself makes available an overview of the programme's status to the interested layperson as well as acting as a reference document.

The **ESPRIT Information Desk** provides institutions, participants (potential and actual), the media and interested individuals and organizations from both within and outside the Community with information about the ESPRIT programme. The type of information requested ranges from the very general (on Community R&D policy) to the very specific (concerning particular projects and participants). As well as dealing with requests for information, the information desk supports ESPRIT involvement at exhibitions, conferences and other public events. In a typical month several hundred requests for documents are received and several thousand documents sent out.

Press-releases and **information sheets** are regularly mailed out or distributed at press briefings and conferences to several hundred periodicals, journalists, companies and institutions. They cover calls for proposals, selection of projects to be funded, announcements of conferences and other notable events or news items.

Special interest groups and ESPRIT Clubs

Microelectronics

CAD for VLSI in Europe (CAVE)

The first CAVE workshop was held in May 1983. Workshops were held in May and December of 1990 and another one in May 1991. The aims of CAVE are to:

— disseminate the results of ESPRIT CAD projects;

— ensure the rapid and consistent exploitation of new research ideas by means of selected tutorials;

— maintain the strong sense of identity of the existing community of CAD researchers in Europe;

— encourage strategic thinking and debate on critical issues and draw up recommendations for future action in this field.

The final CAVE workshop under the sponsorship of ESPRIT was held in Edinburgh in December 1991. The Technical Committee intends to continue the series as an independent activity under the same name.

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VLSI manufacturing automation and standards

This group has the following objectives:

— exchanging views and experience about the implementation of standards and recommending changes and additions to them;

— promoting future industrial cooperative actions for tackling VLSI automation-related problems;

— collating semiconductor manufacturing requirements for automation and reliability in order to provide informal recommendations to manufacturers and users;

— promoting the use of and disseminating information about a uniform set of standards.

The core participants are partners in ESPRIT and EUREKA projects; others may participate by invitation.

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Lithography

This group has the following objectives:

— exchanging views in the field of optical, E-beam and X-ray lithography;

— promoting the standardization of metrology procedures.

The core participants are partners in ESPRIT and EUREKA projects, but others may participate in certain events. A workshop was held at IMEC in June 1991.

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Reliability

The main objectives of the group are to:

— establish a framework for coordinating current and new activities within ESPRIT in this area;

— provide a forum for the dissemination of results and for stimulating their take-up and use in other projects;

— prepare surveys on the state of the art of major reliability issues.

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Analog design

The broad aims of the new NEAR group (Network of European Analog Researchers) are to provide, through a network, a forum for the exchange of ideas; debate and establish an overall strategy for research activities; enable the rapid dissemination of relevant ESPRIT project results; obtain and provide updates on new trends in the analog domain; promote education and training; and enable the formation of new international working relationships in the area of analog circuit design.

Following the enthusiastic introductory workshop held in Milan in September 1991, and to respond to the great interest demonstrated by experts and researchers in the field, a second workshop was held in Scheveningen (NL) in April 1992 and a third in Copenhagen in September 1992. The role of the network was further defined and reinforced, a steering committee was formed to coordinate activities, and a database of European analog researchers created. Two years' activity are planned, together with a bi-annual newsletter and bi-annual workshops.

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Electronic materials

Networks of European experts have been active in various fields of electronic materials science under the framework of the European Materials Research Society which, through conferences and symposia, maintains contacts with over 2 000 researchers. These ESPRIT-funded networks offer both industrial and university researchers open forums for assessing the potential of a variety of new materials, processes and techniques.

The positive work resulting from dynamic interaction of E-MRS members has now been expanded to 13 networks to include topics with increasing importance for both scientific and economic interests. Within a longer term strategy the E-MRS ESPRIT networks also achieved a significant first by succeeding in bringing together the national authorities in charge of materials programmes to discuss the coordination of national and European policies on advanced electronic materials.

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Information processing systems and software

Graphics and interaction

The objective is to encourage information exchange in the computer graphics field. A workshop on user-interface management and design was held in Lisbon in June 1990. Its proceedings (edited by J. Lee et al.) have been published by Springer-Verlag in the Eurographic Seminars series.

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VDM-Europe/Formal Methods Europe

VDM-Europe was formed in 1985 with the aim of increasing the awareness, use, development and standardization of the Vienna

Development Method (VDM). VDM-Europe is being transformed into Formal Methods Europe, a forum for any formal method user, with special attention to industrial use.

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Software maintenance

This SIG acts as a communication forum for its members, who are drawn from industry and research institutes across Europe. The main aim is to establish and publish information on the practice of software maintenance. This brings benefits to the practitioners themselves, who can compare their operations with those of others, and to researchers, who can learn of the problems that truly concern people, and so guide their research accordingly.

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European Languages Standards Group for MIMD Computers

This working group concentrates on standardizing parallel constructs in Fortran 90 and C. Regular meetings are held to write the draft standards. Collaboration is being sought with similar groups in the USA to ensure there is no duplication. Final drafts will be distributed for public comment.

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Metrics

The objective of this group is the promotion of software metrics and certification. Coordinated by PYRAMID (project 5425), it organizes various events throughout the Community, some of which are devoted to specific metrics application areas such as banking, telecommunications, the health sector, etc.

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Advanced business and home systems — Peripherals

Open microprocessor systems initiative (OMI)

OMI aims to provide a complete competitive microprocessor capability for both computer systems and embedded control, ranging from very high performance (over 1 000 Mips) to very low power (down to 0.01 watt). The initiative (which is fully described in Volume 6 of the 1992 edition of the ESPRIT synopses) builds on European strengths in advanced RISC microprocessors, and is both technically and institutionally 'open'. The new family of OMI microprocessors, which is based on both licensed foreign technology (e.g. SPARC, MIPS) and European technology (ARM, Transputer), also includes a next-generation post-RISC family of processors. This microprocessor family will be provided as macrocells in a standard design library of microelectronic components. Systems software also forms an important part of the initiative. Users are involved at all stages of the initiative, both in requirements definition and in pilot applications. Universities will obtain early access to developments under a technology transfer scheme so that the next generation of young hardware-, software- and applications engineers is trained in using the OMI technology. The OMI dissemination pro-

ject (OMI/DIS, 6175) is setting up a number of special interest groups in both the technological and applications domains.

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RICHE (Réseau d'information et de communication hospitalier européen)

The RICHE (project 2221) special interest group provides a focus for suppliers and users in the field of hospital systems to work together in developing a common approach to systems capable of meeting the needs of European hospitals. Although the RICHE project has been successfully completed, the special interest group is continuing as part of the ongoing activities aimed at facilitating the application and further development of RICHE's results. Potential users or other interested parties are welcome to join the SIG.

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Distributed systems (SIGDIS)

Established in February 1991, this SIG aims to stimulate and encourage cooperation between firms and organizations and to help form links with end-users and broad-based end-user groups with interests in distributed systems. The group operates on a six-month rolling programme which includes plenary meetings two or three times a year and meetings of topic-oriented working groups. Workshops have been held in Brussels and Washington DC to discuss the technical achievements and industrial implications of the work on distributed systems, especially the achievements of ISA (project 2267) and COMANDOS (projects 834 and 2071). The workshops helped to identify areas in which collaboration between European and US organizations could be mutually beneficial, and established a basis for more detailed discussions with particular US organizations, including DARPA and NSF.

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European Home Systems Association (EHSA)

The European Home Systems Association (EHSA) has been founded by members of the HOME (project 2431) consortium. Membership or associate membership of the Association is open to organizations, companies or individuals, both in Europe and beyond, who support the following aim: to enable the introduction of integrated applications in homes and buildings by supporting and promoting activities that lead to the harmonization and use of standards for homes and buildings throughout the world.

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Peripherals

The objectives of this SIG are to:

— form a group of experts in the field of peripherals with a common interest in establishing a strong European R&D base;

— propose actions which will fill gaps in the overall European peripherals activity;

— ensure that studies include an analysis of the evolution of the technology with respect to market opportunities;

— define or redefine the notion of 'peripherals' with respect to newly emerging functionalities, manufacturing techniques and market approaches.

The group will meet at least three times a year. It is open to participants in Europe working in the field of peripherals technologies and subsystems who are able to discuss their work (in confidence with other members) in the particular areas to be addressed.

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Computer-integrated manufacturing and engineering

CIM-Europe

CIM-Europe, now in its eighth year, continued its role in disseminating information regarding the progress, achievements and results of CIME, both to the CIM R&D community and to manufacturing industry. The year 1991/92 was characterized by a continued emphasis on public events (the annual conference and many workshops) and the launch of several new CIM-Europe interest groups, which now actively involve about 200 industrialists and researchers.

The highlight of 1992 was the eighth annual conference, with around 250 delegates, which was held in Birmingham, UK on 27 to 29 May and co-hosted by the DTI (UK Department of Trade and Industry). Over 50 presentations were given by world-leading experts, with a particular emphasis on presenting the results of finished or ongoing ESPRIT CIME projects.

During 1991/92 special workshops and tutorials were held on model-based predictive control (Ghent), multisupplier operations (Stuttgart), strategies for implementing CIM (Valencia) and results of ESPRIT CIME projects (Bilbao).

Eight CIM-Europe interest groups are now operational, covering topics such as:

- change and innovation management,
- product data technology, identification systems and security,
- user-interface development environments,
- European manufacturing systems,
- open CIM architectures,
- CIM in the process industry, and
- computer-integrated design of industrial control systems.

The output of the interest groups includes overviews of the current state of the art, discussion papers on future research directions, and descriptions of experiences in introducing CIM technologies.

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Basic research

High-temperature superconductivity (HTSC)

A high-level advisory panel composed of 12 European scientists and industry experts and chaired by Nobel Prize-winner K. A. Müller is advising the Commission on matters related to HTSC activities. In 1990 the panel met twice. In its first session a workplan for low-current applications was discussed and endorsed. The second session, which took place on 26 and 27 November in Strasbourg, was organized in tandem with a workshop where Community-funded HTSC projects presented their research work and results. The panel also advised the Commission on the preparation of a brochure on superconductivity.

In 1991, the panel met in November to examine the coverage of the HTSC area in the proposals submitted in response to the ESPRIT call and to recommend the proposals which, by their quality and relevance, would be suitable for support. The panel also discussed and endorsed the organization of the second HTSC contractors' workshop,

which is taking place in Strasbourg on 2 and 3 November 1992.

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Information Exchange System

RARE

RARE is the Association of European Research Networking Organizations and their users. Since 1986 RARE has fostered cooperation between its members to develop a harmonized computer communications infrastructure. RARE's aim is to enable researchers to communicate, to use information and to access computer resources throughout Europe and in other continents.

RARE currently has 39 members, consisting of national networks, user organizations and other organizations concerned with research networking.

By organizing an annual networking conference, RARE stimulates contacts between key people in networking worldwide.

Between 1986 and mid-1991 seven RARE working groups were each responsible for developing coordination and cooperation in their specific technical area, such as MHS, FTAM, information services and directories, network operations and lower layer technology, full screen services, high-speed communications and ISDN and management of network application services.

Funding from ESPRIT supported the work of the RARE technical specialists, enabling them to meet and carry out their programmes.

By mid-1991 RARE reorganized its technical structures: a set of new working groups and *ad-hoc* task forces now carries out a RARE technical programme under the guidance of the RARE Technical Committee. Those activities were partly funded by the Commission VALUE programme.

During 1991 RARE also initiated the setting up of a single operational unit for the management of computer networking services for the European research community.

RARE is represented in a substantial number of professional and standardization organizations such as ETSI, EWOS, ECTUA, EEMA, and the Internet Society.

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The above are available from:
ESPRIT Information Desk
BU29 1/28
200 rue de la Loi
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Mr Patrick Pype
IMEC VZW
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Projects and participants

Microelectronics

10
High-level CAD for interactive layout and design
Bull, Daimler Benz, GEC, Plessey Company

14
Advanced interconnect for VLSI
GEC, Plessey Company, Telefunken Electronic, Thomson-CSF

97 **CATHEDRAL**
Advanced algorithms, architecture and layout techniques for VLSI dedicated digital signal processing chips
Bell Telephone, IMEC, Philips, Ruhr-Universität Bochum, Siemens

232
Compound semiconductor materials and integrated circuits - I
Philips, Plessey Company, Siemens, Thomson-CSF

243
Submicron bipolar technology - I
Cemota, Plessey Company, Technische Universität Berlin, Telefunken Electronic, Thomson-CSF

244 **HYETI**
High-yield, high-reliability ULSI system
British Telecommunications, Bull, CEA, Cirrus Computer, IMAG-LGI, INPG, SGS-Thomson Microelectronics, Technische Hochschule Darmstadt, University of Brunel

245
Silicon-on-insulator (SOI) materials and processing: towards 3-D integration
CEA, CNET, GEC, National Microelectronics Research Centre, SGS-Thomson Microelectronics, University of Cambridge

255
CAD methods for analogue and GaAs monolithic ICs
CISE, Politecnico di Torino, Siemens, Telettra

263
Integrated optoelectronics on InP
Alcatel, Alsthom Recherche, CNET, CSELT, GEC Research, Marconi Research, Heinrich-Herz, Standard Elektrik Lorenz, STC-ICL, Thomson-CSF

271 **ADVICE**
Automatic design validation of integrated circuits using E-beam
British Telecommunications, CNET, CSELT, IMAG-LGI, Trinity College Dublin

281
Submicron bipolar technology - II
RTC, Siemens

305
Assessment of silicon MBE layers
Daimler Benz, GEC, ISA Riber

334
Plasma deposition technology for magnetic recording thin-film media
BASF, Leybold Heraeus, SAGEM

369
Physical-chemical characterization of silicon oxynitrides in relation to their electronic properties
IMEC, Matra-MHS, Philips, UKAEA, Universiteit van Utrecht

370
Silicon-on-insulator systems combined with low-temperature silicon epitaxy
GEC, IMEC, Mietec

380
Optical interconnect for VLSI and high bit-rate ICs
GEC Research, Marconi Research, Telettra, University of Southampton

412 **BiCMOS**
A high-performance CMOS bipolar process for VLSI circuits
Philips, Siemens

443
Molecular engineering for optoelectronics
CNET, ICI, Imagedata, Thomson-CSF, université Notre-Dame de la Paix

456
Improvement of yield and performance of ICs by design centring
AEG, SGS-Thomson Microelectronics, Telefunken Electronic, Universität Stuttgart

491
Materials and technologies for high mobility TFTs for LC display-bus drivers
AEG, CNET, CSEE, Thomson-CSF

509
Substrates for CMOS VLSI technology
IMEC, Matra-MHS, SGS-Thomson Microelectronics

514
Quantum semiconductor devices
GEC, Thomson-CSF

519

Dopant profiling for submicron structures

Daimler Benz, GEC, IMEC

522

Compound semiconductor materials and integrated circuits - II

Bell Telephone, CNET, Farran Technology, GEC, STC-ICL, Telefunken Electronic

544

Investigation of all aspects of interconnection of high pincount ICs

BPA-Technology and Management, British Aerospace, Lucas, National Microelectronics Research Centre

554 **SPECTRE**

Submicron CMOS technology

Århus Universitet, British Telecommunications, Bull, CNET, CNR-Istituto Lamel, IMEC, Matra-MHS, SGS-Thomson Microelectronics, Telettra, UKAEA, université catholique de Louvain

574

High-resolution plasma etching in semiconductor technology: fundamentals, processing and equipment

Fraunhofer IM, Johnson Matthey Chemical, Leybold Heraeus, Mono Light Instruments, UKAEA

802 **CVS**

CAD for VLSI systems

Alcatel, British Telecommunications, CNET, CSELT, Daimler-Benz Elektronik Centralen, GMD, Italtel Telematica, Matra-MHS, SGS-Thomson Microelectronics

824

Wafer-scale integration

British Telecommunications, CEA, INPG, National Microelectronics Research Centre, SGS-Thomson Microelectronics, Technische Hochschule Darmstadt

830

Packages for high-speed digital GaAs integrated circuits

Mo Valve Company, Thomson-CSF

833

Large-area complex LCDs addressed by thin-film silicon transistors

AEG, Aristoteles University of Thessaloniki, CNET, GEC, Modulex, Thomson-CSF, Università di Bologna

843

Compound semiconductor ICs

Farran Technology, GEC, Philips, Plessey Company, Siemens, STC-ICL, Thomson-CSF

887 **ECIP**

European CAD integration project

Alcatel, Bull, Philips, SGS-Thomson Microelectronics, Siemens, STC-ICL

888 **AIDA**

Advanced IC design aids

SGS-Thomson Microelectronics, Siemens, STC-ICL

927

Basic technologies for GaInAs MISFETs

Aixtron, Philips, RWTH Aachen, Wacker-Chemie

957

High-density mass storage memories for knowledge and information storage

Bull, BASF, CEA/LETI, Thomson-CSF, Simulog, Glaverbel, Bogen Electronic

958

High-performance VLSI packaging for complex electronic systems

British Telecommunications, Bull, GEC Research, Marconi Research

962 **EVEREST**

Three-dimensional algorithms for robust and efficient semiconductor simulator

Analog Devices, GEC, IMEC, National Microelectronics Research Centre, Philips, Rutherford Appleton Laboratory, SGS-Thomson Microelectronics, STC-ICL, Trinity College Dublin, Università di Bologna, University College Swansea

971

Technology of GaAs-GaAlAs bipolar integrated circuits

CNET, Farran Technology, GEC, Plasma Technology, Plessey Company

986

Optical interconnect for VLSI and high bit-rate ICs

GEC Research, Marconi Research, Telettra, University of Southampton

991

Multiview VLSI-design system ICD

British Telecommunications, ICS, INESC, PCS Computersysteme, Technische Universiteit Delft, Technische Universiteit Eindhoven, University of Essex

1007

0.5 micron X-ray lithography: sources, masks, resist and transferred image

CNR-IESS, CNRS, King's College London, SGS-Thomson Microelectronics, Thomson-CSF

1043

Advanced mask and reticle technology for VLSI submicron microelectronics devices

BMP Plasmatechnologie, British Telecommunications, Ferranti, IMEC, Siemens, Valvo Unternehmensbereich

1056

Ultrasensitive impurity analysis for semiconductor structures and materials

Cameca, IMEC, Philips Research Laboratories UK, Siemens

1058

Knowledge-based design assistant for modular VLSI design

IMEC, INESC, Philips

1128

Large diameter semi-insulating GaAs substrates suitable for LSI circuits

Philips, université catholique de Louvain, Wacker-Chemie

1270

Advanced processing technology for GaAs modulation doped transistors and lasers

CNET, Elltec, Forth Research Centre, Plessey, University of Wales

1551 **AMS**

Advanced manufacturing system

Marconi, SGS-Thomson Microelectronics

1563 **ACAFS**

Automatic control of an ASIC fabrication sequence as demonstrated in the plasma etch area

Bertin & Cie, European Silicon Structures, Leybold Heraeus, Mietec, Plasma Technology

2016 **BASE**

Bipolar advanced silicon for Europe

IMEC, Philips Gloeilampenfabrieken, Plessey, Ruhr-Universität Bochum, SGS-Thomson Microelectronics, Siemens Semiconductors, Technische Hochschule Darmstadt, Technische Universität Berlin, Telefunken Electronic, Trinity College Dublin, Università di Catania, Swindon Silicon Systems, DRA, National Technical University of Athinai

2035

Advanced GaInAs-based transistors for high-speed integrated circuits

Farran Technology, Forth Research Centre, Philips, Picogiga, Plessey, STC-ICL, Thomson-CSF, Universidad Politécnica de Madrid, université de Lille

2039 **APBB**

Advanced PROM building blocks

Deister Electronic, Eurosil Electronic, Gemplus Card International, IMEC, INESC, INPG, Plessey, SGS-Thomson Microelectronics, Università di Bologna, University College Cork

2048

Deep UV lithography

ASM-Lithography, CEA/LETI, Carl Zeiss, Fraunhofer-IPA, Hoechst, Nederlandse Philips Bedrijven, Siemens, Siemens Semiconductors, University of Edinburgh

2072 **ECIP**

European CAD integration project

Bull, INESC, INPG, Institut méditerranéen de technologie, Nederlandse Philips Bedrijven, SGS-Thomson Microelectronics, Siemens, Siemens-Nixdorf , ICL, Universität Paderborn, Thomson-CSF, Thomson-CSF/SINTRA-ASM, UCI microélectronique, Rutherford Appleton Laboratories, University of Manchester, GMD

2075 **APACHIP**

Advanced packaging for high performance

Bull, GEC Research, Hoechst Ceramtec, MCTS, National Microelectronics Research Centre, Siemens-Nixdorf, Souriau & Cie, Technische Universität Berlin

2193 **ADCIS**

Analogue/digital CMOS ICs

Anacad-Computer Systems, CNM, CNET, Instituto Superior Técnico, Matra-MHS, Mietec, National Microelectronics Research Centre, Universidad de Sevilla

2197 **STORM**

Process modelling and device optimization for submicron technologies

CNET, CNR-Istituto Lamel, Fraunhofer IM, IMEC, National Microelectronics Research Centre, Plessey, SGS-Thomson Microelectronics, Università di Bologna

2260 **SPRITE**

Interactive silicon compilation for high-performance integrated systems

CGED, IMEC, INESC, Philips, Racal Research, DRA, Siemens

2265 **DRYDEL**

Dry develop optical lithography for ULSI

CEA, Farran Technology, IMEC, Philips, Plessey, Siemens, UCB Electronics

2268 **CANDI**

Combined analogue/digital integration

AEG, Alcatel Standard Electrica, Dosis, Fraunhofer-IMSS, Plessey, SGS-Thomson Microelectronics, Telefunken Electronic, Thomson-CSF, Universität Dortmund, université Pierre et Marie Curie

2270 **IDPS**

Integrated design and production system

Bell Telephone, CNET, INMOS, Plessey, SGS-Thomson Microelectronics, Siemens, Siemens-Nixdorf , STC-ICL, Thomson-CSF

2272 **SMILE**

Technological feasibility of high-voltage smart-power ICs for lighting applications

Alcatel Standard Electrica, CNM, Elektronik Centralen, National Microelectronics Research Centre, Philips, SGS-Thomson Microelectronics, Università di Genova, Università di Pisa

2281 **UNITED**

High-T_C superconducting thin films and tunnel junction devices

CNRS, Philips, Thomson-CSF, université de Paris-VII, Universiteit Van Twente, University of Cambridge

2284

Optoelectronics with active organic molecules

CEA, CNET, ICI Imagedata, Thomson-CSF, université Notre-Dame de la Paix

2289 **OLIVES**

Optical interconnections for VLSI and electronic systems

AKZO International Research, CNM, Forth Research Centre, IMEC, Plessey, Siemens, STC-ICL, Swiss Federal Institute of Technology, Thomson-CSF, University College London

2318 **EVEREST**

European vanguard efforts on research and engineering of systems for testing

Bennetts Associates, Bull, Elektronik Centralen, Herie, IMEC, INESC, Philips, Scantest System, Siemens, Technische Universiteit Eindhoven, Telefónica, Universidad de Cantabria, Universidad Politécnica de Cataluña, Universidad Politécnica de Madrid, Universität Duisburg, Universität Gesamthochschule Siegen, université de Montpellier, University College Dublin, University Brunel, RE Technology

2319

ASIC multichamber rapid thermal processing with microwave enhancement

CEA, CNRS-LAAS, SGS-Thomson Microelectronics, Sitesa, Addax, STC-ICL, University of Edinburgh

2394 **ASAC**

Application-specific architecture compilation

Bull, Hitec, INESC, Ing. C. Olivetti, SGS-Thomson Microelectronics, Siemens, STC-ICL, UMIST

2403 **MCBRIDE**

Development of a multichamber batch reactor for the production of multilayer interpoly dielectrics

AMTC, CEA/LETI, SGS-Thomson Microelectronics

2426 **IDPS**

Very fast implementation of complex systems on silicon

Bull Italia, Bull, ES2, IMEC, Marconi, Philips, Robert Bosch Silicon & Software Systems, University of Strathclyde

2430 **BiCMOS**

A high-performance CMOS/bipolar process for VLSI circuits

Entwicklungszentrum für Mikroelektronik, INESC, Nederlandse Philips Bedrijven, Phoenix, VLSI Consultants, Siemens Semiconductors, Trinity College Dublin, Universität Stuttgart

2437 **ICARE**

Industrial characterization of an advanced resonant etcher

Alcatel, CEA-LETI, CNM, CNET, Nederlandse Philips Bedrijven, STC-ICL, Trinity College Dublin

2478

Research into boundary scan test implementation

Elektronik Centralen, INESC, Matra, Philips, SGS-Thomson Microelectronics, Siemens, Silicon & Software Systems, Thomson-CSF

2518

Wafer and epilayer improvement correlated with device performances for InP-based optoelectronics

Aixtron, ICI Wafer Technology, Philips-LEP, RWTH Aachen

5002

New generation DUV-stepper optics

ASM-Lithography, Carl Zeiss, Heraeus Quarzschmelze

5003 **PLANET**

Multiwafer planet MOVPE reactor

Nederlandse Philips Bedrijven, Aixtron, Polyflow, Telefónica

5004 **SEDESES**

Selective deposition of silicides and epitaxial silicon

Advanced Semiconductor Materials International, Alcatel, CNET, IMEC, National Microelectronics Research Centre, Siemens

5005 **ESD**

Protection for submicron technologies

IMEC, Philips, Siemens, Technische Universität München

5014

Mask and reticle technology for advanced high-density and ASIC devices

Balzers, BMP, Plasmatechnologie, Compugraphics International, IMEC, Polymer Laboratories, Semisystems, Siemens, Valvo Unternehmensbereich, Wild Leitz Instruments

5018 **COSMIC**

GaAs monolithic analogue circuits for microwave communication systems up to 23 GHz

Argumens, CNET, Forth Research Centre, Fraunhofer-IIS, Ingenieurbüro für IMHT, Philips, Picogiga, Plessey, DRA, Siemens, Telefónica, Telettra, Università di Roma-La Sapienza

5020 **PATRICIA**

Proving and testability for reliability improvement of complex integrated architectures

Abstract Hardware, GEC, Italtel Telematica, Politecnico di Milano, University of Bristol

5026 **METRICS**

High precision automated CD metrology station

Nederlandse Philips Bedrijven, IMEC, Integrated Circuit Testing, Rutherford Appleton Laboratory, SGS-Thomson Microelectronics, Siemens, University of Edinburgh

5029 **SUBSOITEC**

High-performance submicron SOI/CMOS technologies

CEA, CNRS-LPCS, Fraunhofer, Marconi, National Microelectronics Research Centre, Sextant Avionique, SGS-Thomson Microelectronics, Telefunken Systemtechnik, Thomson-CSF, University of Sheffield

5030 **FREE**

Fast reticle equipment for Europe

ELISA, Cambridge Instruments, SGS-Thomson Microelectronics, Valvo Unternehmungsbereich, University of Cambridge, Technische Universiteit Delft, National Research Centre 'Demokritos'

5031 **MOSDT**

Metal-organic research for semiconductor epitaxy

Forth Research Centre, ISA Riber, DRA, RWTH Aachen, Thomson-CSF, CNET, Universität Stuttgart, CNR, Metaleurop Preussag Pure Metals, SMI Organometallic Division

5032 **AIMS**

Advanced integrated millimetre-wave subassemblies

Alcatel, Daimler-Benz, Elektronik Centralen, Telefunken Electronic, Telefunken Systemtechnik, Thomson-CSF, université de Lille

5033 **PLASIC**

Performance and reliability of plastic encapsulated CMOS ASICs

Elektronik Centralen, Mietec, National Microelectronics Research Centre, SGS-Thomson Microelectronics, Standard Elektrik Lorenz

5041 **PROMIMPS**

Process module integration for a multichamber production system

Alcatel, AST Elektronik, Balzers, CEA, CSIC, Fraunhofer-IFT, Philips, Plasmos, SGS-Thomson Microelectronics, Siemens

5047 **QUICKCHIPS**

A very quick turnaround system for ASIC design and manufacturing supporting multiple design tools and implementation technologies

INESC, CPRM, Milano Research Centre

5048 **ACCES**

ASIC 0.5 micron CMOS

British Telecommunications, CNET, European Silicon Structures, IMEC, Matra-MHS, Mietec, Plessey, Standard Elektrik Lorenz, STC-ICL, Telefónica, Telefunken Electronic

5051 **MORECO**

Integrated circuits for mobile reader and communicator for ISO-standard smart-cards

Telefónica Sistemas, Bull, Philips Composants, Telesincro, Sinory, ELGEIEC

5052 **MONOFAST**

Monolithic integration beyond 26.5 GHz

Alcatel, Farran Technology, GAAS Code, National Microelectronics Research Centre, University of Cambridge, University of Glasgow

5056 **AD 2000**

Advanced CMOS analogue/digital and digital/analogue converters

Instituto Superior Técnico, Italtel SIT, Universidad de Sevilla (AICIA), Università di Pavia, Fujitsu Spain

5075 **IDPS**

Integrated design and production system

Philips International, Robert Bosch, ES2, SGS-Thomson Microelectronics, Siemens, Plessey, STC-ICL, Bull

5080 **JPL**

Joint logic project

Philips International, ES2, Plessey, Siemens-Nixdorf, Telefunken Electronic, SGS-Thomson Microelectronic, Mietec, Matra-MHS

5081

Manufacturing science and technology

Siemens-Nixdorf, ES2, Mietec, Plessey, SGS-Thomson Microelectronics, Telefunken Electronic, STC, Philips International, Matra-MHS

5082

JESSI CAD-frame

Siemens-Nixdorf, Technische Universiteit Delft, ICL, Swedish Telecom, Siemens, SGS-Thomson Microelectronics, Nederlandse Philips Bedrijven, Bell Telephone, University of Manchester, Universität Paderborn, Fernuniversität Gesamthochschule Hagen, Swedish Institute of Microelectronics, Plessey, Forschungszentrum Informatik an der Universität Karlsruhe, IMEC, GMD, CNET, Robert Bosch

5083 **GAME**

Special action in microelectronics for Spain

By mid-1991 over 30 projects had been proposed to the GAME committee for support under this action

5084 **CTA-SME**

Concerted technology access for small and medium-sized enterprises

5691 **AICI**

Special action in microelectronics for Portugal

INESC, Animec, Tecmic, Challenge

5692 **VLSI-DPE**

Special action in microelectronics for Greece: Hellenic VLSI design and prototyping environment

Intracom, Ergon, Zenon, University of Patras, National Technical University of Athinai, Computer Technology Institute, Forth Research Centre, University of Thrace Demokritus, NCSR Demokritos, L-Cube

6016 **CLASSIC**

Components for large-signal 60 GHz GaAs integrated circuits

Argumens, CPRM, Daimler-Benz, Instituto Superior Técnico, Picogiga, Telefunken Systemtechnik, Thomson Composants Microondes, Thomson-CSF, Université de Limoges, Ustlfa

6043 **QUICKCHIPS**

A new system supporting ASIC design and providing rapid turnaround prototyping

CPRM, Himt, IMEC, IMS Stuttgart, INESC, Intracom, Italtel Telematica, Lasarray Holding, University of Patras

6050 **MANPOWER**

Manufacturable power MMICs for microwave systems applications

Argumens, Ceselsa, Dassault Electronique, GEC-Marconi Materials Technology, Oxley, Philips, Politecnico di Torino, Siemens Aktiengesellschaft, Telettra España, Telettra, UCD, Universidad de Cantabria, Universita di Padova, Universita di Roma II-Tor Vergata, Universität Wien

6075 **DESSIS**

Device simulation for smart integrated systems

Bosch, STM-SGS-Thomson Microelectronics, Swiss Federal Institute of Technology, Universita di Bologna

6128 **FORMAT**

Formal methods in hardware verification

Abstract Hardware, Italtel Telematica, Siemens Nixdorf, Tecnologia Grupo INI, Telefonica, Universidad Politecnica de Madrid, Universität Oldenburg, Universität Passau

6134 **HIRED**

High-power red laser for optical recording

Aixtron, IBM Zürich, IMEC, Philips, Universität Stuttgart, University of Surrey

6135 **MIDAS**

Multilayer integrated devices in advanced silicon

Daimler-Benz, Defence Research Agency, IMEC, Linköping University, Philips, Plessey Company, Siemens, Technische Universität Wien, Telefunken Electronic

6137 **FELMAS**

Ferroelectric layers for memory applications and sensors

CEA, EPFL, IMEC, Marconi, Philips, Thomson-CSF

6138 **ARTEMIS**

Advanced research on test and evaluation of mixed signal ICs and systems

Elektronikcentralen, IMEC, INESC, Jenoptik Carl Zeiss, Philips, SGS-Thomson Microelectronics, Thomson-CSF

6164 **VIP**

VLSI postprocessor

Cambridge Instruments, Elisa, European Silicon Structures, IMS Stuttgart, Sigma-C

6200 **IMPROD**

IC multistep process diagnosis

Bosch, CMSU, Consorzio Milano Ricerche, Queen's University Belfast, SGS-Thomson Microelectronics

6240 **B-ASICS**

Bio-sensitive ASICs for smart sensors in medical and environmental monitoring

CBL, Eurosil Electronic, FBA, Frauenklinik, National Microelectronic Research Centre

6276 **HOLICS**

Hierarchical optical interconnects for computer systems

Eidgenoessische Technische Hochschule, GEC-Marconi Materials Technology, IMEC, Siemens, Technical Research Center of Finland, Thomson-CSF

6285 **IBCAR**

Integration of buried capacitors and resistors in ceramic substrate

Combitech Electronics, Du Pont de Nemours Deutschland, Magneti Autronica, Matra, National Microelectr Research Centre, Sorep

6318 **EASE**

European applications for SMEs to improve the exploitation of semiconductor technologies

CEA-LETI, CNFM, CNR, Elektronikcentralen, European Silicon Structures, Fraunhofer IFT, Grupo Activ Microelectrónica España, IMEC, INESC, Institut für Angewandte Mikroelektronik, Intracom, Rutherford Appleton Laboratory, Stichting Centra Voor Mikroelektronica

6374 **MMM GAS**

Materials methods and microtechnologies for selective gas sensing

CNM, Eniricerche, FHG/IFT, IMT, INFM, MBB, Schlumberger Industries

6380 **INDCHIP**

Increasing the usage of ASIC technology by the SMEs of Europe

European Silicon Structures, IDPS Consortium, IMEC, Plessey Company, Rutherford Appleton Laboratory

6386 **ASAP**

Advanced single chip ASIC plastic packaging

ASM/Fico, Bell Telephone, Mietec, National Microelectronic Research Centre, SGS-Thomson Microelectronics, Siemens, Standard Elektrik Lorenz

6416 **MAXIMA**

Multiaxial monolithic integrated accelerometer

Ambit, Bosch, Centro Nacional de Microelectrónica, Fraunhofer IMT, Seat, Universidad Politécnica de Cataluña, University of Uppsala

6427 **ADAPT**

Advanced deposition and processing tools

Bronkhorst High-Tech, Dresdner Anlagen Systeme, Harwell Laboratory, MTG

6484 **POWERCAD**

Computer-aided design tools for power-integrated circuits and systems

Alcatel Standard Electrica, Anacad Computer Systems, Fraunhofer IFT, UCD, Universidad de Cantabria, Universidad Politécnica de Madrid

6485 **STATIC**

Silicon technology for automotive and telecommunications integrated circuits

Alcatel Bell Telephone, Alcatel Standard Electrica, BMW, Centro Nacional de Microelectrónica, Elmos, Fraunhofer-IMS, Mietec, SGS-Thomson Microelectronics

6490 **TRIMOD**

Three-dimensional modules packaging

Alcatel, Implex, MBB, Motorola, National Microelectronic Research Centre, Thomson-CSF, University of Sheffield

6498 **CHESS**

A MIPS cruncher for a distributed concurrent heterogeneous simulation system

Dazix, Italtel Telematica, Sican, Technische Universiteit Delft, Universita di Genova

6505 **AMIS**

Application modular integrated sensors

CEA, CNRS-LAAS, Elmos, Esiee — École supérieure d'ingénieurs électronique, Fraunhofer-IMS, IMT, Sagem

6549 **MOSAIC**

Monolithic and hybrid optoelectronic smart assembled integrated circuits

Alcatel Alsthom Recherche, British Telecommunications, CEA — Commissariat à l'énergie atomique, CNET, Danmarks Tekniske Højskole, Eidgenössische Technische Hochschule, Epitaxial Products International, IMEC, Siemens

6640 **ADMIRE**

Advanced mixed signal integrated design environment

EDC, Elektronikcentralen, Esat, Racal Research, Thomson-CMS

6677 **UNITED-II**

High T_c superconducting magnetic field sensors and digital circuitry

Defence Research Agency, Dornier, Thomson-CSF, Thomson-Sintra, Université de Paris VI, Universiteit van Twente, University of Cambridge

6792 **BOLD**

Beyond 0.3 micron optical lithography development

ASM-Lithography, Carl Zeiss, CEA-LETI, Fraunhofer AIS, Fraunhofer IMT, IBM Deutschland, IMEC, Philips

6793 **ASPRO**

Improved i-line steppers

ASM-Lithography, Carl Zeiss, CNET Grenoble, Fraunhofer AIS, IBM France, IMEC, Philips Semiconductor

6800 **RETIDES**

Real-time DSP emulation system

EDC, INCA, Katholieke Universiteit Leuven, Philips ITCL, Thomson-CSF

6828 **MODSYMEL**

Modular X-ray diffraction system for the characterization of materials for electronics

CNET, CNR Istituto Lamel, CSELT, Seifert

6908 **JEEPS**

Joint European enterprise in phase shift, advanced mask technology: towards 0.25 micron

CEA-Leti, Compugraphics International, Fraunhofer IFT, IHP, IMEC, Philips Semiconductors, Philips, Rutherford Appleton Laboratory, SGS-Thomson Microelectronics, University of Dundee

7101 **MINOSS**

Microintegrated intelligent optical sensor systems

Forschungs Joanneum Research, Intracom, IRST, Kapsch, Mietec, NTUA-Microwave and Optics Group, Universita degli Studi di Pavia, University of Kent

7161 **ACCESSCVD**

Application of a customized CFD environment to the study and simulation of chemical deposition

ASM International, Concentration Heat and Momentum, Fraunhofer AIS, Siemens, Technische Universiteit Delft

7236 **ADEQUAT**

Advanced developments for 0.25 micron CMOS technologies

CEA-Leti, CNET, CNR Istituto Lamel, CNRS, Fraunhofer IFT, IMEC, Max-Planck Institut für Festkörperforschung, National Microelectronic Research Centre, Philips, Plasma Technology, Plessey Semiconductors, RWTH Aachen, SERC/RAL, Siemens, Technische Universität Wien, Technische Universiteit Delft, Technische Universiteit Eindhoven, Universita di Bologna, Universita di Catania, Universita di Modena, Universita di Parma, Universita di Pisa, Universität Hannover, Universiteit van Twente, Universiteit van Utrecht, University of Salford, University of Southampton, University of Surrey, University of Warwick

7284 **APT**

Pellicle technology development for advanced high-density and ASIC devices

IMEC, Mietec, Polymer Laboratories, Semilab

7327 **DIASYSCON**

Development of an advanced diagnostic system for sub-ppt, metal contamination in silicon wafer manufacturing and process

CEA, Gemetec, MEMC, SGS-Thomson Microelectronics

7334 **SUPACT**

Active superconductive components for high-frequency electronic circuits

CEA, GEC Marconi, Siemens Aktiengesellschaft, TH Ilmenau, Université Joseph Fourier-Grenoble, University of Cambridge

7363 **LOGIC**

Joint logic project

CNET, European Silicon Structures, Eurosil Electronic, IMEC, Matra-MHS, Mietec, Philips International, Plessey Company, SGS-Thomson Microelectronics, Siemens

7364 **JCF**

JESSI common frame

Bosch, Technische Universität Delft, Forschungszentrum Informatik, GEC Plessey Telecommunications, GMD, IMEC, INESC, National Microelectronic Research Centre, Philips, SGS-Thomson Microelectronics, Siemens, Siemens Nixdorf, STC-ICL, Swedish Telecom, Technische Hochschule Darmstadt, Universität Hagen, Universität Paderborn, University of Manchester

7365 **MST**

Manufacturing science and technology for front-end and back-end IC production

European Silicon Structures, Matra-MHS, Mietec, Philips International, Plessey Company, SGS-Thomson Microelectronics, Siemens, Telefunken Electronic

Information processing systems and software

26

Advanced algorithms and architectures for speech and image processing

AEG, CSELT, GEC, Thomson-CSF, université Louis Pasteur de Strasbourg

32 **PCTE**

A basis for a portable common tool environment

Bull, GEC Research, Marconi Research, Ing. C. Olivetti, Siemens-Nixdorf, STC-ICL

96 **ESB**

Expert system builder

CIMSA, CSELT, Plessey, Søren T. Lyngsø, Tecsiel

107 **LOKI**

A logic-oriented approach to knowledge and databases supporting natural user interaction

BIM, Cretan Computer Institute, Fraunhofer-IAO, Scicon, SCS Informationstechnik

112

Knowledge integration and management systems

Alcatel, Alsthom Recherche, Bull, Siemens

125 **GRASPIN**

Personal workstation for incremental graphical specification and formal implementation of non-sequential systems

ALGMD, Ing. C. Olivetti, Siemens, Tecsiel

256

Time dependency and system modelling in KBS design for industrial process applications

CISE, Framentec

266 **PEACOCK**

Software development using concurrently executable modules

Eurosoft Systems, Hatfield Polytechnic, Roke Manor Research, Universität Dortmund, Universität Karlsruhe

267 **ASSET**

Automated support for software engineering technology

GPP, Plessey

280 **EUROHELP**

Intelligent help for information systems users

Courseware Europe, CRI, DDC/CRI, STC-ICL, University of Leeds

282 **SPMMS**

Software production and maintenance management support

Data Management, GSI Tecsi Software, Sema Metra Group, Siemens, Alcatel, Sofemasa, STC-ICL

283 **FOR-ME-TOO**

Formalisms, methods and tools

Bull, CSELT, Siemens, Syseca

300 **REQUEST**

Reliability and quality of European software

AEG, CISI, Elektronik Centralen, Esacontrol, GRS, BNR-Europe, Thomson-CSF, UKAEA

302

Investigation of performance achievable with highly concurrent interpretations of functional programs

CAP Sogeti Innovation, INRIA, STC-ICL, University of Stirling

304

Design of techniques and tools to aid in the analysis and design of knowledge-based systems

Scicon, SCS Informationstechnik, South Bank Polytechnic, STC-ICL, Universiteit van Amsterdam

311 **ADKMS**

Advanced data and knowledge management systems

Bull, Ing. C. Olivetti, Siemens-Nixdorf, Technische Universität Berlin

315 **RAISE**

Rigorous approach to industrial software engineering

Brown Boveri & Cie, CRI, STC-ICL

316 **ESTEAM**

An architecture for interactive problem solving by cooperating data and knowledge bases

CAP Sogeti Innovation, CSELT, ONERA-Centre, Philips, Politecnico di Milano

348 **GIPE**

Generation of interactive programming environments

BSO, CWI, INRIA, Sema Metra Group

387 **KRITIC**

Knowledge representation and inference techniques in industrial control

British Telecommunications, Framentec, Krupp, Queen Mary College

390 **PROSPECTRA**

Program development by specification and transformation

Alcatel Standard Eléctrica, CRI, Syseca, Systeam, Universität Bremen, Universität des Saarlandes, Universität Dortmund, Universität Passau, University of Strathclyde

393 **ACORD**

Construction and interrogation of knowledge bases using natural language text and graphics

Alcatel, Alsthom Recherche, Bull, Triumph Adler

401 **ASPIS**

Application software prototype implementation system

CAP Sogeti Innovation, GEC Research, Marconi Research, Ing. C. Olivetti, Tecsiel, université Joseph Fourier (Grenoble)

410 **SEDOS**

Software environment for the design of open distributed systems

Agence de l'informatique, Bull, CNRS-LAAS, Politecnico di Milano, STC-ICL

415 **PALAVDA**

Parallel architectures and languages for AIP: a VLSI-directed approach

CSELT, Daimler-Benz, GEC, Philips, Siemens-Nixdorf, Bull

419 **IMU**

Image and movement understanding

Captec, Katholieke Universiteit Nijmegen, Trinity College Dublin, Università di Genova, Video Display Systems

432 **METEOR**

An integrated formal approach to industrial software development

Alcatel, Alsthom Recherche, ATT Telecommunication, COPS, CWI, Philips, TXT, Universität Passau, université de Paris-Sud

440 **MADS**

Message-passing architectures and description systems

Alcatel, Alsthom Recherche, Bell Telephone, Delphi, Vrije Universiteit Brussel

510 **TOOL-USE**

An advanced support environment for method-driven development and evolution of packaged software

CISI, Generics Software, GMD, Onera-CERT, université catholique de Louvain

527 **CFID**

Communication failure in dialogue: techniques for detection and repair

Alcatel-ESC, Linguistics Institute of Ireland, Memory Computer, St Patrick's College, Università di Pisa, University of Leeds

530 **EPSILON**

Advanced knowledge-based management system

CRISS, Bense, INSA, Systems & Management, Università di Pisa, Universität Dortmund

532 **GENEDIS**

Real-time generation and display of 2.5-D sketches for moving scenes

Barr & Stroud, University of Strathclyde, Zeltron

599 **EMG**

Knowledge-based assistant for electromyography

CRI, Judex Datasystemer, Logica, NUC, University of London

814 **PIMS**

Project integrated management system

BSO, CAP Gemini Sogeti, PA Consulting Group, Turing Institute

818 **DELTA-4**

Definition and design of an open dependable distributed computer system architecture

Bull, CNR-IEI, CNRS-LAAS, Ferranti Computer Systems, Fraunhofer Institut für Information, IMAG-IGI, INESC, J S Telecom, Mari Group, Telettra, Università di Bologna

820 **QUIC**

Design and experimentation of a KBS development tool-kit for real-time process control applications

Aérospatiale, Ansaldo Impianti, CAP Gemini Sogeti, CISE, Framentec, FL Smidth, University of Heriot-Watt

835 **PROSPECTRA-D**

Demonstration of PROSPECTRA methodology and system

Alcatel Standard Eléctrica, Syseca

857 **GRADIENT**

Graphics and knowledge-based dialogue for dynamic systems

ABB Asea Brown Boveri, CRI, Katholieke Universiteit Leuven, Universität Kassel, University of Strathclyde

865 **MUMP**

Non-monotonic reasoning techniques for industrial planning applications

Aeritalia, Battelle Institut, ELSAG

866 **COUSTO**

Integrated optical technologies for real-time wideband optical signal processing

GEC Research, Marconi Research, Selenia, University College London

867 **ARTS-IP**

Adaptive real-time strategies for image processing: a case for satellite data

Dornier System, ESIEE, GEC Research, Marconi Research, Hunting Technical Services, Politecnico di Milano, Polytechnic of Central London, Selenia, Thomson-CSF

874 **CONCORDIA**

Integrated environment for reliable systems

J-S Telecommunications, Mari Group, Telettra, Università di Bologna

881 **FORFUN**

Formal description of arbitrary systems by means of functional languages

Bell Telephone, Katholieke Universiteit Nijmegen, Sagantec, Technische Universiteit Delft

891

Development of an efficient functional programming system for the support of prototyping

Non-standard Logics, STC-ICL, Universiteit van Twente, University of St Andrews

892 **DAIDA**

Advanced interactive development of data-intensive applications

Forth Research Centre, BIM, GFI, SCS Informationstechnik, Universität Frankfurt, Universität Passau

898 **PHOX**

External interface for processing of 3-D holographic and X-ray images for analysis and control

BIAS, GEC, IRAM, Scanray, Universität Dortmund

928 **RUBRIC**

A rule-based approach to information systems development

BIM, James Martin Associates, Micro Focus, UMIST

937 **DESCARTES**

Debugging and specification of Ada real-time embedded systems

Électronique Serge Dassault, Dassault-Breguet Aviation, Foxboro Nederland, GSI, Systeam, Technische Universiteit Eindhoven, University of Stirling

938 **IMPW**

Integrated management process workbench

CETE Méditerranée, NIHE, STC-ICL, Imperial College of Science, Technology & Medicine, Verilog

940 **DMA**

Depth and motion analysis

ELSAG, GEC, INRIA, ITMI, Matra, Noesis, Università di Genova, University of Cambridge

951 **PACT**

PCTE-added common tools

Bull, Eurosoft Systems, GEC Software, Ing. C. Olivetti, Siemens, STC-ICL, Syseca, Systems and Management

967 **PADMAVATI**

Parallel associative development machine as a vehicle for artificial intelligence

CSELT, GEC, Thomson-CSF, First International

973 **ALPES**

Advanced logical programming environments support

Bull, CRIL, Enidata, Technische Universität München, Universidade Nova de Lisboa, université de Paris-Sud

974 **KNOSOS**

A knowledge-based environment for software system configuration reusing components

Alcatel, CNET, Dornier System, ESI, Matra, Yard Software Systems

1005 **MUST**

Next-generation database management system

ABSY, Syseca, Universität Kaiserslautern

1015 **PALABRE**

Integration of artificial intelligence, vocal input/output and natural language dialogue: application to directory services

British Telecommunications, CNET, CNRS, Sarin, Telematica, SESA

1033 **FORMAST**

Formal methods for asynchronous system technology

Advanced System Architectures, ERNO Raumfahrttechnik, Loughborough University of Technology, Imperial College of Science, Technology & Medicine, Universität Kaiserslautern

1035 **COOP**

2-D coherent optical dynamic processor

GEC, Thomson-CSF, université libre de Bruxelles

1041 **GENESIS**

A general environment for formal systems development

Imperial Software Technology, Philips, Imperial College of Science, Technology & Medicine

1063 **INSTIL**

Integration of symbolic and numeric learning techniques

Cognitech, GEC Research, Marconi Research, université de Paris-Sud

1072 DIAMOND

Development and integration of accurate operations in numerical data processing

CWI, Numerical Algorithms Group, Siemens, Universität Karlsruhe

1074

Shipboard installation of knowledge-based systems: conceptual design

Danish Maritime Institute, Krupp, Lloyd's Register of Shipping, Soft International, Soren T. Lyngso, The East Asiatic Company, University of Athinai

1085 SUPERNODE

Development and application of a low-cost, high-performance multiprocessor machine

APSIS, IMAG, INMOS, DRA, Thorn EMI, University of Southampton

1094 PRACTITIONER

Support system for pragmatic reuse of software concepts

Asea Brown Boveri, CRI, PCS Computersysteme, University of Brunel

1098 KADS

A methodology for the development of knowledge-based systems

CAP Gemini Innovation, Scicon, SCS Informationstechnik, South Bank Polytechnic, STC-ICL, Universiteit van Amsterdam

1106 Prolog III

Further development of Prolog and its validation by KBS in technical areas

Daimler-Benz, GIT, Prologia, Robert Bosch, université d'Aix-Marseille

1117 KIWI

Knowledge-based user-friendly system for the utilization of information bases

CRAI, DDC/CRI, Enidata, INRIA, Philips, Università di Roma-La Sapienza, Universitaire Instelling Antwerpen

1133 ISIDE

Advanced model for integration of DB and KB management systems

Agusta, ARS, CRIL, INRIA, SAGEM, Simulog

1158 ATES

Advanced techniques integration into efficient scientific application software

CISI, Philips

1252 AMADEUS

A multi-method approach for developing universal specifications

BIM, HITEC, Interprogram, Telefónica CTNE, UMIST

1256 CHAMELEON

Dynamic software migration between cooperating environments

Delphi, Harlequin, Non-standard Logics

1257 MUSE

Software quality and reliability metrics for selected domains: safety management and clerical systems

Brameur, CRIL, EBO, TÜV

1258 TRUST

Testing and consequent reliability estimation for real-time embedded software

Centre for Software Reliability, John Bell Technical Systems, LDRA, SES Software Engineering Services, University of Liverpool

1261 HTDS

Host-target development system

Logica, Marconi, SFGL, Softlab

1262 SFINX

Software factory integration and experimentation

CRI, ERIA, Sema Group, SFGL, Tecnopolis Csata Novus Ortus

1265 SEDOS-D

SEDOS Estelle demonstrator

E2S, Marben, Verilog

1271 SED

SETL experimentation and demonstrator

CNAM, Enidata, Thomson-CSF, Universität Hildesheim, University of Patras

1277 SAPPHIRE

PCTE portability

GIE-Émeraude, Sema Group UK, Software Sciences

1282 PAVE

PCTE and VMS environment

GEC Software, Syseca

1283 VIP

VDM interfaces for PCTE

Praxis Systems, CWI, OCE-Nederland

1520 ALF

Advanced software engineering environment logistics framework/Accueil de logiciel futur

Cerilor, Computer Technologies, CRIN/ADILOR, GIE-Émeraude, Grupo de Mecánica del Vuelo, STC-ICL, Universität Dortmund, université catholique de Louvain

1527 SPEM

Software productivity evaluation model

CERCI, Fuigi Italiana, O Dati Española, Sofemasa, UKAEA

1532

A preliminary study of a vector processing-oriented parallel architecture

Bull, Siemens

1535 APHRODITE

A PCTE host-target distributed testing environment

Bull, Chorus Systèmes, Delphi, Ferranti Computer Systems, Philips, université de Liège

1542 INDOC

Intelligent documents production demonstrator

ARG, Epsilon Software, INESC

1550 DRAGON

Distribution and reusability of Ada real-time applications through graceful and online operations

Dornier System, GSI, University College Wales Aberystwyth, University of Lancaster

1558 EQUUS

Efficient qualitative and quantitative use of knowledge-based systems in financial management

Citymax, Riada & Co, University College London

1560 **SKIDS**

Signal and knowledge integration with decisional control for multi-sensory systems

British Aerospace, CNRS-LAAS, Krupp, Maps Informática Industrial, Matra Rovsing, Universidad Politécnica de Cataluña, University of Oxford

1570 **ESCA**

Application of expert systems to industrial chemical analysis

Katholieke Universiteit Nijmegen, Organon International, Philips Scientific, Vrije Universiteit Brussel

1588 **SPAN**

Parallel computer systems for integrated numeric and symbolic processing

Computer Technology Institute, INESC, PCS Computersysteme, Thomson-CSF, Thorn EMI, University College London

1592 **TAO**

Therapy adviser for oncology

CITSA, Medimatica, University of Leeds

1598 **REPLAY**

Replay and evaluation of software development plans using higher-order meta-systems

Alpha SAI, CISI, CRI, E2S, Onera-CERT

1609 **SMART**

System measurement and architectures techniques

CCS, CEA, CRI, Matra, Paisley College of Technology

1613 **ITS**

Evaluation of an intelligent tutoring system for industrial and office training

Shell, Datamat Ingegneria dei Sistemi, Education Technology Institute

2025 **EDS**

European declarative system

Bull, CCIP, Chorus Systèmes, Computer Technology Institute, European Computer Industry Research Centre, INESC, Infosys, INRIA, Siemens-Nixdorf, STC-ICL, Swedish Institute of Computer Science, Systems & Management, Telefónica, Imperial College of Science, Technology & Medicine, Universidad Politécnica de Cataluña, University of Athinai, University of Bristol, University of East Anglia, University of Heriot-Watt, University of Manchester

2046 **MERMAID**

Metrication and resource modelling aid

Data Management, NCC, City University London, University College Cork, Volmac Software Groep

2059 **PYGMALION**

Neurocomputing

Alcatel, Alsthom recherche, CEA-LETI, Computer Technology Institute, CSELT, École normale supérieure, INESC, INRIA, IRIAC, Philips, Politecnico di Torino, SGS-Thomson Microelectronics, Standard Elektrik Lorenz, Thomson-CSF, Universidad Politécnica de Madrid, université Joseph Fourier de Grenoble-I, University College London

2080 **REX**

Reconfigurable and extensible parallel and distributed systems

21 Industrial Informatics, GMD, GSI, Intracom, Siemens-Nixdorf, Stollmann, Technische Universität Berlin, Imperial College of Science, Technology & Medicine, Universität Karlsruhe, University of Oxford

2092 **ANNIE**

Application of neural networks for industry in Europe

Alpha SAI, Artificial Intelligence, British Aerospace, CETIM, IBP Pietzsch, Peat Marwick Consultants, Siemens, Technische Hochschule Darmstadt, UKAEA, University of Athinai

2094 **SUNSTAR**

Integration and design of speech understanding interfaces

AEG Olympia, Alcatel Face Standard, Daimler-Benz, Fraunhofer-IPA, INESC, Jydsk Telefon, Telefónica, Universität Stuttgart

2101 **ARS**

Adverse environment recognition of speech

CSELT, Logica, Matra, Page Iberica, Politecnico di Torino, Telecom Paris, Universidad Politécnica de Madrid, University of Cambridge, University of Keele

2104 **POLYGLOT**

Multi-language speech-to-text and text-to-speech system

Bull, CNRS-LIMSI, Katholieke Universiteit Nijmegen, Philips, Ruhr-Universität Bochum, Syntax Software Sistemi, Triumph Adler, Universidad Nacional de Educación, Universidad Politécnica de Madrid, University of Edinburgh, University of Patras, CRAI

2143 **IMSE**

An integrated modelling support environment

Fraunhofer, INRIA, Simulog, SINTEF Group, BNR Europe, Thomson-CSF (LCR), Thomson-CSF (CIM), Università degli Studi di Milano, Università degli Studi di Pavia, Università di Torino, Universität Dortmund, University of Edinburgh

2148 **VALID**

Validation methods and tools for knowledge-based systems

Centre d'Estudis Avançes de Blanes, Cognitech, CRI, Universidad Politécnica de Madrid

2151 **SCOPE**

Software certification on program in Europe

Cabinet Bensoussan, CEA, City University London, Elektronik Centralen, ERIA, Etnoteam, Glasgow College, GMD, GRS, NIHE, Technical Research Centre of Finland, TÜV Bayern, UKAEA, University of Strathclyde, Veridatas, Verilog

2152 **VIEWS**

Visual inspection and evaluation of wide-area scenes

Framentec, Fraunhofer Institut für Information, GEC Research, Marconi Research, Krupp Atlas Elektronik, Thomson-CSF, Queen Mary & Westfield College, University of Reading

2154 **MLT**

Machine learning toolbox

Alcatel, Alsthom Recherche, British Aerospace, Forth Research Centre, GMD, INRIA, I-Soft, Siemens-Nixdorf, Turing Institute, Universidade de Coimbra, université de Paris-Sud, University of Aberdeen

2163 **KBS-SHIP**

Shipboard installation of knowledge-based systems: design and installation

Cambridge Consultants, Danish Maritime Institute, Danmarks Tekniske Højskole, Instituto Superior Técnico, Krupp, Lloyd's Register of Shipping, Soft International, Søren T. Lyngso, The East Asiatic Company, University of Athinai

2167 **AITRAS**

An intelligent real-time coupled system for signal understanding

Artificial Intelligence Systems, Cognitech, CRIN, Laborelec, Tecnatom

2177 **GIPE II**

Generation of interactive programming environments II

ADVORGA FA Meyer, Bull, CWI, GIPSI, INRIA, Planet, PTT Research, Neher Laboratories, Sema Metra Group, Technische Universität Darmstadt, Universiteit van Amsterdam

2218 **SUNDIAL**

Speech understanding and dialogue

CAP Gemini Innovation, CNET, CSELT, Daimler-Benz, IRISA, Logica, Politecnico di Torino, Saritel-Sarin, Telematica, Siemens-Nixdorf, Universität Erlangen-Nürnberg, University of Surrey

2252 **DELTA-4**

Definition and design of an open dependable distributed system architecture

Bull, CNR-IEI, CNRS-LAAS, Ferranti Computer Systems, Fraunhofer Institut für Information, INESC, Mari Group, Renault Automation, Sema Metra Group, UKAEA, Unibanque, université Joseph Fourier de Grenoble-I, University of Newcastle

2255 **TOPMUSS**

Tools for processing multi-sensorial signals for plant monitoring and control

Alcatel, Audi, Cegelec Projects, Danmarks Tekniske Højskole (IAL), DISEL, Bailey Esacontrol, Fraunhofer IITB, Krupp Atlas Elektronik, Stewart Hughes, Universität Hannover (IFW), University of Brunel, Ruston Gas Turbines Engineering Research Centre

2256 **ARCHON**

Architecture for cooperative heterogenous online systems

Amber, CEC-JRC Ispra Establishment, CERN, Electricity Association Services, Framentec, Iberduero, Krupp Atlas Elektronik, LABEIN, Queen Mary & Westfield College, Universidade do Porto, université libre de Bruxelles, Universiteit van Amsterdam, University of Athinai, Volmac Nederland

2288 **NAOPIA**

New architectures for optical processing in industrial applications

Krupp, Risø National Laboratory, Thomson-CSF, Universität Erlangen-Nürnberg

2301 **ORDIT**

Development of a methodology for specifying non-functional requirements

Algotech, Husat Research Centre, Mari Group, University of Newcastle, Work Research Centre

2304 **LOTOSPHERE**

Lotosphere

Alcatel, Standard Electrica, Ascom Holding, British Telecommunications, CNR-IEI, CNRS-LAAS, CPR, GMD, INRIA, OCE-Nederland, PTT Research, Neher Laboratories, Syseca, Technische Universität Berlin, Tecsiel, Universidad Politécnica de Madrid, Universiteit van Twente, University of Stirling

2316 **MUSIP**

Multisensor image processor

GEC Research, Marconi Research, Hunting Technical Services, Marconi, MBB, Thomson-CSF, Università di Genova, University of Reading

2354 **DARTS**

Demonstration of advanced reliability techniques

CEGB, Ceselsa, DSMC, EDF, GRS, UKAEA

2384 **METKIT**

Metrics education tool kit

Brameur, British Telecommunications, CAP, DIDA*EL, GMD, SES, South Bank Polytechnic, Verilog

2397 **PROMISE**

Process operator's multimedia intelligent support environment

Algotech, Dow Benelux, IDS, Katholieke Universiteit Leuven, Realace Scottish Power, Tecsiel, University College Dublin, University of Strathclyde, Work Research Centre

2409 **EQUATOR**

Environment for qualitative temporal reasoning

CENA, CISE, École polytechnique fédérale de Lausanne, Eria, ETRA, Ferranti Computer Systems, PTT Switzerland, Laben, Politecnico di Milano, SWIFT, Syseca, Imperial College of Science, Technology & Medicine, University College London

2424 **KIWIS**

Advanced knowledge-based environments for large database systems

Alcatel, Bell Telephone, Craienidata, Origin/International Business Consultants, Philips, Swedish Institute of Computer Science, Università dell'Aquila, Università della Calabria, Universitaire Instelling Antwerpen, University of Kreta

2427 **TROPICS**

Transparent object-oriented parallel information computing system

CAP Sogeti Innovation, CWI, Delphi, Infosys, Ing. C. Olivetti, Katholieke Universiteit Nijmegen, Philips, Siemens-Nixdorf, Stollmann, Thomson-CSF, Universiteit van Twente

2443 **STRETCH**

Extensible KBMS for large knowledge-based application

Agusta, Alcatel Alsthom Recherche, Infosys, INRIA, MBP Software & Systems, Politecnico di Milano, STZ, TXT, Fernuniversität Gesamthochschule Hagen

2447 **GENESIS**

A European, distributed memory, parallel supercomputer for numerical applications

Bull, Chorus Systèmes, GMD, DRA, Siemens, Syseca, University of Liverpool, University of Southampton

2469 **TEMPORA**

Integrating database technology, rule-based systems and temporal reasoning for effective software

BIM, Hitec, Logic Programming Associates, Sintef, Swedish Institute of Computer Science, Sybase, Imperial College of Science, Technology & Medicine, université de Liège, University of Manchester

2471 **PEPMA**

Parallel execution of Prolog on multiprocessor architectures

BIM, Katholieke Universiteit Leuven, Meiko, Swedish Institute of Computer Science, Universidad Politécnica de Madrid, University of Bristol

2474 **MMI2**

A multi-modal interface for man-machine interaction with knowledge-based systems

ADR-CRISS, BIM, École des mines de Saint-Étienne, INRIA, INSOS, Rutherford Appleton Laboratory, University of Leeds

2487 **REDO**

Maintenance, validation and documentation of software systems

Centrisa, Computer Technologies, Delft Hydraulics, Dr Jens Grumann Daten-Kommunikation, EDF, ITS, Lloyd's Register of Shipping, Marconi, NIHE, University of Oxford

2502 **VOILA**

Variable object identification, location and acquisition

ELSAG, GEC, INRIA, Matra, Roke Manor Research, Università di Genova (DIST), Università di Genova (FISICA), University of Oxford, University of Sheffield

2528 **SUPERNODE II**

Operating systems and programming environments for parallel computers

Aptor, Danish Parsim Consortium, Grupo APD, INPG, IPSYS Software, Numerical Algorithms Group, Ove Arup & Partners, DRA, Syseca, Telmat Informatique, Thorn EMI, Universidad Politécnica de Cataluña, University of Liverpool

2537 **ICARUS**

Incremental construction and reuse of requirements specifications

Alcatel, Alsthom Recherche, Alcatel Standard Eléctrica, INRIA, Sema Metra Group, Teice Control, université Notre-Dame de la Paix, Universidad Politécnica de Cataluña

2565 ATMOSPHERE

Advanced techniques and models of system production in a heterogeneous, extensible and rigorous environment

CAP Gemini Innovation, Bull, Siemens-Nixdorf, Nederlandse Philips Bedrijven, Siemens, GMD, 2I Industrial Informatics, Bull Italia, SERC, University of Strathclyde, Universität Dortmund, Universität Paderborn, Telesoft, SFGL, Sema Group, Nokia, Intecs Sistemi, GIE-Emeraude, Generics Software, GEI, Computer Technologies

2570 MACS

Maintenance capability for software

Centro de Cálculo de Sabadell, CISI, SESA, Tecnopolis Csata Novus Ortus, Universität Bremen, Universiteit van Limburg

2576 ACKNOWLEDGE

Acquisition of knowledge

CAP Gemini Innovation, Computas Expert Systems, GEC Research Marconi, Sintef, Group Telefónica, Universidad Politécnica de Madrid, Universiteit van Amsterdam, University of Nottingham

2589 SAM

Multi-lingual speech input/output: assessment, methodology and standardization

CNR, CRIN/Adilor, CSELT, Daimler-Benz, ELAB, Jydsk Telefon, Logica, National Physical Laboratory, PTT Research, Neher Laboratories, DRA, Ruhr-Universität Bochum, Smiths Industries Aerospace & Defence Systems, Televerket, The Royal Institute of Technology, TNO, Universität Bielefeld, University College London

2592 VIDIMUS

A generic vision system for industrial applications

British Aerospace, CEA-LETI, Daimler-Benz, Deutsche System-Technik, Ibermatica, Philips, Thomson-CSF, University of Strathclyde, Valvo Unternehmensbereich

2615 ITSIE

Intelligent training systems in industrial environments

Alcatel, Alsthom Recherche, CRI, CISE, Iberduero, LABEIN, Marconi, Universidad del País Vasco, University of Heriot-Watt

2620 FOCUS

Front-ends for open and closed user systems

Indecon, Loughborough University of Technology, Metek, Numerical Algorithms Group, Philips, Solvay, Imperial College of Science, Technology & Medicine, Universidad Politécnica de Cataluña, Universität Münster

2686 COSMOS

Cost management with metrics of specification

Alcatel Austria — Elin, British Telecommunications, Nijenrode Universiteit voor Bedrijfskund, Techforce, Telefónica, University of London Goldsmith's College

2701 PUMA

Universal message-passing architectures

Bull, Chorus Systèmes, École normale supérieure, GMD, Inmos, DRA, Siemens, Syseca, University of Liverpool, University of Southampton

2702 GENESIS II

Development of a distributed memory MIMD system for very high performance numerical computing

Pallas, GMD, Krupp Atlas Elektronik, Stollmann, University of Southampton, University of Liverpool, Meiko Scientific, CHAM, TNO, Universität Wien, Universidad Politécnica de Cataluña, University of Jyvaskyla, Tritech, Simulog, NA Software, European Centre for Medium-Range Weather Forecasts, INRIA, First International, Dornier Luftfahrt

2703 HSSC

High-speed scientific computer

ACRI

2716 AMUS

A multiscalar supercomputer

ACRI, Forth Research Centre, EUCAD, SEKAS, Siemens Semiconductors, University of Manchester

5111 DOCKET

Document and code knowledge elicitation toolset

Computer Logic R&D, CRIAI, Software Engineering Service, SOGEI, UMIST, Universidade Portucalense

5143 ARTIST

Advanced reasoning tool for model-based diagnosis of industrial systems

CEPSA, CISE, Delphi, Heriot-Watt University, LABEIN, Siemens

5146 REAKT

Environment and methodology for real-time knowledge-based systems

Comptas Expert Systems, CRIN, Etnoteam, Grupo de Mecánica del Vuelo, Marconi, Syseca, Thomson-CSF, Universidad Politécnica de Valencia

5170 STATLOG

Comparative testing and evaluation of statistical and logical learning algorithms on large-scale applications for classification, prediction and control

Brainware, Daimler-Benz, Isoft, MBB, Turing Institute, Universidad de Granada, Universidade do Porto, Universität Lübeck, University of Strathclyde

5184 LOCOMOTI

Low-cost moving symbols recognition through intelligent vision engineering

Elliop, Katholieke Universiteit Leuven, Robert Bosch, Universidad Politécnica de Madrid

5192 SPELL

Interactive system for spoken European language training

Alcatel Face Standard, Oros, Tecnopolis Csata Novus Ortus, Università di Roma-La Sapienza, University of Edinburgh

5204 PAPYRUS

Pen and paper input recognition using script

Active Book Company, CAPTEC, Katholieke Universiteit Nijmegen, Nottingham Polytechnic, Olivetti Systems & Networks, Pacer Systems, Università di Genova

5210 AIMS

Advanced information management system

Datamont Feruzzi Group, Deutsches Herzzentrum Berlin, ERIA, Non-standard Logics, ONERA-CERT, Quinary, Technische Universität Berlin, Universidad del País Vasco

5212 FASST

Fault-tolerant architecture with stable storage technology

August Systems, Bull, ETRA Electronic Trafic, INRIA, Stollmann, Tolsys, Trinity College Dublin, Universidad Politécnica de Madrid, Universidad Politécnica de Valencia, University of Newcastle

5225 ARVISA

Advanced real-time vision system and architecture

Carl Zeiss, CEA, ELSAG, FIM-FGAN, Fraunhofer-ISI, INPG, Kontron Elektronik, Krupp Atlas Elektronik, Matra, Philips, Signum Computer, Thomson-CSF, Universidad Politécnica de Cataluña, VTE

5246 PRINCE

Prolog integrated with constraints and environment for industrial and financial applications

Banque La Henin, BIM, Daimler-Benz, FAW, Katholieke Universiteit Leuven, Prologia, Robert Bosch, Universidad Politécnica de Madrid, université d'Aix-Marseille, University of Bristol

5248 KADS-II

An advanced and comprehensive methodology for integrated KBS development

CAP Gemini Logic, CAP Sogeti Innovation, ECN, Entel, IBM France, Lloyd's Register of Shipping, Siemens, Swedish Institute of Computer Science, Touche Ross Management Consultants, Universiteit van Amsterdam, Vrije Universiteit Brussel

5254 **PLUS**

A pragmatic-based language understanding system

CAP Gemini Innovation, CNRS-LIMSI, ITK, Omega Generation, CAP Gemini SCS Becom, UMIST, Università di Pisa, University of Bristol, University of Göteborg, Katholieke Universiteit Brabant (ITK)

5291 **CHIC**

Constraint handling in industry and commerce

AIS, Avions Marcel Dassault, Braghenti, Bull, CMSU, ECRC, ETRA, Iberia Lineas Aéreas de España, Onera-Cert, Renault RNUR, Siemens, STC-ICL, Imperial College of Science, Technology & Medicine

5293 **GALATEA**

Neurocomputing

Computer Technology Institute, CRAM, INESC Informatica Sistemi, INPG, Philips, SGS-Thomson Microelectronics, Siemens, Thomson-CSF, University College London

5304 **MULTILEX**

A multi-functional standardized lexicon

CAP Gemini Innovation, Fraunhofer-IAO, GETA, L-Cube Information Systems, Lexicon, Philips, Ruhr-Universität Bochum, Siemens-Nixdorf Informationssystem, Siemens-Nixdorf Sistemas de Información, Triumph Adler, Università di Pisa, université de Paris-VII, Vrije Universiteit Amsterdam, University of Manchester, University of Surrey

5311 **BUSINESS**

Business class

Applied Logic Research, Datamont, Feruzzi Group, ERIA, Etnoteam, Société des outils du logiciel, TAO, Télésystèmes, université de Nice

5312 **EMIR**

European multilingual information retrieval

CEA, Systex, Transmodul, université de Liège

5327 **REBOOT**

Reuse bases on object-oriented techniques

Bull, CAP Sogeti Innovation, INPG, Sema Group, Siemens, Sintef, Televerket, TXT

5330 **NOMOS**

Knowledge acquisition for normative reasoning systems

Axon, CNR-IDG, Hellaslex, INESC, IRETIJ, SOGEI, STEP-Informatique, Teesiel

5342 **PROOFS**

Promotion of formal methods in the European software industry

Entel, France câbles et radio, Prisma Informatica, Sligos, Technische Universiteit Eindhoven, TNO

5345 **DIMUS**

Data integration in multisensor systems

Ansaldo, ELSAG, Istituto Trentino di Cultura, Signum Computer, Technische Universität München, Thomson-CSF, Università di Genova

5362 **IMAGINE**

Integrated multi-agent interactive environment

Intrasoft, Rijksuniversiteit Leiden, Roke Manor Research, Siemens, Steria, Imperial College of Science, Technology & Medicine, University of Keele

5363 **GLAD-IN-ART**

Glove-like advanced interface for the control of manipulative and exploratory procedures in artificial realities

AITEK, Eeidetics, Scuola Superiore, Technology Applications Group, Trinity College Dublin, Video Display Systems

5365 **VITAL**

A methodology-based workbench for KBS life-cycle support

Andersen Consulting, Bull, Koninklijke PTT Nederland, Nokia Research Centre, Onera-Cert, Open University, Syseca, University of Nottingham

5375 **ISSS**

Intelligent signals, sensors and surveillance

Academisch Ziekenhuis Rotterdam, Aristoteles University of Thessaloniki, Daltek, IBC-DANICA, Philips, Scaitech

5383 **LACOS**

Large-scale correct systems using formal methods

Bull, CRI, INISEL, Lloyd's Register of Shipping, Matra, Space Software Italia, STC-ICL, Sypro København, Technisystems

5390 **RTGC**

Real-time gaze control

GEC, INRIA, SAGEM, University of Oxford

5398 **SHAPE**

Second-generation hypermedia application project environment

Alcatel, Bureau Marcel van Dijk, Datamont Feruzzi Group, Transtools, University of Glasgow

5399 **COMPARE**

Compiler generation for parallel machines

ACE, CWI, GMD, Harlequin, INRIA, Steria, Universität des Saarlandes

5404 **GP MIMD**

General-purpose MIMD machines

CERN, Grupo Apd, INESC, Inmos, IRISA, Meiko Scientific, Parsys, Parsytec, Siemens, Swedish Institute of Computer Science, University of Southampton

5409 **COMPLEMENT**

Comprehensive large-scale engineering methodologies and training

British Aerospace, CEGELEC, GEI, HCS Industrial Automation, Intrasoft, Ipsys Software, IRIT, Matra, RWTH Aachen, SAS, Software Ireland, Syseca, Systems Designers Europe, Universidad de Murcia, University of Southampton, University of Ulster, Veridatas

5425 **PYRAMID**

Promotion of metrics

Brameur, Desisco, Euroexpert & Partners, Siemens, Veridatas

5429 **MUSIC**

Metrics for usability standards in computing

Veriditas-Brameur, Data Management, Ergonomic Institut, Husat Research Centre, National Physical Laboratory, SEMA Group, Technische Universiteit Delft, Universität Münster, University College Cork

5433 **NEUFODI**

Neural networks for forecasting and diagnosis applications

Austrian Research Institute of Artificial Inteligence, BIKIT, EYS, KTAS, LABEIN, Société lyonnaise des eaux

5441 **BOOTSTRAP**

Bootstrap

2I Industrial Informatics, E2S, Etnoteam, Robert Bosch, Technische Universität Graz

5473 **PAYDIRT**

Processing architecture yielding deductions in real time

Krupp, Atlas Elektronik Bremen, Lloyd's Register of Shipping, SINAPSE, Société lyonnaise des eaux

5477 **CONSTRUCT**

Computer-aided knowledge engineering for construction tasks

Renault automation, Siscog, Vrije Universiteit Brussel

5494 **AMI**

Applications of metrics in industry

Advanced Software Technology, Alcatel Austria — ELIN, Bull, Corelis Technologie, GEC Alsthom, GEC Marconi, ITS, RWTÜV, South Bank Polytechnic

5516 **ROARS**

Robust analytical speech recognition system

CRIN, ENA Telecomunicaciones, Thomson-CSF, Universidad Politécnica de Valencia

5570 **IPTES**

Incremental prototyping technology for embedded real-time systems

CEA, ENEA, IFAD, Mari Group, Politecnico di Milano, Technical Research Centre of Finland, Telefónica, Universidad Politécnica de Madrid

5661 **STANDARDIZATION**

Standardization for object-oriented systems

D-Tech, INTECS International, Teclab

5662 **SOFTWARE TOOLS**

Software tools: intercommunications

Dr Jens Grumann, Daten-Kommunikation, Software España, Systems & Management, Techforce

5663 **REAL-TIME**

Real-time systems

Autograph International, CSC, Diseño y Metodologia, Intron, Katholieke Universiteit Leuven, Systeam

5664

Multimedia systems and human-computer interface

Envirotech International, Epsilon Software, Selisa, Silvertech

5665

Trends in operating systems for parallel computing

GPP, Standard International Consulting

5666

Massively parallel platform

Active Memory Technology, Dancomp (Decanter, Richter & Rosenstand), PCS Computersysteme, Pliroforiki, TECMIC

5667

Parallelizing tools

AIIT, Elabodater, Parseq, TNO, Tritech

5668

Neural computing

ARITEX, DIDA*EL, IBP Pietzsch, Jenni-International User Group, Software de Base

5669

Measurement of advanced architecture

Algotech, First International, Mental Images, Simulog

5670

Fault-tolerant systems

SEPA, Software Cientifico y Técnico, Verilog

5671

Improvement of complex systems using KB techniques

Corelis Technologie, Ingegneria Informatica, Knossos Technologies, Soren T. Lyngsø, Vision Computing

5672

Vision systems

Athinai Technology Centre, INTECS International, Maptel

5673

Multisensor systems

AIIT, And Software, Universidade de Coimbra, Zenon

5674

Quality assessment in KBS

AITEC, Cetena, IGC, LDRA

5675 **AMKBS**

Applications of multi-agent KBS

Artificial Intelligence Systems, Elabodater, Indecon, Advanced Technology, Instituto Superior Tecnico, PROSS

5676 **PCTE**

PCTE policy options

Elios informatique, Generics Software, GMD, OVUM

5677 **ROBUST**

Robust speech understanding

ENA Telecomunicaciones, Knowledge, Lernout & Hauspie Speech Products

6013 **I-SEE**

Interactive self-explaining engine

BIM, BMT, CNAM, Lyonnaise des Eaux, SERC/RAL, Syseca

6057 **EDS II**

Evaluation for exploitation

Bull, Chorus systèmes, Esiee — École supérieure d'ingénieurs électronique, European Computer-Industry Centre, Heriot-Watt University, ICL, INESC, Infosys, INRIA, Siemens Nixdorf, Systems and Management, Universidad Politecnica de Cataluña, University of Athens, University of East Anglia, University of Manchester

6059 **EPOCH**

European parallel operating system based on Chorus

ICL, Institut für Arbeitswissenschaft & Technik, ORCE, Siemens Nixdorf, Université René Descartes LAA

6083 **UNITE**

Integration support for uncertain incomplete and temporal dependent applications

British Telecommunications, CAP Gemini Innovation, Eritel, ITMI, MMS, Queen Mary College, Sintef Delab

6086 **PROTEUS**

Support for system evolution

CAP Gemini Innovation, CAP Sesa Telecom, Intecs, Mms, Siemens, Sintef, University of Lancaster

6089 **PEDMON**

Pedestrian monitoring in public places

CEM Systems, IRST, Mari Group, Newcastle-upon-Tyne Polytechnic, SNCF Direction R

6095 **CHARADE**

Combining human assessment and reasoning aids for decision-making in environmental emergencies

Alcatel, Alenia, Inisel, IRST, Italsoft Ingenieri di Sistemi, Thomson-CSF

6115 **GOODSTEP**

General object-oriented databases for software engineering processes

British Airways, Cefriel, École polytechnique fédérale de Lausanne, Engineering, INRIA, O2, SERC/RAL, Universität Dortmund, Universität Frankfurt, Université Joseph Fourier-Grenoble, University of Manchester

6125 **VIVA**

Verification improvement and validation of knowledge-based systems

CISI, CRI, ESTEC-European Space Agency, Lloyd's Register of Shipping, Logica UK, Université de Savoie, University of Aberdeen

6166 FREETEL

Enhancement of hands-free telecommunications

ILSP, Athens, Imperial College, Matra, Page Iberica, Telecom Paris / Arecom, Université de Rennes

6173 DESIRE

Design by simulation and rendering on parallel architectures

Bertin & Cie, Delcam, Mental Images, Parsytec, University of Warwick

6253 SHIPS

A multiscalar supercomputer

ACRI, Aeset, FORTH Research Centre, Phoenix VLSI Consultants, Sekas, University of Edinburgh, University of Manchester

6283 GOAL

Generic object-oriented multi-application project management tool for large interorganizational projects

Alcatel, CETE Mediterannée, City University London, Fraunhofer, GSE, Imperial Cancer Research Fund-London, Melte, Standard Elektrik Lorenz

6290 HAMLET

High-performance computing for industrial applications

AEG Electrocom, CAP Sogeti Innovation, Construcciones Aeronauticas, Daimler-Benz, Deutsche Forschungsanstalt für Luft und, Dornier, Fraunhofer-IPK, Hitec, INESC, Inmos, Parsytec, Piraiki-Patraiki, Technische Universität München, Telefunken Systemtechnik, TNO

6310 MMTCA

Multimedia toolbox for cooperative applications

Banercio, Intracom, Intrasoft, ISL, Novosoft, Paisley College of Technology, Sistemas y Tratamiento, Teletek

6322 CABARET

An integrated case-based reasoning tool

Acknowledge, Bull, Irish Medical Systems, Tecinno, Universität Kaiserslautern

6333 IDEA

Intelligent database environment for advanced applications

Bull, European Computer-Industry Centre, ICL, Imperial Cancer Research Fund-London, Infosys, INRIA, Politecnico di Milano, TXT, Universität Frankfurt, Université Catholique de Louvain

6334 SCALE

System composition and large-grain component reuse

ADR-CRISS, Bull, GIE-Émeraude, INRIA, Intecs Sistemi, Logica UK, SFGL

6339 GEOWORKS

Multimedia and geo-referenced information delivery systems

Bull, City of Bologna, City of Lille, CMSU, IGN-France International, INESC, ISSI, Kommunedata, Neri, Olivetti Systems & Networks, Siemens Nixdorf, Telesystemes

6355 IMPRESS

Integrated multi-paradigm reliable and extensible storage system

Alcatel Alsthom Recherche, Alcatel, Bureau van Dijk, Iberduero, Infosys, Universiteit van Twente

6369 HANSA

Heterogeneous application generator standard architecture

IFP, J&J, Mimetics, Olivetti, SCBF, Thorn EMI, University College London

6373 TRACS

Flexible real-time environment for traffic control systems

Aeritalia, Rigel Engineering, Scuola Superiore St. Anna, Teclab, Universita di Pisa

6447 HINT

Heterogeneous integration architecture for intelligent control systems

Dassault Electronique, IIC, INESC, Infologics, Ramboll and Hannemann, Repsol, Universidad Politécnica de Madrid

6464 HERACLES

High-level engineering for automation conceptual level design production and diagnosis

BMT, Kade-Tech, Pirelli, Siemens, SNIA BPD — Fiat Group

6488 HIMARNNET

Study of hidden Markov models and neural networks for robust isolated word recognition

Ascom Holding, EPFL, Faculté Polytechnique de Mons, Iselqui, Lernout & Hauspie Speechproducts, Universita di Roma-La Sapienza

6500 AFRODITE

Applying formal methods to real-size object oriented designs in technical environments

CAP Gemini, CERN, Defence Research Agency, Helintec, Imperial College, Lloyd's Register of Shipping, Technische Universiteit Delft, Universiteit van Utrecht, University of Manchester

6516 PREPARE

Programming environment for parallel architectures

ACE, Aérospatiale, Dornier, GMD, INRIA, Parsytec, Steria, Technische Universität München, TNO, Universität Osnabrück, Universität Wien

6532 HI-FI

Hypertext interface for information multimedia and relational database

Benaki Museum, Epsilon Software, GMD, Music/FORTH, Politecnico di Milano, Siemens, Siemens Nixdorf, Syntax Software Sistemi, Systems and Management

6548 IMIS

Integrated information management for industrial control systems

02 Technology, Alcatel Alsthom Recherche, Cegelec, Primeur, Psl, University of Glasgow

6593 INTUITIVE

Interactive user interface and tools for information in a visual environment

CAP Gemini Innovation, City University London, Everly, Ibermatica, INRIA, Lloyd's Register of Shipping, SISU, TSOL

6612 F3

From fuzzi to formal

British Aerospace, Inisel, Politecnico di Milano, Rutherford Appleton Laboratory, Sema Metra Group, SISU, TXTA, UMIST, Universität Frankfurt, Université de Paris

6643 PPPE

A portable parallel programming environment

Advanced Computing Systems, BAE, Dornier, ESI, European Centre for Weather Forcasting, First, Gie-Emeraude, GMD, INRIA, Meiko Scientific, NA Software, Pallas, Simulog, Technische Universität München, TNO, Universität Wien, University of Liverpool, University of Southampton

6676 NAOPIA II

New architectures for optical processing in industrial applications

Alenia, Institut d'optique théorique et appliquée, Krupp, PSA, Ris National Laboratory, Thomson-CSF, Universität Erlangen-Nürnberg

6708 APPLAUSE

Application and assessment of parallel programming using logic

Dassault Aviation, ESI, European Computer-Industry Centre, Imperial Cancer Research Fund-London, Imperial College, Systems and Management, University of Athens

6709 HUMANOID

Real-time and parallel system for the simulation of virtual humans

EPFL, RTL-Productions, Silicon, Telmat informatique, Universität Karlsruhe, Université de Geneve, Wavefront Europe

6715 CONNY

Robot control based on neural network systems

CRAM, Framentec, Fraunhofer-IPA, MBB/Erno Raumfahrttechnik, Mimetics, Thomson-CSF, Universidad Politecnica de Cataluña, University College London

6731 FTMPS

A practical approach to fault-tolerant massively parallel systems

British Aerospace, Katholieke Universiteit Leuven, Parsytec, Universidade de Coimbra, Universität Erlangen-Nürnberg, Universität Paderborn

6753 IDENTIFY

Interactive design by simulation, animation and virtual reality of fluid flow problems on transputer-based multiprocessors

Bertin & Cie, BMW, Indo, Parsys, Rutherford Appleton Laboratory, Universidad Politecnica de Cataluña

6756 CAMAS

Computer-aided migration of applications system

ACE, British Aerospace, ESI, Fegs, Parsytec, Silicomp, Universiteit van Amsterdam, University of Southampton

6757 EMS

Data fusion for an environmental monitoring system

Atlas Elektronik, Lyonnaise des Eaux, Technische Universität München, CNRS

6765 CHIC

Component heuristics and improvements for copiers

CEA, Knossos Technologies, Oce-Nederland, TNO

6768 HEDRA

Heterogeneous distributed real-time architecture

Barco Industries, Hema Elektronik, Katholieke Universiteit Leuven, LVD Company, Universität Stuttgart

6819 SAM A

Speech technology assessment for multilingual applications

CNRS-LIMSI, CSELT, Defence Research Agency, Fondazione Ugo Bordoni, ICP-Speech Communication Institute, INESC, Jydsk Telefon, Logica UK, National Physical Laboratory, Ruhr-Universität Bochum, Telecom Paris/Arecom, Televerket, TNO, Universidad Politecnica de Cataluña, Universität Bielefeld, University of Patras, Vecsys

6857 PAPAGENA

Programming environment for applications of parallel genetic algorithms

Brainware, CAP Gemini, GMD, INPG, Telmat Informatique, University College London

6862 TIGER

Real-time situation assessment of dynamic, hard-to-measure systems

CNRS-Laas, Dassault Aviation, Exxon Chem Fep, Intelligent Applications, JBE, Universidad Politecnica de Cataluña

6942 PEPS

Performance evaluation of parallel systems

Intecs, National Physical Laboratory, Simulog, Sosip, Thomson, University of Warwick

7050 HICOPOS

Highly integrated and compact optical processor for on-board systems

BNR Europe, École nationale supérieure des télécommunication, Friederich Alexander Universität Erlangen, LPICM-École polytechnique, MBB, PSA, Siemens Aktiengesellschaft, University of Cambridge, University of Edinburgh

7074 PASHA

Parallel software-hardware application

Active Memory Technology, BIBA-Bremen, Concentration Heat and Momentum, Emit, Parsytec, Vrije Universiteit Brussel

7089 RECYCLE

Recycle

Applied Logic Research, Data Borough, ENEA, Engineering-Engegneria Informatica, GRS, Integro, Télésystèmes, University of Limerick

7091 PYTHAGORAS

Performance quality assessment of advanced database systems

Bull, CCIP, European Computer-Industry Centre, Heriot-Watt University, ICL, Ifatec, Infosys, SMC/CWI, University of East Anglia

7153 SPELL II

Interactive system for spoken European language training

Alcatel, Oros, Technopolis Csata Novus Ortus, Universita di Roma-La Sapienza, University of Edinburgh

7185 NEUROQUACS

Neural network-based vision and signal system for industrial quality control

Hema Elektronik, Kærgård Industri Automatic, Mimetics

7207 AZZURRO

Data fusion for environmental monitoring system

Agusta Sistemi, Katholieke Universiteit Leuven, Onera-CERT, Piaggio, Steria, Telmat Informatique

PARALLEL COMPUTING ACTION PCA

LRI Lab. de Recherche Vidal-Naquet en Informatique, Universidad Politécnica de Madrid, Technische Universität Berlin, University of Thessaloniki, Technische Hochschule Darmstadt, University of Athinai, Universität Erlangen-Nürnberg, Johann Wolfgang von Goethe Universität Frankfurt, Odense Universitet, Università di Bologna, université de L'État à Mons, Polytechnic of Central London, Politecnico di Milano, Universität Karlsruhe, Universität Köln, National Technical University of Athinai, Technische Universiteit Eindhoven, Università di Bari, Katholieke Universiteit Leuven, Universität Paderborn, Rijksuniversiteit Gent, TNO, Onera-CERT, Vrije Universiteit Brussel, University of Sheffield, CNR, University College London, Trinity College Dublin, Università di Genova, University of London (Birkbeck College), University College of North Wales, IFISIC-Rennes, University of Bristol, Katholieke Universiteit Nijmegen, University of Reading, Universität Bremen, INESC, Universiteit Twente, Universiteit Kaiserslautern, Universidade do Porto, Universidade Nova de Lisboa, université Louis Pasteur (Strasbourg), Universidad Politécnica de Cataluña, University of Ulster, Università di Torino, CSIC, INT, université de Bourgogne, Ålborg Universitet, Università di Roma II, université de Franche-Comté, université Pierre et Marie Curie

Advanced business and home systems — peripherals

28 MULTOS

A multimedia filing system

Battelle Institut, CNR-IEI, Cretan Computer Institute, Epsilon Software, ERIA, Ing. C. Olivetti, Philips, Triumph Adler

43 E-INTERFACE

Standardization of integrated LAN services and service access protocols

Alcatel, British Telecommunications, Bull, CAP Gemini, Sogeti, CSELT, GEC Research, Marconi Research, OCE-Nederland, Philips International, Plessey, RCE, Roke Manor Research, Siemens-Nixdorf, Universiteit van Twente

56 FAOR

Functional analysis of office requirements

GMD, STC-ICL, The East Asiatic Company, Universität Köln-BIFOA

59 MINSTREL

New information models for office filing and retrieval

DDC/CRI, GN, National Software Centre, University College Dublin

64 **SPIN**

Speech interface at office workstation

Alcatel, Alsthom Recherche, CEA, CMSU, CSELT, Daimler-Benz, Oros, CAP-SESA, Siemens-Nixdorf, SNS Pisa, Universiteit van Amsterdam

73 **BWN**

Broad-site local wideband communication system

CEC, Bell Telephone, CISI, CMSU, France câbles et radio, SG2, Informatique Stollmann, université de Liège

82 **IWS**

Intelligent workstation

Bull, Forth Research Centre, INRIA, Katholieke Universiteit Nijmegen, OCE-Nederland, Vrije Universiteit Brussel

121 **HERODE**

Handling mixed text/image/voice documents based on a standardized office document architecture

Alcatel, CRIN, Siemens

169 **LION**

Local integrated optical network

Alcatel, British Telecommunications, CSELT, Politecnico di Milano, université de Paris, université Paul Batier de Toulouse, University of Patras

231 **DOEOIS**

Design and operational evaluation of office information servers

Bull, STC-ICL, Trinity College Dublin, Universität Stuttgart

234

Cognitive simulator for user interface design

Alcatel-ESC, GEC, Logos Progetti, Medical Research Council

237 **CSA**

Communications systems architecture

ITK, Mari Group, Philips, Roke Manor Research, SYD

249 **UCOL-1**

Ultra-wideband optical coherent LAN

Alcatel, Face Standard, GEC Research, Marconi Research, Politecnico di Milano

285 **OSSAD**

Office support systems analysis and design

Centre d'études du management, IOT, CRI, Università degli Studi di Milano

291 **LING-ANALYSIS**

Linguistic analysis of the European languages

Acorn Computers, CNRS-LIMSI, Ing. C. Olivetti, Katholieke Universiteit Nijmegen, Ruhr-Universität Bochum, Tecnopolis Csata Novus Ortus, Universidad Nacional de Educaciône, University of Patras

295 **PAPER**

The paper interface

AEG Electrocom, Ing. C. Olivetti, Philips, Plessey

367 **SOMIW**

Secure, open, multimedia integrated workstation

AEG Electrocom, Bull, CSELT, INESC, INRIA, Italtel Telematica, RITEL, SCK-CEN, Sema Group Belgium

385 **HUFIT**

Human factors laboratories in information technologies

Bull, Fraunhofer-IAO, Husat Research Centre, Ing. C. Olivetti, Philips, Piraeus Graduate School, Siemens, STC-ICL, Universidade do Minho, Universität Münster, University College Cork

395 **INCA**

An integrated network architecture for office communications

GEC, Ing. C. Olivetti, Modcomp, Siemens-Nixdorf, Systems Wizards, University College London

449 **SPEECH**

Investigation into the effective use of speech at the human-machine interface

British Maritime Technology, Cortec, Fincantieri, STC-ICL, Voice Input

563 **PICA**

A high compression picture-coding algorithm for videotex

British Telecommunications, CCETT, CSELT, IBA, KTAS, PTT Research, Siemens-Nixdorf

612 **MODEL-DISPLAY**

Modelling and simulation of the visual characteristics of modern display technologies under office work conditions

Barco Industries, GEC, MYFRA, OCE-Nederland, Thomson-CSF, université de Paris, Universiteit van Twente

813 **TODOS**

Tools for designing office systems

CNR-IEI, Dornier System, Italtel Telematica, OCE, Politecnico di Milano, Sema Metra Group, Systems & Management, Thomson-CSF, Universität Köln-BIFOA, université de Paris-I

831 **ASTRA**

Advanced and integrated office systems prototypes for European public administrations

Bull, Cesia, CRIAI Datacentral, Datenzentrale Schleswig-Holstein, GSI, Ing. C. Olivetti, MC2, Silogia, Sogei

834 **COMANDOS**

Construction and management of distributed office systems

ARG, Bull, CNR-IEI, Fraunhofer IM, IMAG, INESC, Ing. C. Olivetti, Siemens-Nixdorf, STC-ICL, Trinity College Dublin, Universität Stuttgart

853 **TRUE-COLOUR**

Acquisition, compression and reproduction of true-colour image documents

Ing. C. Olivetti, Intersys Graphic, Katholieke Universiteit Leuven

855 **TYPEWRITERS**

European typewriters and other workstations integration

AEG Olympia, Ing. C. Olivetti, Politecnico di Torino, Triumph Adler

870 **TALON**

Testing and analysis of local area optical networks

Cossor Electronics, NKT Elektronik

878 **PROMINAND**

Extended office process migration with interactive panel displays

IAB, Modulex, Risø National Laboratory, Scaitech, Technische Universität München

890 **PANGLOSS**

Parallel architecture for networking gateways linking OSI systems

7-Technologies, CAP PCS Computersysteme, université de Liège, Universiteit van Twente, University of Reading

901 **DOMESDAY**

An intelligent general public data, voice and picture storage retrieval system

BBC, Bureau van Dijk, CRIN, Logica, Philips Gloeilampenfabrieken

925 **CODING-256**

Coding for moving pictures and still pictures at 256 Kbit/s and 64 Kbit/s

Alcatel, GEC, Philips, Société anonyme de télécommunication, Sepa, Telefónica

954 **IKAROS**

Intelligence and knowledge-aided recognition of speech

Alcatel, Alsthom Recherche, Fraunhofer-IAO, GEC, Universität Stuttgart

956 **COCOS**

Components for future computing systems

Bull, Ing. C. Olivetti, INRIA, SGS-Thomson Microelectronics, Siemens-Nixdorf, STC-ICL

998 **MARS**

Highly secure office information systems

Bertin & Cie, COPS, Protexarms Rovsing, Universität Köln-BIFOA, University of East Anglia

1024 **PODA**

Piloting the office document architecture

Alcatel, Bull, Ing. C. Olivetti, OCE-Nederland, Siemens, Siemens-Nixdorf, STC-ICL, Syntax Software Sistemi, Queen Mary & Westfield College, University College London

1030 **IT-UPTAKE**

Human and economic factors in IT uptake processes

Empirica, Irish Medical Systems, STC-ICL, Work Research Centre

1051 **A-Si IMAGER**

Amorphous silicon contact imager for office and graphic applications

Agfa Gevaert, CNRS-Lepsi, IMEC, MBB

1057 **MIAC**

Multipoint interactive audiovisual communication

Alcatel, Face Standard, British Telecommunications, CNET, CSELT, PTT Research, Neher Laboratories, STC-ICL, Telefónica, Thomson-CSF

1059 **DAMS-1**

Dynamically adaptable multi-service switch

J-S Telecom, Roke Manor Research, TN Telenorma

1533 **MIS**

Multilingual information system

Bull, Ing. C. Olivetti, Siemens-Nixdorf, STC-ICL

1541 **MULTILINGUA**

Multilingual speech input-output assessment, methodology and standardization

CNET, CSELT, Jydsk Telefon, Universiteit van Amsterdam, University College London

1573 **IBASS**

Intelligent business application support system

Bull, Datamont, Feruzzi Group, Langton, Siemens-Nixdorf, South Bank Polytechnic

2001 **SPRITE**

Storage, processing and retrieval of information in a technical environment

ADV/ORGA FA Meyer, AEG Electrocom, Alcatel, Armines, Katholieke Universiteit Brabant, OCE-Nederland, Trinity College Dublin, Universität Hamburg, Daimler-Benz, Akademie der Wissenschaft

2013 **MAGNOPTIC**

Development of European magneto-optical drives

CEA, Coventry Polytechnic, NIHE, GEM, Olivetti Systems & Networks, Philips Nederland, Philips Dupont Optical

2054 **UCOL-2**

Ultra-wideband coherent optical LAN

Alcatel, Alsthom Recherche, Face Standard, COSI, Daimler-Benz, IDATE-Yves Gassot, INESC, PTT Research, Neher Laboratories, Standard Elektrik Lorenz, STC-ICL, Telettra España, University of Southampton

2058 **ICI**

Intelligent communication interface

British Telecommunications, SAIT Electronics, Universidad Politécnica de Cataluña, Universidad Politécnica de Madrid

2071 **COMANDOS-2**

Construction and management of distributed open systems

Bull, Chorus Systèmes, Fraunhofer-ITW, IMAG-LGI, INESC, Siemens-Nixdorf, Trinity College Dublin, Universidad Politécnica de Cataluña, Universität Stuttgart, University of Glasgow

2082 **HECTOR**

Harmonized European concepts and tools for organizational information systems

CAP Sogeti Innovation, CRAI, Delga International, Dornier Systems, Fraunhofer-IPA, IOT, KPMG-Peat Marwick McLintock, PA Consulting Group, Universität Köln-BIFOA

2083 **SIMPR**

Structured information management: processing and retrieval

CAP Gemini Europe, CRI, Dublin City University, Nokia, Research Unit for Computational Linguistics, Universidade Católica Portuguesa, Universiteit van Amsterdam, University College Dublin, University of Strathclyde

2100 **MAX**

Metropolitan area communication system

3IT, Alcatel, CSELT, Hewlett-Packard, KTAS, L-Cube Information Systems, NKT, Sirti, université de Paris-VI, University of Patras

2102 **COMIS**

Standard for coding moving images on digital storage media

British Telecommunications, CNET, CSELT, Deutsche Thomson-Brandt, Eikon, Inmos, Halbleiterwerk der Deutsche, Philips Research Laboratories UK, PTT Research, Neher Laboratories, Sidac, Thomson-CSF, TN Telenorma, Universität Hannover

2103 **MASCOT**

Multi-environment advanced system for colour treatment

Computer Logic R&D, Hitec, ICI, Ing. C. Olivetti, Katholieke Universiteit Leuven, Kern & Co, OIS, Syntax Software Sistemi, Thomson-CSF

2105 **MULTIWORKS**

Multimedia integrated workstations

Acorn Computers, AEG Olympia, Bull, Chorus Systèmes, Daimler-Benz, GMD, Harlequin, Ing. C. Olivetti, INPG, INRIA, Philips, Polytechnic of Kreta, SGS-Thomson Microelectronics, Triumph-Adler, Tecnopolis Csata Novus Ortus, Télésystèmes

2109 **TOOTSI**

Telematic object-oriented tools for services interfaces

Algotech, ARG, Centro di Cultura Scientifica — A. Volta, Desarrollo de Software, Infotap, Politecnico di Milano, Saritel, Sophiatec, Télésystèmes, université de Nice-Lisan, System & Management

2111 **PONTIFEX**

Planning of non-specific transportation by an intelligent fleet expert

Aeritalia, CAP Gemini Europe, CNR-IASI, Iberia Lineas Aéreas de España, Siemens-Nixdorf, O Dati Española SL, Sipe Optimation, TAP Air Portugal, Trademco Trut — Kykloforiaki

2114 **LSVI**

Large-size visual interface design for multimedia workstation terminals

Pilkington, Standard Elektrik Lorenz, Thomson-CSF

2121 **ITHACA 1**

Integrated toolkit for highly advanced computer applications

Bull, CAP Sogeti Innovation, CNRS-LADL, Communication and Management System Unit, D-TECH, Datamont Feruzzi Group, Delphi, E2S, Forth Research Centre, INRIA, Politecnico di Milano, Siemens-Nixdorf, TAO, Trinity College Dublin, Università degli Studi di Milano, Universität Karlsruhe, université de Genève

2125 **ETR**

Electrothermal ribbon

AEG Olympia, Baltea, Ing. C. Olivetti, Manchester Polytechnic

2144 **IT-USE**

Information technology uptake support environment

Datacentralen, Futurmedia, Groningen University, Handelshøjskolen i København, Irish Medical Systems, Memory Computer, Work Research Centre

2146 **DAMS-2**

Dynamically adaptable multiservice system

INESC, J-S Telecom, RWTH Aachen, STC-ICL, TN Telenorma, Universidad Politécnica de Madrid, Universität Kaiserslautern, Universität Stuttgart, University of Patras

2170 **SUPERDOC**

A set of software tools for a document workstation

Addax, Bull Italia, Epsilon Software, INESC, Lombardia Informatica, Politecnico di Milano, Selisa, Sistemas Multiposto e Distribuidos, Strategic International, Teseo

2221 **RICHE**

Health services information and communication network for Europe

Actir-Sante, Bazisleid, Bull, GESI, IRIAM Irish Medical Systems, Lombardia Informatica, SIG Services, STAF-Conseil de Filière, Università Cattolica del Sacro Cuore, NHS Management Information Centre

2239 **SESEFA**

Self-service facilities architecture

ERIA, IKOSS-Software Service, Prisma Informatica, Silogia, Università di Firenze, ERITEL

2267 **ISA**

Integrated systems architecture for ODP

British Telecommunications, CASEG, Chorus Systèmes, CNET, Computer Technology Institute, Deutsche Thomson-Brandt, Daimler-Benz, Digital Equipment, GEC Marconi, GEC Plessey Telecommunications, GESI, Hewlett-Packard, Modcomp, Philips International, Siemens, STC-ICL, Syseca, Televerket

2283 **MATRIX-LCD**

Active matrix LCD for TV and office systems

AEG, Aristoteles University of Thessaloniki, GEC, IMEC, Rytrak Seleco, Thomson-CSF, Thomson-LCD

2294 **TOBIAS**

Tools for object-based integrated administration systems

GIE-Émeraude, Intecs International, Intrasoft Planet, University of Newcastle

2315 **TWB**

Translator's workbench

Mercedes Benz, Fraunhofer-IPA, L-Cube Information Systems, Siemens-Nixdorf, SPAI, Triumph Adler, Universidad Politécnica de Cataluña, SNI CDS

2322 **ISEM**

IT support for emergency management

ADV/ORGA FA Meyer, ENEA, GRS, IGC, Jydsk Telefon, Risø National Laboratory, SCK-CEN, Studsvik Nuclear Technical Research Centre Finland, Tecnatom, Técnicas Reunidas, Uitesa

2360 **FELICITA**

Development of ferroelectric liquid crystal devices for information technology applications

BDH, GEC, Lagerwall RL, Merck, OCE-Nederland, Robert Bosch, DRA, Seleco, Thomson-CSF, Thorn EMI, Universidad Politécnica de Madrid, Università di Bari, University of Hull

2374 **PODA-2**

Piloting of the office document architecture

ICL, British Telecommunications, Siemens-Nixdorf, Olivetti Information Services, Alcatel TITN, OCE-Nederland, IBM Deutschland, Bull, University College London, SSI

2382 **ELO**

Elusive office

Bonnscript, CLS Computer Lernsysteme, Empirica, Fraunhofer-ISI, Heptacon Neptune Freight, OEVA-Versicherungen, Otter Online, Rutherford Appleton Laboratory, Standard Elektrik Lorenz

2404 **PROOF**

Primary rate ISDN OSI office facilities

3 Net, Systems Wizards, University College London

2431 **HOME**

Home systems

AEG, Alcatel Standard Eléctrica, Asea Brown Boveri, Bang & Olufsen, Bassani Ticino, British Telecommunications, Busch-Jäger-Elektro Centre, GEC, Honeywell Europe, Ikerlan

2455 **LTI**

Large-image terminals

Nokia Grätz, Standard Elektrik Lorenz, Thorn EMI, University of Heriot-Watt

2463 **ARGOSI**

Applications-related graphics and OSI standards integration

COSI, Fraunhofer Graphische Datenverarbeitung, GESI, GMD, INRIA, Laser-Scan Laboratories, Rutherford Appleton Laboratory, Tecsiel, Thomson-CSF, University of East Anglia

2466 **KWICK**

Knowledge workers intelligently collecting, coordinating and consulting knowledge

ADV/ORGA FA Meyer, Artificial Intelligence Systems, Bull, CEC, ISPRA Establishment, CMSU, CNRS, Elsa Software, Elsevier Science Publishers, Espasa-Calpe, IRIAM, Maatschappij Voor Informatica Diensten, Office Workstations, Tecograf Software, Università degli Studi di Milano, University of Glasgow

2476 **BANK '92**

Bank '92

Banco de Sabadell, Banco Herrero, Bull España, Caja de Ahorros del Mediterráneo, Caja Insular de Ahorros de Canarias, CAP Gemini Sogeti, Computer Logic R&D, Credito Italiano, Entel, Ikoss, INESC, CRI, Prisma Informatica, Silogia, STC-ICL, Thomson-CSF, Unibanque

2484 **SPIRIT**

High-performance technical workstation

ACE, British Aerospace, Caption, GIPSI, Kontron Elektronik, Telmat informatique, Queen Mary & Westfield College, Universität Tübingen, University of Sussex, École polytechnique fédérale de Lausanne

2499 **CDR**

CD-ROM workbench

ACT, Clarinet Systems, Elektroson, Katholieke Universiteit Nijmegen, Textware

2512 **IACIS**

Intelligent area communication and information system

Administração do Porto de Lisboa, Port Autónom de Barcelona, Bull Italia, CSELT, Entel, INESC, Ositel, Prisma Informatica, SECRE, SEGET, SIRTI, SISMET, Porto di Genova, Stollmann, SYD, Synergia, Tecno T&G, Telefónica, Televas, Universidad Politécnica de Madrid, Universität Stuttgart

2563 GAUCHO

General distributed architecture for unified communication in heterogeneous OSI-environments

ADV/ORGA FA Meyer, Dannet, Fischer & Lorenz, Project Management Consultants, RC-Computer Telefónica, Universidad Politécnica de Madrid

2569 EWS

European workstation

Bull, Chorus Systèmes, Fraunhofer Graphische Datenverarbeitung, GIPSI, Grupo Apd, INESC, INRIA, Rutherford Appleton Laboratory, Siemens-Nixdorf, University of Brunel

2633 MAG-UHD

Magnetic media for future ultra-high-density information storage

Agfa Gevaert, Aristoteles University Thessaloniki, BASF, CNRS-Mulhouse, Du Pont de Nemours de Luxembourg, Institut national polytechnique de Lorra, université de Bordeaux

2638 ADOT

Advanced display optimization tools

British Aerospace, City University (London), OCE-Nederland, Sogitec, TNO

2649 VASARI

Visual arts system for archiving and retrieval of images

Brameur, Direction des musées de France, Dörner Institut, Eikon, National Gallery, Syseca, Telecom Paris, Thomson-CSF, TÜV, University of London (Birkbeck College)

2684 MIAS

Multipoint interactive audiovisual system

Alcatel, Amper, British Telecommunications, CNET, CSELT, PTT Research, Neher Laboratories, Telefónica

2704 CRYPTO-CARD

Development of a dedicated microprocessor with a universal crypto processor and its integration into high-security IC-cards

Bull, Siemens

2705 ITHACA

Integrated toolkit for highly advanced computer applications

Bull, CNRS-LADL, CMSU, D-TECH, Datamont Feruzzi Group, Delphi, Forth Research Centre, PTT Research and Development, Gip Altair, IFATEC, INRIA, Politecnico di Milano, Siemens-Nixdorf, SQL Databanksysteme, TAO, Technische Universität Dresden, Trinity College Dublin, Università degli Studi di Milano, Universität Zürich-IRCHEL, université de Genève

5011 JEPS

Bootstrap project for joint European printer server

Bull, OCE-Nederland, Siemens-Nixdorf

5012 PREJEEMI

Bootstrap project for a multiple device file server

Bull, Philips, Rodime

5140 HIVE

Home interactive environment

Bang & Olufsen, Centra Burkle, Honeywell Europe, Jydsk Telefon, University of Bristol

5165 DOMAINS

Distributed open management architecture in networked systems

Harwell Laboratory, ITK, Mari Group, Philips, Roke Manor Research Limited, Siemens, université Pierre et Marie Curie, University of Athinai, Architecture Projects Management

5167 EURORIP

European raster image processor for common fonts and page description languages

Autograph International, Fraunhofer Graphische Datenverarbeitung, URW

5193 MAXI

Metropolitan area communication system

Alcatel, British Telecommunications, CSELT, Hewlett-Packard, IRIT, KTAS, L-Cube Information Systems, NKT, SIRTI, Telettra, université Pierre et Marie Curie, University of Athinai

5199 ISA-DEMON

A distributed environment monitor for the ISA architecture

Architecture Projects Management, Mari Group, Universidade de Aveiro

5203 INTREPID

Innovative techniques for recognition and processing of documents

AEG Electrocom, CTA, EWH Koblenz, Nottingham Polytechnic, Olivetti Systems & Networks, Pacer Systems, Università di Napoli

5233 TELESTATION

Telestation

Active Book Company, Alcatel, ARG, Daimler-Benz, Hewlett-Packard, Olivetti Systems & Networks, Perihelion Software

5252 HYTEA

Hypertext authoring

CEC-JRC Ispra Establishment, Epsilon Software, GMD, Ing. C. Olivetti, Politecnico di Milano, Siemens, Systems & Management

5279 HARNESS

European distributed system integration project

British Telecommunications, Bull, CAP Sogeti Innovation, CNRG, Datamont Feruzzi Group, Ensta-Lies Grupo, INESC, INRIA, Kapsch, Siemens, STC Technology, Trinity College Dublin, Universitaire Instelling Antwerpen, Volmac Nederland, Architecture Projects Management

5303 EUROCOOP

IT support for distributed cooperative work

Arhus Universitet, Empirica, GMD, Jydsk Telefon, STC-ICL, Storebæltsforbindelsen-Great Belt, Triumph Adler, X-TEL Services

5320 PODA-SAX

Piloting ODA extensions and their applications in systems

Bull, IBM Deutschland, Olivetti Information Services, Siemens-Nixdorf, STC-ICL, Syntax Software Sistemi, University College London

5322 CHALENGE

Standardized EDI platform for applications using OSI

Bull HN Information Systems, EPEC, Epsilon Software, Ibermatica, Informabel, Irish Medical Systems, Siemens-Nixdorf, Pross

5341 OSI 95

High-performance OSI protocols with multimedia support on HSLANs and B-ISDN

Alcatel Austria — Elin, Bell Telephone, Bull, INRIA, Institut national des télécommunications, Intracom

5346 EUROSHOP

Distributed electronic shopping and integrated retail logistics for Europe

Corte Inglés, GIE-Recherche Haussmann, Littlewoods Organization, Siemens-Nixdorf, Sligos

5371 PEMMON

Performance management and monitoring of open networks in heterogeneous contexts

CSEE, Selenia, université Pierre et Marie Curie, University College Dublin

5374 QLIS

Software scenario models for quality of life in information society

Bang & Olufsen, BBC Productions, Open University, CAP Sogeti Innovation, Copenhagen Business School, Datamont Feruzzi Group, Fiat, Siemens-Nixdorf, Universität Marburg

5376 **ROCKI**

Raster to object conversion aided by knowledge-based image processing

Algotech, CNR, Fraunhofer-IPA, OCE-Nederland, TNO

5386 **OMIMAP**

Open microsystems initiative: microprocessor architecture project

Acorn Computers, Active Book Company, Bull, European Educational Software, IMEC, Inmos, Olivetti Systems & Networks, DRA, Siemens, Thomson-CSF, University of Manchester

5402 **FODATEC**

Feasibility demonstration of ODA for technical documents

Bureau van Dijk, Caption Kapsch, Universidad Politécnica de Cataluña, Universität Karlsruhe

5405 **HERMES**

Highly interactive environment resource management extendible system

Algotech Sistemi, Ayuntamiento de Sevilla, Azienda Servizi Municipali Comune di Brescia, CRI, Kommunedata, Novosoft, Paisley College Technology

5432 **PANDA**

Public administration demonstrator

Bull, Datacentralen, Grupo APD, IABG, SOGEI, Telefónica

5444 **ACIBS**

Architecture for computer-integrated business systems

CMSU, Norcontel (Ireland), Philips, Trinity College Dublin

5448 **IIH**

Integrated interactive home

British Telecommunications, Daimler-Benz, GEC Marconi, Legrand, Philips International, Siemens, Thomson-CSF, Thorn EMI, Zeltron

5469 **CITED**

Copyright in transmitted electronic documents

British Library, Bull, Bureau van Dijk, Charles Clark, Computer Industry Research Unit, Elsevier Science Publishers, Jaime Brull, NTE, Oxford University Press, Telematic Services, Télésystèmes

5470 **MORESYS**

Accreditation and access control for smart-card mobile reader and communications system

Bull, Elgelec, SINORG, Telefónica, Telesincro

5492 **PROVIDE**

Digital distribution of video

Desisco, Iselqui

5631 **WINS**

Wireless in-house network studies

Alcatel Portugal, Ergon, Maintenance & Automation, Ste Seferiades & Associates, Universidade de Aveiro, Universidad Politécnica de Madrid, NTUA Propagation Group, NTUA Microwave & Optics Group, Universidad de Las Palmas de Gran Canaria, University of Limerick, LEREA SNC

5633 **HYTECH**

Hypertextual and hypermedia documentation

Datamont, Ifatec, INESC, Magneti Marelli, Universität Münster, Etnoteam

5634 **AURA**

Adaptable user interfaces for reusable applications

Fraunhofer, ISA, Mari Group, Thomson-CSF, University of Leeds

5636 **ALDUS**

Artificial legal draftsman for use in sales

Machine Intelligence, BIKIT, Hellenic Information Systems, Universiteit van Amsterdam, Wolters Kluwer, Imperial College of Science, Technology & Medicine, DIDA*EL, CNR-IDG

5638 **KIM**

Knowledge-based information management

Consorzio Roma Ricerche, Futurmedia, GESI, Irish Medical Systems, Software Italia, Trinity College Dublin, Università di Roma-La Sapienza

5639 **SMESPRIT**

An SME expert support system for planning and reporting about information technology

Addax, Algosystems, Delphi, Experteam, Hellenic Management Association, LSE

5640 **PIA**

Public information access

Sistemas Modulares, Association Aeropol, System & Management, INESC

5641 **INCH**

Intelligent charts

Bull, CMSU, Datenzentrale Schleswig-Holstein, IGN-France international, INESC, ISSI, Kommunedata, Magistratsdirektion Wien, Télésystèmes

5644 **EXPORT**

Extended X-protocol for office-related technology

CNRG, Framentec, Meterquest

5650 **ERWIN**

European railways wireless in-house network

Autophon, CER, Plessey, Trialog Informatique

5652 **HYPERDOCSY**

Automatic production of technical documentation

Alcatel, Alsthom Recherche, Avions Marcel Dassault-Breguet Aviation, OC Consulting Engineers & Planners, Siemens SI

5653 **FOES**

Front-office environment study

Banque nationale de Paris, Bull, Concept Logiciels Expert, Pliroforiki, SELISA, Thorn EMI, Time Sharing, University College London

5656 **OSMOSE**

Open standard for multimedia optical storage environments

Espasa-Calpe, Ing. C. Olivetti, Pergamon Compact Solution, Philips TDS

5660 **PECOS**

Perspectives on cooperative systems

AIS, BIKIT, EMMEPI, Industrias de Telecomunicazione Lombardia, Mari Group, Universidad Politécnica de Madrid

6005 **TWB II**

Translator's workbench

CCE SDT, Debis, Institut für Arbeitswissenschaft & Technik, L-Cube Information Systems, Siemens Nixdorf, Site, Triumph-Adler, Universidad Politécnica de Cataluña, Universität Heidelberg, University of Surrey

6092 **IDEM**

Integrated domestic energy management

Boro, Easl Eng & Safety Div, Helgeco, Landis & Gyr, Mari Group, Micro Tech, Zeltron

6105 **SPECTRE**

Advanced interactive 3-D graphics system for the enhancement of multimedia

ACE, Caption, PCS Computersysteme, Telmat Informatique, Universität Tübingen, University of Sussex

6155 **EUROCODE**

CSCW open development environment

Århus Universitet, Empirica, GMD, Jydsk Telefon, Norsk Regnesentral, Rank Xerox, Storebæltsforbindelsen, Triumph-Adler, X-Tel Services .

6189 **MIHFAD**

Miniature heads for advanced disk drives

CEA-Leti, CPE, Silmag

6196 **CHIMENE**

Collective home interface made out of existing networks in Europe

Clemessy, Domos Consortium, E & E, EDP, Elkron, Institut Cerda, Landis & Gyr, Merlin Gerin, Philips, Pluricom, TDF-Cerlor, Universidade de Aveiro

6219 **TWIN**

Technologies for wireless interconnection of mobile networks

Autophon, Community of European Railways, ENA Telecomunicaciones, Siemens Plessey Controls, Telettra, The Antwerp Telephone and Electrical Works, Thomson-CSF, Trialog Informatique

6307 **MADE 1**

Multimedia application development environment

Barclays Bank, British Aerospace, Bull, CWI, ESI, Gipsi, INESC, Iselqui, Norsk Regnesentral, Siemens Nixdorf

6311 **IDSM**

Integrated distributed system management

Bull, Fraunhofer-IITB, Koninklijke PTT Nederland, Mari Group, NTUA, Siemens, Synergic

6331 **MIDAS**

Management in a distributed application and service environment

Cellware, CSI-Piemonte, GMD-Fokus, Systems Wizards, University College London

6398 **VENUS**

Visual enquiry user-oriented system

Bull, Consorzio Roma Ricerche, ENEA, Futuremedia, GESI, Irish Medical Systems, Olivetti Systems & Networks, Software Italia, Trinity College Dublin, Universita Cattolica del Sacro Cuore, Universita di Roma-La Sapienza

6441 **HS FVI**

Home systems functional validation and interoperability

Conphoebus, Daimler-Benz, European Home Systems Association, SED, TDF-Cerlor

6530 **MINERS**

An editorial platform for electronic and traditional publishing

CTA, GMD, IGDA, Il Tridente, Marsilio, Music/FORTH, Politecnico di Milano, RSCG Interactif, Siemens, Systems and Management

6542 **MIPS**

Multimedia information presentation system

Corte Ingles, Dansk Teknologisk Institut, Heriot-Watt University, Longman Cartermill, Rutherford Appleton Laboratory, Sema Group Belgium, Sistemas y Tratamiento, Trinity College Dublin

6657 **HICOS**

Hierarchical integrated case processing system

BISS, CLS Computer Lernsysteme, Empirica, ODAV, OEVA-Versicherungen, Science & Engineering Research Council, Wiener Städtische Versicherungen

6691 **FAST**

Financial applications in servicing and training

Banco Bilbao Vizcaya, Bull, CAP Gemini, Cariplo Caridata, Etnoteam, INESC, Sema Group, Syntax Sistemi Software

6726 **M-CUBE**

Multiple media multiple communication workstation

Olivetti Office, Olivetti Systems & Networks, Siemens, Thomson Consumer

6763 **DOCS**

Document logistics

Baileys, Shaw & Gillett, Baker & Mckenzie, Fraunhofer-Gesellschaft, Lawrence Graham, OCE-Nederland, Scamoni, Chiavegatti e Associati, Studio Bernini, Syseca, Universita di Bologna, University of Brunel

6782 **HS-COMPONENTS**

Home systems components

Daimler-Benz, EDF-Electricité de France, European Home Systems Association, Landis & Gyr, SGS-Thomson Microelectronics, TDF-Cerlor, TER, Thomson Consumer, Thorn EMI, VLSI Vision

6784 **HS-CONFORMANCE**

Home-systems conformance testing and certification

Acerli, Daimler-Benz, European Home Systems Association, Fraunhofer-IITB, LCIE, Zeltron

6788 **OSMOSE**

OSMOSE

Audiovisual, Bull, CAP Sesa Telecom, Maxwell Multi Media, Olivetti Systems & Networks, Philips, Track One, UNI-C, University of Athens

6789 **HOMESTEAD**

Home shopping by television and disc

Barclays Bank, Freemans, Little Big One, Page & Moy, Philips

6812 **PAINTAMORESYS**

Personally addressed integrated information network in airports based on access mobile reader system

Elgelec, Ergon, NTUA-Microwave and Optics Group, OA, Penburg, Philips Composants, Sinorg

6816 **LYNX**

Enhanced multimedia object system

Aitec, APD, Iona Technologies, SISU, Transtools, Trinity College Dublin, University of Ulster

6882 **MULTIDOC**

Management of complex multimedia dossiers

BMC, Consuldata Nederland, Epsilon Software, Falcon Informatica, Music/FORTH, Selisa

6892 **POWER**

Portable workstation for education in Europe

Acorn Computers, Alcatel Portugal, ARM, Etnoteam, GEC Marconi, Idate-Yves Gassot, Lernout & Hauspie Speechproducts, Opsis, Pluricom, Triumph-Adler, Universidade de Aveiro

6937 **MARC**

Methodology for arts reproduction in colour

Baerische Staatsgemadesammlungen, CCD Videométrie, Crosfield Electronics, Ihirmer Verlag, National Gallery of London, Schwitter, Thomson-CSF, University of London

6994 **FACE**

Familiarity achieved through common user-interface elements

Bticino, Husat Research Center, Institut für Arbeitswissenschaft & Technik, Legrand, Philips Consumer Electronics, Thomson Consumer, Thomson-CSF

7023 **CAFE**

Conditional access for Europe

Århus Universitet, CJS Consultancy, CWI, Digicash, Gemplus Card International, Infhil, Ingenico, Institut für Sozialforschung, Katholieke Universiteit Leuven, KTAS, Mathrizk, NTR, PTT-DNL, Sept

7026 **SYSMAN**

Open distributed systems management

AEG-ATM, Alcatel Austria-Elin, BP International, ICL, Imperial College, Siemens, Synergie

7061 **OPENMAN**

Optimal energy managememt configurable system

EDF, Iberdrola, Keon, Schlumberger Industries

7244 **PSPGF**

Présentation du système de planification et de gestion de fréquence

CIFA Institut, CML, IC&M

7272 **MODECS**

Modular distributed enterprise-wide communication system

Ascom Holding, INESC, J-S Telecom, NKT, NTUA, Telenorma Bosch Telecom, Thomson-CSF, Universidad Politécnica de Madrid, Universidade de Aveiro

7314 **MANTIS**

Metropolitan area networks for integrated services

INESC, KTAS, L-Cube Information Systems, Marconi, NKT, NTUA, Sirti, TLP

7359 **LAURA**

Local-area network user radio access

Dassault Automatismes et Télécom, Électronique Serge Dassault, Elettronica Communicazioni, INRIA, Symbionics, University of Bradford, University of Bristol

Computer-integrated manufacturing and engineering

9

Exploitation of real-time imaging for arc welding

Babcock Energy, Messer Griesheim, RWTH Aachen, Welding Institute of Cambridge

34

Design rules for computer-integrated manufacturing systems

ISTEL

75

Design rules for the integration of industrial robots into CIM systems

Fraunhofer IPK, University College Galway, Renault Automation, RPK der Universität Karlsruhe

92 **CIPI**

A computer-integrated production insula: design rules and standards

Logica

118

General-purpose sensory-controlled systems for parts production

Comau, IPA-Fraunhofer Gesellschaft, OCN-PPL, Siemens-Nixdorf, SINCON

179

Integrated electronic subsystems for plant automation

AEG, GEC Marconi Research

197

Computer-aided thermal image technique for real-time inspection of composite material

Barr & Stroud, CNR, University of Strathclyde

278

Integrated sensor-based robot system

IPA-Fraunhofer Gesellschaft, Joyce-Loebl, Mari Group, Robert Bosch, Universidade Nova de Lisboa, National Technical University of Athinai, University of Newcastle

293

Knowledge and decision support for material-handling systems

Alcatel, Alsthom Recherche, CGP, Fraunhofer-IPK, IBM Deutschland, Instituto Superior Técnico

319

Data transfer between CIM systems and management information systems

Computer Systems Development, Mentec International, Trinity College Dublin

322 **CAD-I**

CAD interfaces

BMW, Cisigraph, Cranfield Institute of Technology, Danmarks Tekniske Højskole, GFS, Katholieke Universiteit Leuven, Kernforschungszentrum Karlsruhe, Leuven Measurement & Systems, NEH Technology, Rutherford Appleton Laboratory, Universität Karlsruhe

338

Product design for automated manufacture and assembly

CIMAF, COMAU, Cranfield Institute of Technology, Renault automation

384

Integrated information processing for design planning and control of assembly

AEG, Fraunhofer-IPK, GEC Research, Marconi Research, Induyco/Investronica, Télémécanique

409

Development of an integrated process and operations planning system with the use of interactive 3-D modelling techniques

EXAPT-Systems Technology, Matra Datavision, Volkswagen

418

Open CAM system allowing modular integration into factory management of a workshop structured in functional cells with various levels of automation

CIG, Ing. C. Olivetti, Logica, Matra, Procos, RTM, RWTH Aachen, université de Bordeaux

477 **COSIMA**

Control systems for integrated manufacturing

COMAU, Digital Equipment, Renault automation

496 **PAPILLON**

Design and specification of configurable graphics subsystems for CIM

Generics Software, GTS, Trinity College Dublin

504 **PAQO**

Plant availability and quality optimization

ADERSA, AMTRI, Battelle Institut, Danobat Coop, GRS, Ikerlan, Stewart Hughes, Technische Hochschule Darmstadt

534

Development of a flexible automated assembly cell and associated human factors study

Dantec Elektronik, Medical Research Council, Risø National Laboratory, Vrije Universiteit Brussel, Westland

595

The application of CIM to welded fabrication

Ålborg Shipyard, Danish Welding Institute, Italsiel, Odense Steel Shipyard, Università di Genova, Welding Institute of Cambridge

623

Operational control for robot system integration into CIM

CNR-LADSEB, FIAR, Fraunhofer-IPK, Kuka Schweißanlagen & Roboter, Politecnico di Milano, PSI, Renault automation, Seram, Universidad Politécnica de Madrid, Universidade Nova de Lisboa, Universität Karlsruhe, université de Valenciennes, Universiteit van Amsterdam, University College Galway

688 AMICE

A European computer-integrated manufacturing architecture

AEG, Aérospatiale, Alcatel, AT&T Nederland, British Aerospace, Bull, CAP Gemini Innovation, Cegelec Projects, Digital Equipment, Dornier System, Fiat Aviazione, Hewlett-Packard France, IBM Deutschland, Italsiel, Philips, Procos, RWTH Aachen, SEIAF, Siemens, STC-ICL, Volkswagen

809

Advanced control real-time CIM systems and concepts for flexible automation

Krupp, STC-ICL, TDS Dextralog, Technische Universiteit Delft, Universiteit van Twente

812

Experimental centre for system integration in CIM

Aeritalia, ELSAG, Philips, Politecnico di Milano, RWTH Aachen, SESA

850

Predesign of FMS for small-batch production of electronic cards

CSEA, ERIA, Eurosoft Systems

909

Development of tools for economic evaluation of CIM in smaller manufacturing companies

AMTRI, BIBA-Bremen, Institute for Industrial Technologies, CIMAF, Danmarks Tekniske Højskole, Mentec International, WTCM/CRIF

932

Knowledge-based real-time supervision in CIM

AEG, ARS, BICC Technologies, CEA, Fiar, Fraunhofer IPA, Philips, Pirelli, Politecnico di Milano, SGN Graphael, SIS AV, Universität Karlsruhe, université de Savoie

955 CNMA

Communication network for manufacturing applications

Aeritalia, BMW, British Aerospace, Bull, CGE, Elf Aquitaine, Fraunhofer Institut, GEC, Olivetti IS, Ricerca SCPA, PSA, Siemens-Nixdorf, STC-ICL

975 TRACIT

Transponders for real-time activity control of manufacturing links to CIM information technology systems

Polydata, Redar NAH-Ortungstechnik, TMTED

1062 ACCORD

Computer-aided engineering software for advanced workstations in the CIM environment

Athinai School of Economics, Bertin & Cie, GEC Research, Marconi Research, Philips, Société générale de techniques et d'études, Trinity College Dublin, Università di Genova, Vector Fields

1136 DASIQ

Distributed automated system for inspection and quality control

CEA-LETI, Microtecnica, SAGEM, Universität Hannover, Visitec

1199

Human-centred CIM system

BICC Technologies, Danmarks Tekniske Højskole, Dansk Teknologisk Institut, Greater London Enterprise, Krupp, NEH Technology, Rolls Royce, Universität Bremen, University of Liverpool, University of Manchester

1556 VITAMIN

Visualization standard tools in manufacturing industry

Fraunhofer Institut für Industrieinformation, Politecnico di Milano, Syseca, Team, université de Valenciennes

1561 SACODY

A high-performance flexible manufacturing system robot with dynamic compensation

AEG, Bertin & Cie, Katholieke Universiteit Leuven, Kuka Schweißanlagen & Roboter, Leuven Measurement & Systems, University College Dublin

1572

Basic technologies for high-performance solid-state image sensors

Thomson-CSF, Valvo Unternehmensbereich

1653

Intelligent process control by means of expert systems

Centre d'Estudis Avançats de Blanes, CNRS-LAAS, Dornier System, Eltec Elektronik, Miniwatt, Philips Composants, Universidad Politécnica de Cataluña

2010 NEUTRABAS

Neutral product definition database for large multifunctional systems

BIBA, Bremer Vulkan, Chantiers de l'Atlantique, GEC Alsthom, Construnaves, Cotec Computing Services, Decision International, Gesellschaft zur Entwicklung von DV-Methoden, Howaldtswerke — Deutsche Werft, Institut de recherche de construction navale, ITS, Schiffko, Sener-Sistemas Marinos, Technische Universität Berlin, Universidad Politécnica de Madrid, université Paul Sabatier de Toulouse, University of Strathelyde

2017

Automated process and assembly inspection by 3-D vision

INISEL, Philips Robotiker, Siemens, Silicon & Software Systems, Universität Erlangen-Nürnberg, Zenon

2032 CIM ALIVE

Implementation addressing levels of integration in various environments

AEG, Carlo Gavazzi Impanti, CEC Electrical Projects, Philips, SNIA BPD — Fiat Group

2043 MARIE

Mobile autonomous robot in an industrial environment

Framatome Group, Framentec, Hitec, IAI, Metek, Robert Bosch, Universiteit van Amsterdam, University of Strathelyde, Volmac Nederland

2090 EPIC

Early process design integrated with controls

Info Systems, City University (London), Intrasoft, Metek Motor Oil, Planet, Special Analysis & Simulation Technology, TNO

2091 VIMP

Vision-based online inspection of manufactured parts

Caption, CCD and CAD Image Comparison, Fraunhofer Institut für Information, Speroni, Universität Karlsruhe, université Louis Pasteur de Strasbourg

2127 HIDCIM

Holographic labelling techniques for automatic identification in CIM environments

ICI Imagedata, King's College London, Krupp, Mandelli, Standard Elektrik Lorenz, Universidade do Porto

2165 IMPPACT

Integrated modelling of products and processes using advanced computer technologies

Games Ingenieri France, Hellenic Aerospace Industry, Krupp, Lips, Unibed, Norsk Data, PAFEC, RWTH Aachen, Centre for Industriforskning, Sintef Group, Technische Universität Berlin, TNO, Universität Karlsruhe

2172 DIAS

Distributed intelligent actuator and sensors

EDF, Electricidade de Portugal, Empresa Fabril de Máquinas Eléctricas, ENEL, Esacontrol, Hartmann & Braun / Schoppe & Fäser, Instituto Superior Técnico, Mentec International, Montefibre, Sema Group Belgium

2178 **RA-IQSE**

Revision advisor — an integrated quality support environment

Asociación de La Industria Navarra, Computer Technologies, CRI, HCS Industrial Automation, Paisley College of Technology

2189 **BIPMS**

Building industry project management system

Baan Info Systems, Centre scientifique et technique de la construction, UTI Services

2192 **AIMBURN**

Advanced intelligent multisensor system for control of boilers and furnaces

Electricidade de Portugal, Fábrica de Vidros Barbosa & Almeida, IDS, IGC, Instituto Superior Técnico, Mague, Servotrol, Imperial College of Science, Technology & Medicine, Trion Präzisionselektronik & Co, Unisoft

2195 **CADEX**

CAD geometry data exchange

BMW, Det Norske Veritas, Disel, FEGS, Fiat Aviazione, GFS, Hewlett-Packard, Isykon Software, Italcad Tecnologie e Sistemi, Norsk Data, Procad, Senter for Industriforskning, Siemens-Nixdorf, University of Leeds

2198 **FCPN**

Factory customer premises network

Compañia Sevillana de Electricidad, EDF, INPT/ENSEEIHT, National Research Centre, Polydata, Pross, Robert Bosch, Thomson-CSF, Universidad Politécnica de Madrid, University of Patras, University of Thrace 'Demokritus'

2202 **CIM-PLATO**

CIM system planning toolbox

Bull, CNR-LADSEB, Fiar, Fraunhofer-IPK, Induyco/Investronica, Kuka Schweißanlagen & Roboter, Politecnico di Milano, Psi, Renault Automation, Universidad Politècnica de Madrid, Universidade Nova de Lisboa, Universität Karlsruhe, Universiteit van Amsterdam, University College Galway

2277 **CMSO**

CIM for multi-supplier operations

Actis Zentrale Verwaltung, Afia, Alcatel, BIBA, Institute for Industrial Technologies, Catia Software Service, CMSU, DAF, Helsinki University of Technology, Instituto Superior Técnico, Lucas Automotive, OY Saab-Valmet, Technische Universiteit Delft, University of Warwick, Vegla Vereinigte Glaswerke, Wilhelm Karmann

2280 **LAMA**

Large manipulators for CIM

AEG, Bertin & Cie, CASA, Dansk Teknologisk Institut, Fraunhofer-IPA, Fraunhofer-IPK, HF Jensen, Moog Controls, Putzmeister-Werke

2292 **TT-CNMA**

Testing technology for communications networks for manufacturing applications

Acerli, Alcatel, BMW, Fraunhofer Institut für Informationstechnik, Siemens, SPAG-CCT, Swedish Telecom, TNC

2312 **CIRCE**

Application and enhancement of an experimental development centre

Aeritalia, Alcatel, Elsag, Philips, RWTH Aachen

2331 **ADEPT**

Advanced distributed environment for production technology

CMSU, Sema Group UK, Syntax Factory Automation, Teknecomp

2338 **IMPACS**

Integrated manufacturing planning and control system

Alcatel, Alsthom Recherche, Comau, Digital Equipment, PA Consulting Group, université de Bordeaux, University College Galway, CENTUNION

2349

Fault tolerance in the control and management of production systems

Adersa, AMTRI, Ikerlan, Mandelli, Pegaso/Enasa, PSA, Seram, Stewart Hughes

2415

Distributed manufacturing planning and control

Harmonic Drive Antriebstechnik, Krupp, RDP Technology, Technische Universiteit Delft, Imperial College of Science, Technology & Medicine

2422 **AMICE II**

Amice II/P — CIM-OSA releases

AEG Aerospatiale, British Aerospace, Alcatel, ATT Nederland, Bull, CAP Gemini, Sogeti, Cegelec Projects Digital Equipment, Dornier System, Fiat Aviazione, Hewlett-Packard France, IBM Deutschland, Italsiel, Philips, Procos, RWTH Aachen, SEIAF, Siemens-Nixdorf, STC-ICL, Volkswagen

2428 **IPCES**

Intelligent process control by means of expert systems

Centre d'Estudis Avançqas de Blanes, CNRS-LAAS, Dornier System, Eltec Elektronik, Philips Composants, Miniwatt, Solam-CAM, Universidad Politécnica de Cataluña

2434

Knowledge-based real-time controllers for distributed factory supervision

Alcatel Austria — Elin, ARS, BICC Technologies, CEA, CGE, Fiar, Fraunhofer-IPA, Games Ingenieri, Noratom, Philips, Pirelli, Politecnico di Milano, RWTH Aachen, SIS AV, Steria, Tecnicas Reunidas, Universität Hannover, Universität Karlsruhe, université de Savoie

2439 **ROCOCO**

Real-time monitoring and control of construction site manufacturing

Biba, Bremer Vulkan, British Maritime Technology, Cortec, CAP Gemini Europe, Chantiers de l'Atlantique, GEC Alsthom, Eleusis Shipyards, Fincantieri Helsinki, University of Technology, Magnemag, Masa-Yards, Microlog Team, Universiteit van Amsterdam

2457 **FLEXPLAN**

Knowledge-based planning and control in manufacturing environments

ADV/ORGA FA Meyer, Artificial Intelligence Systems, CIM-Fabrik Hannover, IDS, Katholieke Universiteit Leuven, LVD Company, Metek, NTE, Universität Hannover

2483 **PANORAMA**

Advanced perception and navigation system for autonomous mobile applications

British Aerospace, Mobile Robots, CEA, CRIF/WTCM, Easams, EID, Helsinki University of Technology, LNETI, Rauma-Repola, Sagem, Sepa, Tampelle Technical Research Centre of Finland, Universidad Politécnica de Madrid, University of Southampton

2486 **DYNAMO**

Integrated CAE techniques for dynamic analysis of structures

Fiat Aviazione, Katholieke Universiteit Leuven, Leuven Measurement & Systems International, NCODE International, Politecnico di Torino, Porsche, Straco, Tritech, Universität Karlsruhe, université de technologie de Compiègne

2527 **CIDAM**

System with distributed database and configurable modules

Digital Kienzle, Fiat Aviazione, Fichtel & Sachs, Mannesmann Hartmann & Braun, Sesam, Syseca, Trinity College Dublin, Universität des Saarlandes

2588 **DSDIC**

Design support for distributed industrial control

AEG, GEC Electrical Projects, F. L. Smidth & Co., GEC Research, Marconi Research, Procos

2590 **IPDES**

Integrated product design system

CETIM-Établissement de Senlis, Charmilles technologies, Coretech International, Deltacam Systems, École centrale de Lyon, Exapt-Systems, Gildemeister Automation, IDS, Kade-Tech, Matra, Mecánica de La Pena, Technische Hochschule Darmstadt

2614 **NIRO**

Neutral interfaces for robotics

Byg Systems, CASA, Danmarks Tekniske Højskole, Dansk Ingeniør System, Disel, Kernforschungszentrum Karlsruhe, PSI, Reis & Co Maschinenfabrik, Seeber

2617 **CNMA**

Communications network for manufacturing applications

Aeritalia, Aérospatiale, Alcatel, British Aerospace, Bull, CEGELEC Projects, Comconsult Communication Technologies, École polytechnique fédérale de Lausanne, Fraunhofer Institut für Information, Magneti Marelli, Olivetti IS, Ricerca SCPA, Renault, DiO Robotiker, Siemens-Nixdorf, Universidade do Porto, Universität Stuttgart

2623 **MAGIC**

Methods for advanced group technology integrated with CAD/CAM

CAP Gemini, Sogeti, CETIM-Établissement de Senlis, LVD Company, Michel van de Wiele, WTCM/CRIF

2626 **AUTOCODE**

Intelligent system for automatic processing of design codes of practice

Analyse de systèmes et informatique, Babcock & Wilcox Española, Ingeciber, CAE ISQ, Unisys España, Universidad Politécnica de Madrid

2637 **ARMS**

Advanced robotics manipulation system

CEA, Citroën-PSA, CRIF/WTCM Industrial Automation, Industrie Zanussi, INRIA, Kuka Schweißanlagen & Roboter, Sipa, Tecnomatix Europe, Télémécanique, UKAEA, Zeltron

2640 **ICI**

Integration of intelligent process control and inspection in robot finishing

Andenosa-Empresa Nacional de Óptica, Fraunhofer-IPK, Joyce-Loebl, Metalworks of Attika, University of Newcastle, Zenona

2656 **IDRIS**

Intelligent drive for shop-floor systems

Mari Group, Nada Consulting Group, Robert Bosch, University of Newcastle

2658 **ARTIFACTS**

Advanced robotics in flexible automation: components, tools and strategies

Fraunhofer-IPA, Intracom, Joyce-Loebl, Loughborough University of Components, Technology Mari Group, Robert Bosch, Siemens, Sincon, Universidade Nova de Lisboa, Universität Erlangen-Nürnberg, Universität Stuttgart, Zenon

2671 **KB-MUSICA**

Knowledge-based multi-sensors systems in CIM applications

ARS, British Maritime Technology, Cortec, Cambridge Control, CGE Drägerwerk, Fabrica Escola Irmaos, Stephens EP, Fraunhofer-IPK, ICI, Krupp, Pegaso/Enasa, Senter for Industriforskning, Tecnopolis, CSATA Novus Ortus, Turing Institute, université de Savoie

2706 **MICIM**

Methodology for the introduction of CIM

Carlo Gavazzi Systems, GEC Marconi, Philips International, TNO

2711 **MULTICON**

Multi-level shop-floor control

AEG, AEG Ibérica de Electricidad, Biba, Carlo Gavazzi Impianti, Compagnia Generale Contatori, Officine Galileo di Sicilia, Technische Universität Braunschweig, Tecnopolis Csata Novus Ortus

5104 **CNMA**

Communications network for manufacturing applications

Alcatel, British Aerospace, Bull, École polytechnique fédérale de Lausanne, Efacec, Fraunhofer-IITB, Magneti Marelli, Siemens-Nixdorf, Olivetti Information Services, Renault, Robotiker, Siemens, Syntax Software Sistemi, Télémécanique, Universidade do Porto, Universität Stuttgart

5109 **NIRO**

Neutral interfaces for robotics

Byg Systems, Construcciones Aeronauticas, Danmarks Tekniske Højskole, Dansk Ingeniør System, Disel Fiat, Kernforschungszentrum Karlsruhe, Odense Steel Shipyard, PSI, Reis & Co Maschinenfabrik, SEEBER

5114 **DIREK**

Knowledge-based real-time diagnosis and repair for a complete robotized handling and storage system

BMT Fluid Mechanics, Pirelli, Siemens, SNIA BPD — Fiat Group

5136 **LITE**

Links and interfaces for tool data exchange

Adepa, CIM-Centre NW F Technologie Transfer, Ikerlan, Kendu S Coop, RWTH Aachen, TOOL, Universität Karlsruhe

5161 **KBL**

Design, development and implementation of a knowledge-based leitstand

AHP Havermann und Partner, AIC Management, IDS, Institute of Product Development

5168 **CACID**

Computer-aided concurrent integral design

Albert Nestler Electronics, Association française de normalisation, BER Dessindus, Danobat Coop, Falko Standard EDV Software, Tecnation per l'Innovazione Tecnologica, Universität Karlsruhe

5172 **IDAM**

An integrated design and analysis environment for advanced magnetic devices

Ansaldo, Bertin & Cie, Electrotecnica Arteche, Labein, Polymotor, Rutherford Appleton Laboratory, Università di Genova, Vector Fields

5178 **DISCO**

Distributed management and coordination of scheduling system in a multisite production environment

AEG, Bull, Fraunhofer-IAO, ISA, Magneti Marelli, PROMIP

5194 **CIVIS**

CIM vision system

Adec Robot, Fraunhofer-IPA, I2S, IMEC, Kronimus, Optec, PSI Co Laboratories RCA

5206 **FICIM**

Fieldbus integration into CIM

AEG Automatisierungstechnik, Alcatel, Bull, École polytechnique fédérale de Lausanne, EDF, Endress & Hauser, Esacontrol, Fraunhofer-IITB, Gespac, Hartmann & Braun / Schoppe & Fäser, Namur, Nuovo Pignone, Philips Robotiker, Senter for Industriforskning, Siemens, Softing, Universidade do Porto, Universität Karlsruhe, Universität Stuttgart

5220 **CAR**

Calibration applied to quality control and maintenance in robot production

Fraunhofer-IPK, Kuka Schweißanlagen & Roboter, Leica, Taighdeclar Genesis Teoranta, Universiteit van Amsterdam

5272 **CIM-SEARCH**

Open sensor integrated architecture for managing manufacturing uncertainty

Prozeßsteuerung und Schweißtechnik, Renault automation, University of Surrey

5288 **AMICE**

Amice II/M — CIM-OSA releases

Aérospatiale, Alcatel, ATT Nederland, British Aerospace, Bull, CAP Gemini Europe, Daimler, Digital Equipment International, Ensidesa, Fiat Gepro, Hewlett-Packard France, IBM Deutschland, Italsiel, Philips, Procos, RWTH Aachen, Siemens, STC-ICL, Universidad de Valladolid

5292 **MOSAIC**

Modular open system architecture for industrial motion control

BMW, CEA, Fagor, Fraunhofer-IPA, Marben, Mari Group, Mikron, Odense Steel Shipyard, Philips, ROL, Tecniro, Universität Stuttgart-IFF

5338 **CIMPLIFY**

Computer-integrated manufacturing of PCBs by laser-induced photolithography

Electrónica Básica, ENS-DE chimie de Mulhouse, Philips, Rijksuniversiteit Gent, UCB Electronics, Universidad del Pais Vasco

5352 **PROFIT**

Process plant reliable operations facilitated and enhanced by information technology

City University, DSM Research, Intrasoft, Modcomp, Sast, Sintef Group, Statoil, TNO

5369 **HEPHAESTOS**

Intelligent robotic welding systems for unique fabrications

Algosystems, Centre de robotique intégrée, I & T Kalogeridis, IAI, Technische Universiteit Eindhoven, Torre, University of Goteborg, University of Lund, Welding Institute of Cambridge

5379 **FRUIT**

Fresh fruit tracking system

Bristol Polytechnic, Fomesa, Robotec, Syntax Factory Automation, Trademco

5391 **HYPERFACE**

A hypermedial user interface management system for industrial applications

CESI, CNR-IMU, Ensidesa, ERIA, Etnoteam, INESC, Non-standard Logics, Università degli Studi di Milano

5392 **TT-CNMA II**

Testing technology for CNMA — Phase II

Acerli, Alcatel, BMW, Bull, Fraunhofer-IITB, SPAG

5416 **CIMDATA**

A database for selection of CIM tools

Cambashi, Fordesi, Fraunhofer-IPK, GEPRO, Longman Cartermill, Teknologisk Institut, TNO, WTCM/CRIF

5417 **BECAUSE**

Benchmark of concurrent architectures for use in scientific engineering

Bertin & Cie, INRIA, Parsys, Rutherford Appleton Laboratory, University of Athinai, Vector Fields

5424 **CIMPLE**

User-driven and configurable tool set for CIM implementation in SMEs

Asociación de Investigación, Tekniker, BIBA-Bremen, Institute for Industrial Technologies, Blobis, Fordesi, IBK System- und Softwarehaus, Isardata, Kewill Systems, Nokia Research Centre

5467 **CIMSIM**

Integrated simulation for economic and technical evaluation of CIM implementation and management for SMEs

ABC Systems & Software, AMTRI, BIBA, Institut for Industrial Technologies, CAP Gemini Europe, CERN, Fordesi, Isomag, Teknologisk Institut, WTCM/CRIF

5471 **FAME**

Five-axis manufacturing

Fidia, Spalips Unibed, NEH Technology, Norsk Data, Norsk Jetmotor, Sintef Group, Technische Universität Berlin, Universität Stuttgart, Waldrich Siegen

5474 **COALA**

Computer-aided manufacturing layout design

CAP Gemini Europe, Ilog, INRIA, Orbis, Serete Productique, université libre de Bruxelles

5478 **SUB-CONTROL**

Modular framework for evolutionary implementation of shop-floor control

Asociación de la Industria Navarra, Fraunhofer-IPA, Hyperion Energy System, INESC, Picotron

5497 **PROCIC**

Process computer for computationally intensive control

Delta T, Instituto Superior Técnico, Microprocessor Engineering, THOT Informatique

5499 **CODE**

Computer-supported enterprise-wide data-engineering

Extech, Manager Software Products, Pilkington, RWE-DEA für Mineralöl und Chemie, Universität des Saarlandes

5510 **VOICE**

Validating OSA in industrial CIM environments

Fraunhofer-IPK, ISMCM, Kernforschungszentrum Karlsruhe, Prism Computer & Communication Systems, Renault automation, TNO, Traub, Zenon

5524 **MDS**

High-performance computing for multidisciplinary dynamic simulation of mechanism

ABB Robotics, Dansk Teknologisk Institut, Det Norske Veritas, Dornier System, FEMVIEW, Kernforschungszentrum Karlsruhe, Norsk Forsvarsteknologi, Sintef Group, Syntax Factory Automation

5532 **CIMPRES**

CIM model and implementation concept in precision and special tooling industry

CIM-Fabrik Hannover, EICAS Automazione, IBM Deutschland, OSI, RWT, Wilhem Fette

5564 **IDEAL-CIM**

Integrated design and evaluation of assembly lines within CIM

AEG, Delta Industrie Informatik, Fraunhofer-IAO, Intracom Intrasoft, Sema Metra Group

5601

Design and implementation of CNMA-based networks for CIM applications in SMEs

Intracom, Fraunhofer-IPK

5602 **KNOBA**

Knowledge-based real-time systems for fault diagnosis of flexible manufacturing systems

Asociación de Investigación, Teknikerdoimak, Fatronik System, GEPRO, LABEIN, Technische Universiteit Delft

5603 **CIM-SME**

Joint technical and organizational design of CIM systems for SMEs

BIBA, Cheshire Henbury Research & Consultancy, Danmarks Tekniske Højskole, EXTECH, GEPRO, Intervisie Strategie & Organisatie Advies

5604 **CIB**

Computer-integrated building

CSTB, D'Appolonia, Dialogic, Euroexpert & Partners, PCK & Associates, Scott Wilson Kirkpatrick & Partners, SOGEA, Taywood Engineering, Technische Universiteit Delft, université de Liège, Volmac Nederland

5605 **CIA**

Application of concepts, architectures and technology to computer-integrated agriculture

Big Dutchman, Danish Meat Research Institute, Fraunhofer-IAO, Hotrasoft, I & ME Gesellschaft für Informatik & Mikroelektronik, Land-Data

5606 **PRO-DATIS**

Analysis of car crash behaviour through simulation

Cranfield Institute of Technology, ESI-Engineering Systems, FEGS, Systex

5607 **FLEXICOM**

Multimedia communication system for the SME manufacturing environment

BICC Technologies, Globalsis Engenharia Sistemas, Greater London Enterprise, Solari Udine, TSI, University College Galway, University of Strathelyde

5608 **TRAMON**

Material flow transportation monitoring system

CLB Electronics, ORE, Polydata, Redar Nah-Ortungstechnik

5609 **SMART**

Yield improvement in SMD assembly

Fine Pitch, CSEA, University College Cork, Valtronic France, Weld-Equip

5610 **ASSAN**

Advanced sensor systems for autonomous navigation

Calabrese Engineering, CRIF/WTCM, Isra Systemtechnik, Robosoft, Sincon, Technische Hochschule Darmstadt, Tecnopolis Csata Novus Ortus, Università di Genova, Zenon

5611 **OFSES**

Fibre-optic sensor systems

Catsaros Automation, Leas Industrie, National Research Centre 'Demokritos', Imperial College of Science, Technology & Medicine

5620 **ADONIS**

Adaption of numerical hydrodynamic tools for integration into ship design systems

Astilleros Españoles, Cetena, Concentration Heat & Momentum, Danish Maritime Institute, DMT-Marinetechnik, EMIT

5630

AI for fashion design and manufacturing

ABC Tecniche Avanzate di Gestione, ECC Couture, Face, Investil, Pili Carrera, Universidad de Málaga, Zenon

6040 **PRODEX**

Product model exchange using STEP

CETIM, Cimio, Cisigraph, EPM Consultants, Framasoft & CSI, Fraunhofer IPA, GFS, Hewlett-Packard, IAD, Italcad Tecnologie e Sistemi, Senter for Industriforskning

6041 **MARITIME**

Modelling and reuse of information over time

BIBA-Bremen Institute for Industrial Technologies, Bremer Vulkan, Det Norske Veritas, KCS, Metis, RDM, Senter for Industriforskning, Technische Universität Berlin, TNO

6042 **HEPHAESTOS 2**

Intelligent robotic welding systems for unique fabrications

Algosystems, CRIIF, CSIC-Instituto de Automática Industrial, Kalogeridis, M Torres Diseños Industriales, Technische Universiteit Eindhoven, TWI, University of Lund

6051 **ACRO**

Autonomous cleaning robot with task-level programming

British Rail, CEA, COMATEC, Fraunhofer-IPA, Hako, Linak, Rol, Sagem, University Stuttgart-IFF

6061 **INTERACTORS**

High-level multimedia user-interface interactors for real-time industrial applications

Etnoteam, INESC, Keon, Non Standard Logics, Universita degli Studi di Milano, Universita di Parma

6068 **ATHENA**

Advanced tele-operation for earthwork equipment navigation

Arnex, Assolari Nuove Tecnologie, Benati Macchine, Calabrese Engineering, CRIF/WTCM Industrial Automation, ISRA Systemtechnik, Robosoft, Tecnopolis CSATA, Universita di Genova, Zenon

6090 **FIRES**

Feature-based integrated rapid engineering system

CETIM, Cimdata, Delcam, Mares, Technische Hochschule Darmstadt, Tekniker

6118 **SINTOMA**

Sensor integration and artificial intelligence application for an optimal set-up of machine-tools

Danobat, Ideko, INA, UCD

6140 **ALERT**

Advanced laser reflow soldering for surface mount technology

Deutsche Thomson-Brandt, Philips, SIAP Sistemi, Universität Erlangen-Nürnberg

6147 **AMICOS**

Advanced map mining communication system

Aitemin, KFA, La Camocha, MB Data, Ruhrkohle

6165 **IMPROVE**

Integrated multi-level power network voltage control

ABB Industria, ABB Muratori, Enel, Red Electrica de Espana, University of Strathelyde, Volmac Nederland

6168 **CAPISCE**

Computer architecture for production information systems in a competitive environment

ICI, IDS, SAP, Universität des Saarlandes

6169 **TENPRO**

Total environmental protection

EDP, ICI, INESC, Instituto Superior Tecnico, Labein, Mentec International, Sema Metra Group

6188 **PRIAM**

Prenormative requirements for intelligent actuation and measurement

Bailey Esacontrol, Bailey Sereg, Biffi Italia, BP International, CRAN/LACR, EDF, EDP, Enel, Hartmann & Braun, L. Bernard, Laborelec, Montefibre, Sema Group Belgium, Sema Metra Group, SNEA, Techniques nouvelles d'informatique

6212 **PROCESS BASE**

Data management and exchange for process plant design, construction and operation

AKZO, Bertin & Cie, Caesar Systems, Framatome, Initec, SERC

6245 **MATRAS**

Manufacturing technology for complex geometries based on rational splines

Aérospatiale, Atek NC-Systems, Ethz, Mandelli

6293 **HIQU**

High quality in milling technologies of moulds and dies

Boko, Fidia, Grau, Universität Stuttgart, WBK

6304 **CIM-REFLEX**

CIM with real-time shop-floor scheduling using expert system technology

Artix Limited, Copenhagen Business School, Decibac, Prolog Development Center, Sunderland Polytechnic

6379 **OSACA**

Open system architecture for controls within automation systems

Atek NC Systems, CGFT, COMAU, Fagor, FISW, Huron-Graffenstaden, Index-Werke, NUM, Robert Bosch, Siemens

6391 **MUSYK**

Integrated multi-level control system for one-of-a-kind production

Ahlstrom, BIBA-Bremen, CAP Gemini, Emit, IIA

6408 **FLEXQUAR**

Adaptive system for flexible, high-quality and reliable production

ARS, British Aerospace, Clemessy, Pirelli, Technische Universität Hamburg, Université de Bordeaux

6450 **ROCCO**

Robot assembly system for computer-integrated construction

Berghof Labor, CRIF/WTCM Industrial Automation, IASA, Isocom, Kalk Schenek-ing, Lissmac, Mayer, Servifran, Universidad Politécnica de Madrid, Universität Karlsruhe

6457 **INTERROB**

Interoperability of standards for robotics in CIM

BYG Systems, Danmarks Tekniske Højskole, Kernforschungszentrum Karlsruhe, Odense Steel Shipyard, Reis & Co Maschinenfabrik, Rolls Royce

6463 **TRUTH**

Time-critical rescheduling using truth-maintenance

BMT, Iberia, Pirelli, Siscog, Syseca, University of Leeds

6506 **LOCRIS**

Low-cost robot by means of integrated servocontrol

CEA, Fraunhofer-IITB, Kuka Schweissanlagen & Roboter, Sagem

6521 **OLMECO**

Open library for models of mechatronics components

CEA, ECN, Fagor, IKERLAN, PSA, Universiteit van Twente

6522 **DEKLARE**

Design knowledge acquisition and redesign environment

Copreci S. Coop., IKERLAN, Ilog, PSA, University of Aberdeen

6526 **FICOMP**

Fieldbus components

Cegelec, EDF, Marconi Automazione, Semisa, Softing

6534 **3D-FASHION**

Distributed and cooperative 3-D fashion and modelling design system

Adetti, CAD Modelling, Citer, CPRM, ENEA, Fraunhofer/IAO, Maconde, Simint, Trinity College Dublin

6559 **UNIQUE**

A knowledge-based approach to quality control to provide a unified quality environment

APW, CAP Sesa Industrie, E2S, Intelltech, Kapsch, Portsmouth Polytechnic

6562 **SCOPES**

Systematic concurrent design of products, equipment and control systems

Cranfield Institute of Technology, CRIF/WTCM Industrial Automation, Dassault systèmes, EPFL, Fichtel & Sachs, Mandelli, Memziken Automation Mat, Télémécanique, University Stuttgart-IFF

6572 **ITAQUA**

Information technology applied to quality

Athens Technology Centre, Brameur Germany, Bull, Data Logic, EFQM, EOQ, Esme Institute, Euroexpert, Kaleidoscope Consultants

6588 **ICEP**

Integrated and concurrent enterprise planning

Alcatel Bell Telephone, BIS, SNECMA, UCG

6599 **EAGLE**

European advanced global logistics enterprise

Fiat, HUA-IDS, Husat Research Center, Imperial College, Intesa, Promodes

6609 **COMBI**

Computer-integrated object-oriented model for the building industry

Apollonia, General Construction Company, Institut fur Massivbau und Baustellen, Leonhardt Andrae and Partners, Schmidt Schieketanz and Partner, Sofistik

6617 **COMPASS**

Strategy and performance measurement for small and medium-sized businesses

BIBA-Bremen, BLOBIS, Kewill Systems, Team, Teamco, Universita Bocconi

6660 **ROAD ROBOT**

Operator-assisted mobile road robot for heavy-duty civil-engineering applications

Advanced Robotics Research, APS, Face, IKERLAN, Joseph Vogele Mannheim, Universidade Nova de Lisboa

6661 **ROPROG**

Universal robot programming system for small-batch manufacturing of products with large dimensions and several thousand spot and arc welds

APS, Bisiach & Carru, Fiat Ferroviaria, Sorefame, Talbot

6668 **MARTHA**

Mobile autonomous robots for transportation and handling applications

ECT, FAG, Framatome, IKERLAN, Indumat, Mannesmann, Promip, Rol, SNCF Direction R, Universität Karlsruhe

6682 **VOICE II**

Validating OSA in industrial CIM environments by integration and implementation

Fraunhofer-IPK, ISMCM, Kernforschungszentrum Karlsruhe, Prism, Renault Rnur, TNO, Traub

6706 **MS20**

Multi-supplier/multi-site operations

Actis Zentrale Verwaltung, Alcatel, Audi, BMW, Mercedes-Benz, Saint Gobain Recherche, Volmac Nederland

6742 **SEPADES**

Advanced sheet metal part design system

AWV, Blobis, KadeTech, LGAI

6751 **APSIS**

Automatic polishing system for improving surface quality in mould and optics industries

Bertin & Cie, Leico, Sema Metra Group, SESO, Technische Universität Berlin

6779 **DINAS-DQS**

Design and implementation of CNMA in SMEs: a distributed quality control system

Data Collection Systems, INESC, Intracom, Intrasoft, IPK

6805 **COMPASS**

Concurrent manufacturing planning and shop control for small-batch production

Artificial Intelligence Systems, CIM-Fabrik Hannover, Competence Center Informatik, Katholieke Universiteit Leuven R&D, LVD Company, Universität Hannover, WTCM/CRIF Mechanical Engineering

6860 **IT-CIM**

Integration testing for computer-integrated manufacturing

Acerli, Fraunhofer-ISI, Sema Group, Universität Karlsruhe

6874 **MASS**

Microsystem analysis and simulation system

Computational Mechanics International, Microparts, Technische Universität Berlin, Wessex Institute of Technology

6876 **PISA**

Product life cycle models for integrated system applications

Adepa, BMW, CAP Gemini, SESA Belgium, Digital Equipment International, Pafec, RPK, TNO, University of Leeds CAD-CAM

6896 **CONSENS**

Concurrent and simultaneous engineering system

AEG, Fraunhofer/Iao, Instituto Superior Tècnico-Adist, Olivetti Information Services, Siemens Nixdorf, WTCM/CRIF Mechanical Engineering

6901 **ROBOFISH**

Intelligent sensor-controlled robotic system for fast integrated handling and online inspection of fish for autonomous operation in an unstructured, hostile and hygienic environment

Hitec, Icetech, Kask, Marel, Matcon, Oxim, University of Bristol

6911 **3DSCAN**

Integrating 3-D scanning into CIM

3D Scanners, Fidia, Liverpool Polytechnic, Mecof, Technische Universität Berlin, Université Lyon 3-IAE

6922 **CIP-COST**

Computer-integrated product costing system

Cheshire Henbury, Hs Elettronica, Human Centred Systems, Intervisie Strategie & Organisatie Advies, Stork Demtec

6936 **MONOLIN**

Mobile node logistics and industrial network

Datatronic, Davy Mckee, DSA-Daten und Systemtechnik, Redar Nah-Ortungstechnik, Renault, Royal Institute of Technology, Saab-Scania

7092 **FOTO**

A novel approach to force and torque sensing for process control

ENSPS, Pegard Productics, Siemens

7096 **CCE-CNMA**

CIM computing environment integrating CNMA

Aérospatiale, Alcatel, British Aerospace, Bull, Empresa Fabril de Màquinas Eléctricas, EPFL, Fraunhofer-IITB, Magneti Marelli, Mercedes-Benz, Olivetti Information Services, Robotiker, Siemens Nixdorf, Universidade de Porto, Universität Stuttgart

7110 **AMICE**

AMICE III/P CIMOSA releases

Aérospatiale, ATT Nederland, British Aerospace, Bull, CAP Gemini Sesa Belgium, Daimler-Benz, Digital Equipment International, Ensidesa-Empresa Nacional Siderúrgica, Fiat, Gepro, Hewlett-Packard France, Hochschule St.-Gallen, IBM Deutschland, ICL, Italsiel, National Aerospace Laboratory, RWTH Aachen, Siemens, Universidad de Valladolid, Université de Bordeaux

7131 **BIDPREP**

An intergrated system for simultaneous bid preparation

BIBA-Bremen, Dansk Teknologisk Institut, EB Teknologi, Krüger Engineering, NEH Technology, Sintef Group, Team, Wohlenberg

7210 **OLCHFA**

An open low-cost time-critical wireless fieldbus architecture

Bats, British Steel, Cockerill Sambre R&D, I2IT, Incom, Universität Erlangen-Nürnberg

7280 **ATLAS**

Architecture, methodology and tools for computer-integrated large-scale engineering

Centun, Esp. de Coord. Tecn. y Financiera, CSTB, IEZ, Siemens Nixdorf, Taywood Engineering, TNO

7294 **MIDAS**

Magnetic integrated design and analysis system

Ansaldo, Cranfield Institute of Technology, Labein, Rutherford Appleton Laboratory, Universita di Genova, Vector Fields

7302 **ASPIC**

Automation and control systems for production units using an installation bus concept

ADL Automation, Bosch, J.L. Automation, Moog, Steinbeis Foundation Stuttgart, University of Newcastle

7318 **CIA**

Computer-integrated agriculture

Danish Agricultural Advisory Centre, Fraunhofer/IAO, Land-Data, LH Agro, Uagri

Basic research

3001 **INSIGHT**

Vision systems for a natural human environment

Centre de mathématiques de l'École polytechnique, INRIA, Katholieke Universiteit Leuven, Royal Institute of Technology, Ruhr-Universität Bochum, Università di Genova, Universität Karlsruhe, Universiteit van Utrecht, University College London, University of Keele, University of Oxford, University of Sheffield, University of Stirling

3003 **CLICS**

Categorical logic in computer science

Århus Universitet, CNRS-ENS, GMD, INRIA, Imperial College of Science, Technology & Medicine, Università di Parma, University of Cambridge

3006 **CONCUR**

Theories of concurrency: unification and extension

CWI, INRIA, Swedish Institute of Computer Science, Universiteit van Amsterdam, University of Edinburgh, University of Oxford, University of Sussex

3011 **CEDISYS**

Models, languages and logics for concurrent distributed systems

Århus Universitet, INRIA, Università di Pisa, University of Sussex

3012 **COMPULOG**

Computational logic

ADER, European Computer Industry Research Centre, Katholieke Universiteit Leuven, RWTH Aachen, Imperial College of Science, Technology & Medicine, Uninova, Università di Pisa, Università di Roma, Universität Kaiserslautern, Universität Passau, Universität Tübingen, université d'Aix-Marseille, University of Bristol, University of Edinburgh, University of Uppsala

3014

High-temperature superconductivity: concepts, models and methods

ISI, Max-Planck-Gesellschaft für Festkörperforschung, Rutherford Appleton Laboratory

3017 **NOISE**

Electrical fluctuations and noise in advanced microelectronics: submicron, 2-D gas and low-temperature devices

CNET, IMEC, Plessey, Research Caswell, Technische Universiteit Eindhoven, Università di Modena, université de Lille, université de Montpellier, Universiteit van Utrecht

3020 **INTEGRATE**

Integrating the foundations of functional, logic and object-oriented programming

CNRS, CWI, Philips Research Laboratories, Imperial College of Science, Technology & Medicine, Universidade Nova de Lisboa, Università di Pisa

3023 **IS-CORE**

Information systems: correctness and reusability

INESC, Katholieke Universiteit Brabant, Technische Universität Braunschweig, Imperial College of Science, Technology & Medicine, Universität Dortmund

3026 **HESSILSIL**

Heterostructures of semiconducting silicides on silicon: applications to Si-compatible optoelectronic devices

CRMC2-CNRS, Universidad Autónoma de Madrid, Università di Roma II, universités de Paris-VI et de Paris-VII, IESS-CNR

3030 **ACQUILEX**

Acquisition of lexical knowledge for natural language processing systems

CNR, Universidad Politécnica de Cataluña, Università di Pisa, Universiteit van Amsterdam, University College Dublin, University of Cambridge

3038 **VAP**

Vision as process

Ålborg Universitet, INPG, Linköping University, Royal Institute of Technology, University of Surrey, LIFIA, LTIRF

3041 **MESH**

Possible mechanisms for high-T_c superconductivity and phenomenological approaches

CNRS-PMTM, Forth Research Centre, Universität Dortmund, Universität Karlsruhe, université de Paris-Sud, University of Oxford

3042 **NANOFET**

Performances and physical limits of heterostructure field-effect (HFET) transistors

ARMINES, CNRS, IMEC, University of Cambridge

3043 **LATMIC**

Lateral microstructures: fabrication, low dimensionality effects and applications to III-V devices

CNET, CNRS, National Microelectronics Research Centre, DRA, Universität Stuttgart, University of Cambridge, University of Exeter

3049 **NERVES**

Innovative architectures for neurocomputing machines and VLSI neural networks

CSEM, École polytechnique fédérale de Lausanne, INPG, Politecnico di Torino, St Patrick's College, Universität Dortmund, Universität Stuttgart, université catholique de Louvain, université Joseph Fourier de Grenoble-I, University of Edinburgh, University of Oxford

3059 **ECOLES**

Development of representation in machine learning

Turing Institute, Universidade do Porto, université de Paris-Sud, University of Bradford

3066 **AMODEUS**

Assimilating models of designers, users and systems

Københavns Universitet, Logica Cambridge Ltd, Medical Research Council, Rank Xerox, Standard Elektrik Lorenz, université Joseph Fourier de Grenoble-I, University of York

3070 **FIDE**

Formally integrated data environment

IEI-CNR, Gip Altair, Università di Pisa, Universität Hamburg, université de Paris-Sud, University of Glasgow, University of St Andrews

3074 **SEMAGRAPH**

The semantics and pragmatics of generalized graph rewriting

CNRS, CWI, Katholieke Universiteit Nijmegen, STC-ICL, Imperial College of Science, Technology & Medicine, University of East Anglia

3075 **ALCOM**

Algorithms and complexity

Århus Universitet, Computer Technology Institute, École des hautes études et sciences sociales, Freie Universität Berlin, INRIA, Trinity College Dublin, Universidad Politécnica de Cataluña, Università di Roma-La Sapienza, Universität des Saarlandes, Universiteit van Utrecht, University of Warwick, Rijksuniversiteit Utrecht

3085 **DRUMS**

Defeasible reasoning and uncertainty management systems

Centre d'Estudis Avançats de Blanes, CNRS-LRI, Imperial Cancer Research Fund, IRISA, Queen Mary College, Universidad de Granada, université d'Aix-Marseille, université libre de Bruxelles, université Paul Sabatier de Toulouse

3086 **LDS**

Low dimensionality structures for future quantum semiconductor devices

CNRS, École centrale de Lyon, LEAME/ISEN Lille, Forth Research Centre, INSA Lyon, Universidad de Barcelona, Universidad Politécnica de Madrid, université Blaise Pascal de Clermont-II, University College Cardiff

3092 **PDCS**

Predictably dependable computing systems

Centre for Software Reliability, CNR-LEI, CNRS, Technische Universität Wien, Universität Karlsruhe, University of Newcastle, University of York

3096 **SPEC**

Formal methods and tools for the development of distributed and real-time systems

Forth Research Centre, Katholieke Universiteit Nijmegen, Swedish Institute of Computer Science, Technische Universiteit Eindhoven, Imperial College of Science, Technology & Medicine, université de Grenoble, université de Liège, University of Manchester, University of Oxford

3104 **PROCOS**

Provably correct systems

Århus Universitet, Danmarks Tekniske Højskole, Royal Holloway & Bedford New College, Universität Kiel, University of Manchester, University of Oxford

3105 **MOHAWC**

Models of human-actions in work context

ISPRA, Risø National Laboratory, Roskilde Universitetse Center, Universität Bamberg Psychologie II, université de Liège, université de Paris-Nord, University of Manchester, University of Uppsala

3109 **PROMPT**

Programme for MOS processing technology

Harwell Laboratory, IMEC, University of Cambridge

3121 **MOLCOM**

Conducting organic materials as molecular components for microelectronics

CNRS, H. C. Ørsted Institute, ADIST-Instituto Superior Técnico, LNETI

3124 **SEMANTIQUE**

Semantics-based program manipulation techniques

École Polytechnique, Københavns Universitet, Imperial College of Science, Technology & Medicine, University of Glasgow

3125 **MEDLAR**

Mechanizing deduction in the logics of practical reasoning

INPG, ONERA-CERT, Research Institute for Symbolic Computation, Imperial College of Science, Technology & Medicine, Universität Kaiserslautern, université Paul Sabatier de Toulouse, Universität München, University of Oslo

3133 **NANSDEV**

Nanostructures for semiconductor devices

CNM, IMEC, Ludwig Maximilian Universität, Philips Research Laboratories, Technische Universiteit Delft, Thomson-CSF, University of Glasgow

3143 **FOF**

Factory of the future production theory

Bremen Institute for Industrial Technologies, Danmarks Tekniske Højskole, Helsinki University of Technology, SINTEF Group, Technische Universiteit Eindhoven, université de Bordeaux, University College Galway

3146 **DIRTYSUPRA**

Study of the influence of impurities on the properties of high T_c superconductors

Max-Planck-Institut für Festkörperforschung, université de Paris-Sud, université libre de Bruxelles

3147 **PHOENIX**

Hierarchical integration of logic and functional paradigms: specifications, refinement and implementation

GMD, Katholieke Universiteit Nijmegen, Imperial College of Science, Technology & Medicine

3148 **DEMON**

Design methods based on nets

GMD, Rijksuniversiteit Leiden, Technische Universität München, Universidad de Zaragoza, Università degli Studi di Milano, Universität Passau, université de Paris-Sud, université libre de Bruxelles, University of Newcastle

3149 **MUCOM**

Multisensory control of movement

CNR, CNRS, Katholieke Universiteit Nijmegen, Ruhr-Universität Bochum, université catholique de Louvain, université de Genève, University of Zürich

3152

Foundations of legal reasoning

Imperial College of Science, Technology & Medicine, università di Pisa, Universität Kiel, Universität Tübingen, université d'Aix-Marseille, University College Cork, University of Edinburgh, University of London, University of Oxford, Bristol Polytechnic, Machine Intelligence Ltd

3160 **DIALOGUE**

Models for explanation and learning

City University, CNR — Istituto di Linguistica Computazionale, Queen Mary College, Università di Pisa, University of the Aegean

3166 **ASMICS**

Algebraic and syntactic methods in computer science

École normale supérieure de Lyon, INIC, LITP, Politecnico di Milano, Rijksuniversiteit Leiden, RWTH Aachen, Technische Universität Berlin, Technische Universität München, université de l'État à Mons, université de Lille, Università degli Studi di Milano, Università di Napoli, Università di Palermo, Universität des Saarlandes, université de Bordeaux, University College Dublin

3168 **DX CENTRES**

Limiting factors in III-V semiconductor devices due to donor-related deep states

CNRS, Universidad Politécnica de Madrid, Università di Pisa, Universität Paderborn, université de Paris-VII, University of Lund, University of Sheffield

3174 **Si/Ge SLS**

Ultrathin silicon/germanium superlattices

AEG, University of Lund, Universität München, University of Newcastle

3175 **DYANA**

Dynamic interpretation of natural language

Technische Universität München, Universität Stuttgart, Universität Tübingen, Universiteit van Amsterdam

3177 **EPIOPTICS**

European project: investigation of optical probe techniques for interface characterization

DRA, Technische Universität Berlin, Trinity College Dublin, Università di Messina, Università di Roma II, University College Cardiff, University of Liverpool

3178 **REFLECT**

Reflective expertise in knowledge-based systems

BSR Consulting, ECN-NETH Energy Research Foundation, GMD, Interface Concilium, Universiteit van Amsterdam

3180 **FOCUS**

Foundations of optoelectronic computers

IMEC, LEP Philips, Roke Manor Research, Trinity College Dublin, Universidad de Madrid — ETSI, Universidad Politécnica de Madrid, université de Paris-VII, University College London, University of Sheffield

3186 **NOROS**

Quantum noise reduction schemes in optical systems

CNRS, CNET, INFM, Universität Konstanz, Max-Planck-Institut für Quantenoptik, DRA

3191 **BASIC GOODS**

Basic research actions for a geographic object-oriented database system

Algotech, CNR-ISRDS, CNR-IASI, Fernuniversität Hagen, Universität Freiburg, INRIA, Università di Roma-La Sapienza

3199 **EOC**

ESPRIT optical computing

CERT, CNET-CNRS, CNRS-LAAS, Heriot-Watt University, IMEC, IOTA, Istituto Nazionale di Ottica, Johann Wolfgang von Goethe-Universität, King's College London, Odense Universitet, Politecnico di Milano, Technische Universität Braunschweig, université Louis Pasteur, université de Toulon, Universidad de Madrid, Universität Erlangen-Nürnberg, Universität Kaiserslautern, Universität Münster, Vrije Universiteit Brussel

3200 **OLDS**

Structure and transport properties of organic low-dimensional systems for application to information technology

Helmut Hund, Max-Planck-Institut für Festkörperforschung, Trinity College Dublin, Università di Genova, Universität Tübingen, University of Edinburgh, University of London (Queen Mary College)

3207 **ACTS**

High-resolution speech recognition: auditory connectionist technologies for speech

INESC, INPG, Medical Research Council, Università di Milano, University of Cambridge, University of Edinburgh

3215 **CHEOPS**

Higher order logic-supported design for complex data-processing systems

IMEC, Philips Research Laboratories, University of Cambridge

3216 **CHARME**

Correct hardware design methodology: towards formal design and verification for provably correct VLSI hardware

Politecnico di Torino, Technische Hochschule Darmstadt, IMEC, université de Provence, University of Strathclyde

3219 **KAUDYTE**

Knowledge acquisition and use in dynamic task environments

Institut für Informatik der Universität Bonn, Universität Bayreuth, Universität der Bundeswehr, université libre de Bruxelles, University of Oxford

3228 **SPRINT**

Speech processing and recognition using integrated neuro-computing techniques

CAP Gemini Innovation, École nationale supérieure des télécommunications, IRIAC, DRA, Standard Elektrik Lorenz, Universidad Politécnica de Madrid

3230

Common foundations of functional and logic programming

CNRS, Eidgenössische Technische Hochschule, Swedish Institute of Computer Science, Università di Roma, Universität Kaiserslautern, University College Swansea, University of Athinai

3234 **SELF**

Organization and analogical modelling using subsymbolic computing

CEAB-Blanes, Rolf Nevanlinna Institute, Universität Hamburg, université de Genève, université libre de Bruxelles, University of Lappeenranta, Vrije Universiteit Brussel

3237 **PATMOS**

Power and timing modelling, optimization and specification

Telecom Paris, Universidad Politécnica de Canarias, Universität Kaiserslautern

3245 **LF**

Logical frameworks: design, implementation and experiment

Chalmers University of Technology, INRIA, Università di Torino, université de Paris-VII, University of Cambridge, University of Edinburgh, University of Manchester, University of Oxford

3247 **DESON**

Disorder and electrical properties in silicon oxynitrides

CNRS-LEPES, IMEC, Universidad Autónoma de Madrid, université de Montpellier, Universiteit van Utrecht

3249 **WGQR**

European working group on qualitative reasoning

École polytechnique fédérale de Lausanne, Fraunhofer IITB, Heriot-Watt University, Siemens, Università degli Studi di Milano, University College London

3260 **TOPP**

Transverse optical patterns

INFM, Physikalisch-technische Bundesanstalt

3264 **COMPASS**

A comprehensive algebraic approach to system specification and development

Katholieke Universiteit Nijmegen, Technische Universität Berlin, CRI, Technische Universität Braunschweig, Universidad Politécnica de Cataluña, Università di Genova, Universität Bremen, Universität Dortmund, Universität Passau, université de Paris-Sud, University of Edinburgh

3267

Use of children's and teachers' explanations in the specification of systems of explanation for intelligent learning environments

Kingston Polytechnic, London Institute of Education, London Mental Models Group (King's College), Royal Danish School of Educational Studies, université de Paris-Sud

3274 **FIRST**

Fundamentals of intelligent reliable robot systems

INPG, Katholieke Universiteit Leuven, Università di Genova, Universität Karlsruhe, University of Oxford

3279 **ACCOR**

Articulatory-acoustic correlations in coarticulatory processes: a cross-language investigation

CNR-Consiglio Nazionale delle Ricerche, CNRS, Ludwig-Maximilians-Universität, Siemens, Trinity College Dublin, Universidad de Barcelona, Universidad Politécnica de Valencia, University of Reading, University of Stockholm

3280 **NANA**

Novel algorithms for new real-time VLSI architectures

IMEC, INPG, INRIA, Katholieke Universiteit Leuven, Technische Universiteit Delft

3281 **ASCIS**

Behavioural synthesis, partitioning and architectural optimization for complex systems on silicon

IMEC, INPG, Danmarks Tekniske Højskole, Technische Hochschule Darmstadt, Technische Universiteit Eindhoven, University of Patras

3299 **COMPUGRAPH**

Computing by graph transformations

Freie Universität Berlin, Rijksuniversiteit Leiden, Technische Universität Berlin, Università di Pisa, Universität Bremen, université de Bordeaux

3314 **MOLSWITCH**

Evaluation of molecular switch type devices: theory and experiment

Københavns Universitet, Max-Planck-Institut für Festkörperforschung, université de Strasbourg, University of Uppsala

3327 **SUPRADYNAMICS**

Lattice dynamics of high T_c single crystal superconductors

CNRS-CRPHT, Kernforschungszentrum Karlsruhe

3350 **COSTY**

Computers and optics study group

CNET, IMEC, Philips-LEP, Roke Manor Research, Trinity College Dublin, Universidad de Madrid — ETSI, Universidad Politécnica de Madrid, université de Besançon, université de Paris-VII, université libre de Bruxelles, University College London, University of Athinai, University of Sheffield

3351 **DANDI**

Dialogue and discourse

BIM, Copenhagen School of Economics & Business, École Polytechnique, IDSIA-Fondazione dalle Molle, Institiuid Teangeolaiochta Eireann, Institut für Deutsche Sprache, Katholieke Universiteit Brabant, Katholieke Universiteit Nijmegen, Max-Planck-Institut für Psycholinguistik, UMIST, Università di Milano, Università di Udine, Universität des Saarlandes, Universität Stuttgart, Universität Tübingen, Universitaire Instelling Antwerpen, université de Liège, Universiteit van Amsterdam, University of Cambridge, University of Essex, University of Oslo

3352

Working group on vision

Ålborg Universitet, City University London, CNRS-LAAS, Fraunhofer-IITB, INPG, Linköping University, Morpho-Systèmes, NIHE, Norwegian Institute of Technology, Philips, Royal Institute of Technology, Tampere University of Technology, Technische Universität Hamburg, Technische Universität München, Trinity College Dublin, Universidad Politécnica de Cataluña, Universidade de Aveiro, Universidade de Coimbra, Universidade do Minho, Universidade Nova de Lisboa, Università di Genova, Università di Torino, Università di Trento, Università di Udine, Universität Karlsruhe, université de Paris-VI, University College of North Wales (Bangor), University of Brunel, University of Kent, University of Surrey, University of Sussex

3700 VLSI DESIGN

VLSI design training action

Ålborg Universitet, Centre commun de micro-électronique, City University London, CMSU, CNRS, Danmarks Tekniske Højskole, Dorset Institute, École polytechnique fédérale de Lausanne, ENSEA, Fachhochschule Augsburg, Fachhochschule Ulm, Georg-Simon-Ohm Fachhochschule, GMD, Helsinki University of Technology, Heriot-Watt University, IMEC, INPG, INSA, Institute of Higher Professional Education, Instituto Superior Técnico, Johann Wolfgang von Goethe-Universität, Katholieke Industriële Hogeschool West-Vlaanderen, King's College London, LABEIN, Lancashire Polytechnic, Middlesex Polytechnic, Napier Polytechnic of Edinburgh, National Microelectronics Research Centre, Newcastle upon Tyne Polytechnic, NIHE, Plymouth Polytechnic, Pôle de formation en micro-électronique, Politecnico di Milano, Politecnico di Torino, Polytechnic of Central London, Portsmouth Polytechnic, Rijksuniversiteit Gent, Rutherford Appleton Laboratory, RWTH Aachen, Sheffield City Polytechnic, Staffordshire Polytechnic, Tampere University of Technology, Techdarm Technische Hochschule Darmstadt, Technische Universität Braunschweig, Technische Universität Graz, Technische Universität Hamburg, Technische Universität Wien, Technische Universiteit Delft, Teesside Polytechnic, Thames Polytechnic, Trent Polytechnic, Trinity College Dublin, université de Lille, Universidad de Barcelona, Universidad de Cantabria, Universidad de Las Islas Baleares, Universidad de Las Palmas, Universidad de Sevilla, Universidad Politécnica de Cataluña, Universidad Politécnica de Madrid, Universidad Politécnica de Valencia, Universidade de Aveiro, Universidade de Coimbra, Universidade do Porto, Università di Bologna, Università di Genova, Università di Parma, Università di Pisa, Università di Roma, Universität Bremen, Universität des Saarlandes, Universität Duisburg, Universität Hagen, Universität Hamburg, Universität Kaiserslautern, Universität Karlsruhe, Universität Oldenburg, Universität Passau, Universität Tübingen, université catholique de Louvain, université de Montpellier, université de Paris-VII, université Pierre et Marie Curie, Universiteit van Amsterdam, Universiteit van Twente, University College of North Wales, University of Aberdeen, University of Bath, University of Bradford, University of Bristol, University of Brunel, University of Cambridge, University of Kreta, University of Essex, University of Exeter, University of Hull, University of Kent, University of Liverpool, University of Manchester, University of Newcastle, University of Nottingham, University of Oulu, University of Patras, University of Reading, University of Sheffield, University of Strathclyde, University of Sussex, University of Thrace 'Demokritus', University of Ulster

3701

Network of excellence in speech and natural language

Roskilde Universitet, LIMSI/CNRS, Universität Stuttgart, University College Dublin, Instituto di Linguistica Computazionale/CNR, Universiteit Amsterdam, INESC, Ålborg Universitet, CNRS (Aix-en-Provence), National Technical University of Athinai, University of Cambridge, Kobenhavns Universitet, Universität Hamburg, UMIST, Università di Pisa, Rijksuniversiteit Utrecht, Universiteit van Tilburg, Universität des Saarlandes

3702

Network of excellence in distributed computing systems architecture

Università di Bologna, Università di Pisa, University of Cambridge, INESC, INRIA/IRISA, Universität Kaiserslautern, LAAS/CNRS, Universitet van Twente, Technische Universität Wien, Architecture Project Management, Bull-IMAG, Chorus Systèmes, Computer Technology Institute, ETSIT, IEI del CNR, Itatel, GMD-Fokus, université de Liège, Trinity College Dublin, Rijksuniversiteit Utrecht, Vrije Universiteit Amsterdam

3703

Network of excellence in computational logic

Université d'Aix-Marseille-II, CWI, University of Bristol, University of Edinburgh, SLS CAP Gemini, Universität Kaiserslautern, Katholieke Universiteit Leuven, Universidade Nova de Lisboa, Universidad Politécnica de Madrid, ECRC, Universität Passau, Università di Pisa, Università di Roma I, Università di Roma II, IRST, University of Uppsala

6017 FALCON

Fuzzy algorithms for control

CNRS, RWTH Aachen, Siemens Automotive, Technische Universiteit Delft, Universidad de Malaga, Université de Savoie, Université libre de Bruxelles, Université Paul Sabatier-Toulouse, University of Bristol

6018 CHARME - 2

Formal design and correctness verification of synchronous and asynchronous digital VLSI systems

IMEC, Politecnico di Torino, Technische Hochschule Darmstadt, Université de Provence, Université Joseph Fourier-Grenoble, University of Strathclyde

6019 INSIGHT II

Vision systems for a natural human environment continuation

Computer Technology Institute, INRIA, KTH, Ruhr-Universität Bochum, Universita di Genova, Universität Karlsruhe, Université Catholique de Louvain, ESAT, Universiteit van Utrecht, University Hospital Zürich, University of Oxford, University of Sheffield, University of Sterling, UNSA

6020 ILP

Inductive logic programming

CNRS, Université Paris-Sud, GMD, Institut Jozef Stefan, ITK, Katholieke Universiteit Leuven, Universita di Torino, Universität Stuttgart, University of Stockholm, University of Strathclyde

6021 REACT-P

Building correct reactive systems

ICS, INPG, Swedish Institute of Computer Science, Universität Kiel, Université de Liège, University of Oxford

6028 CCL

Construction of computational logics

COSYTEC, DFKI, INRIA, Max Planck Institut für Informatik, Technische Universität München, UCM, Universidad Politecnica de Cataluña, Université de Paris-Sud

6067 CALIBAN

Causal calculus based on nets

Bull, GMD, Helsinki University of Technology, Newcastle-upon-Tyne Polytechnic, Rijksuniversiteit Leiden, Technische Universität München, Universidad de Zaragoza, Universita degli Studi di Milano, Universität Hildesheim, Université de Paris-Sud, Université Libre de Bruxelles

6071 IS-CORE

Information systems correctness and reusability

GMD, Imperial College, INESC, Katholieke Universiteit Brabant, Technische Universität Braunschweig, Universita di Genova, Universität Hannover, Université de Paris-Sud, Universiteit van Amsterdam, University of Oxford

6106 HETERO

Hetero-epitaxial deposition of diamond and silicon carbide films

Epichem, MBB, Technische Universität München, UKAEA

6108 ASSIST

Atomic-scale control of surfaces and interfaces in silicon technology

Harwell Laboratory, IMEC, University of Cambridge, Wacker Chemitronic

6112 COMPASS

A comprehensive algebraic approach to system specification and development

Århus Universitet, CNRS, Université Paris-Sud, CRIN, FORWISS, INESC, Institute of Computer Science, Katholieke Universiteit Nijmegen, Liens, Max Planck Institut für Informatik, Technische Universität Berlin, Technische Universität Braunschweig, Technische Universität München, Technische Universitat Dresden, Universidad Politécnica de Cataluña, Universita della Aquila, Universita di Genova, Universität Bremen, University of Edinburgh, University of Oslo, University of Oxford

6113 SUPERMICA

High T_c superconducting films for microwave applications

Bergische Universität Wuppertal, CNRS, Defence Research Agency, INPG, Laboratoria Nacionale de Engeneria e Tecnica, Universität Augsburg, University of Birmingham

6146 SMMMS

Study of magnetic multilayers for magnetoresistive sensors

KFA, Philips, Siemens, Technische Universiteit Eindhoven, Thomson-CSF, Université Louis Pasteur, Universität Erlangen, Université de Paris-Sud

6156 **DRUMS II**

Defeasible reasoning and uncertainty management systems II

Álborg Universitet, Centre d'Estudis Avançais de Blanes, CNRS, Université Paris-Sud, DFKI, Imperial College, IRISA, IRIT, Linköping University, Queen Mary College, Technische Universität Braunschweig, UIA, Universidad de Granada, Universita di Torino, Université de Provence, Université libre de Bruxelles, Université Paul Sabatier-Toulouse, Universiteit van Amsterdam, University of Fribourg, University of Lund

6225 **COMIC**

Computational mechanisms of interaction in cooperative work

GMD, Risø National Laboratoty, Swedish Institute of Computer Science, Universidad Politecnica de Cataluña, Universita Degli Studi di Milano, Universiteit van Amsterdam, University of Lancaster, University of Manchester, University of Nottingham

6296 **GRACE**

Graphical communication in HCI

IRST, Risø National Laboratory, Universiteit van Amsterdam, University of Edinburgh

6298 **VOX**

The analysis and synthesis of speaker characteristics

CNRS, IKP Universität Bonn, Royal Institute of Technology, Trinity College Dublin, Université de Genève, University of Cambridge, University of Edinburgh, University of Reading, University of Sheffield

6309 **FIDE2**

Formally integrated data environment

CNR, INRIA, Universitá di Pisa, Universität Hamburg, University of Glasgow, University of St Andrews

6312 **QUANTECS**

Quantized electronics

CNM, EPFL, IMEC, Ludwig Maximilians Universität, Philips, Technische Universiteit Delft, Thomson-CSF, University of Glasgow, University of Lund, University of Nottingham

6317 **ASMICS 2**

Algebraic and syntactic methods in computer science

CNRS, École normale supérieure de Lyon, Politecnico di Milano, Rijksuniversiteit Leiden, Université de l'État à Mons-Informatique, Universidade de Porto, Universita Cattolica del Sacro Cuore, Universita di Milano, Universita di Palermo, Universität der Bundeswehr, Universität des Saarlandes, Universität Frankfurt, Universität Kiel, Universität Stuttgart, Université de Paris VI, Université Pierre et Marie Curie, Ustlfa

6345 **SEMAGRAPH II**

The semantics and pragmatics of extended term-graph rewriting

CWI, European Computer-Industry Research Centre, Imperial College, Katholieke Universiteit Nijmegen, Université de Rennes, University of East Anglia

6353 **NATURE**

Novel approaches to theories underlying requirements engineering

City University of London, ICS, RWTH Aachen, SISU, Université de Paris

6358 **SCATIS**

Spatially coordinated auditory/tactile interactive scenario

Álborg Universitet, Head Acoustics, Ruhr-Universität Bochum, Scienzia Machinale, Scuola Superiore S. Anna

6360 **BROADCAST**

Basic research on advanced distributed computing from algorithms to systems

Bull/Imag, EPFL, GMD, INESC, INRIA, IRISA, Universita di Bologna, Universiteit van Twente, University of Newcastle

6362 **PDCS2**

Predictably dependable computing systems

Chalmers Tekniska Högskola, City University London, CNR, CNRS, Technische Universität Wien, Universidad Politécnica de Cataluña, Universita di Pisa, Université Catholique de Louvain, University of Newcastle, University of York

6363 **ELTRASIN**

Electrical transport parallel and perpendicular to semiconductor heterointerfaces

CUNFM, DEIUPD, Forschungszentrum Jülich, Universidad Politecnica de Madrid, Ustlfa

6378 **PROJECT**

Fail-safe semicustom design

IMS Stuttgart, INPG, Politecnico di Milano

6448 **VIVA**

Viewpoint invariant visual acquisition

GEC Marconi, INRIA, Katholieke Universiteit Leuven, KTH, Universität Hamburg, Universiteit van Utrecht, University of Keele, University of Liverpool, University of Lund, University of Oxford

6453 **TYPES**

Types for proofs and programs

Chalmers Tekniska Högskola, CNRS, INRIA, Katholieke Universiteit Nijmegen, Philips, Technische Universität München, Universita di Torino, University of Cambridge, University of Edinburgh, University of Manchester

6454 **CONFER**

Concurrency and functions evaluation and reduction

CWI, École normale supérieure, European Computer-Industry Research Centre, Imperial College, INRIA, Swedish Institute of Computer Science, Universita di Pisa, University of Edinburgh

6471 **MEDLAR II**

Mechanizing deduction in the logics of practical reasoning

ICL, Imperial College, INPG, Max Planck Institut für Informatik, Onera-CERT, Research Institute for Symbolic Computation, Technische Hochschule Darmstadt, Technische Universität München, Universita di Torino, Université Paul Sabatier-Toulouse, University of Olso

6487 **WERNICKE**

A neural network-based, speaker-independent, large vocabulary, continuous speech-recognition system

INESC, Lernout & Hauspie Speechproducts, University of Cambridge

6536 **LATMIC II**

Lateral microstructures fabrication, low dimensionality effects and application to III-V devices

CNRS, National Microelectronic Research Centre, University of Cambridge, University of Exeter

6546 **PROMOTION**

Planning robot motion

CNRS, École Normale Supérieure, INRIA, Universidad Politécnica de Cataluña, Universita di Roma-La Sapienza, Universiteit van Utrecht

6573 **EUROCHIP**

VLSI design training action (second phase)

Danmarks Tekniske Højskole, GMD, IMEC, INPG, SERC

6575 **ATSEC**

Advanced test generation and testable design methodology for sequential circuits

GMD, Katholieke Industrie Hogeschool West-Vlaanderen, Politecnico di Torino, Universität Duisburg, Université de Montpellier, Universiteit van Twente, University of Oxford

6576 **MIRO**

Multimedia information retrieval

CNR, ETHZ, GMD, Université Joseph Fourier-Grenoble, University of Glasgow

6586 PEGASUS

Distributed multimedia operating system for the 1990s

Universiteit van Twente, University of Cambridge

6615 MUCOM

Multisensory control of movement

CNR, CNRS, INRIA, Ruhr-Universität Bochum, Universita di Roma-La Sapienza, Université Catholique de Louvain, Université Pierre et Marie Curie, Universiteit Nijmegen, University Hospital Zürich, Université de Genève

6620 ATHOS

Advanced topics in high order statistics

Defence Research Agency, École normale supérieure de Lyon, EDF, Imperial College, INPG, Istitudo di Elettronica, Universitá Perugia, Ruhr-Universität Bochum, Télécom Paris, Thomson-CSF, Université Nice-Informatique, Universidad Politécnica de Cataluña, Universita di Roma-La Sapienza, Universita di Trieste, Universität Erlangen-Nürnberg, Université Catholique de Louvain, Université de Nice-Lisan, Université de Rouen, University of Athens

6625 X BAND SRO

GaAs HEMT-HTS resonator-based X-band oscillator made by hybrid and integrated technology

Alcatel Alsthom Recherche, CEA, CNR Istituto Lamel, IMEC, Universidad de Valladolid, Ustlfa

6632 NANA - 2

Novel parallel algorithms and new real-time VLSI architectural methodologies

École normale supérieure de Lyon, IMEC, INRIA, Katholieke Universiteit Leuven, Technische Universiteit Delft

6634 APPARC

Performance-critical applications of parallel architectures

KFA, Onera-CERT, Queen's University Belfast, UNI-C, Universidad Politécnica de Cataluña, Université de Rennes, Universiteit van Utrecht, University of Manchester, University of Patras

6665 DANDELION

Discourse functions and discourse representation: an empirically and linguistically motivated, interdisciplinary-oriented approach to natural language texts

FTT, GMD, Universidad Complutense, Universität des Saarlandes, University of Edinburgh

6675 MTVLE

MOCVD technology for visible light-emitting II-VI lasers

ASM, EPFL, Epichem, Thomson-CSF, Université de Montpellier

6707 PARFORCE

Parallel formal computing environment

European Computer-Industry Research Centre, INRIA, Swedish Institute of Computer Science, Universidad Politecnica de Madrid, Universita di Pisa, University of Bristol, University of Southampton

6719 NANOPT

Nanometre structures for future optoelectronic applications

Alcatel Alsthom recherche, École normale supérieure, EPFL, INFM, Technische Universität Darmstadt, Universidad Autonoma de Madrid, Universita di Bari, Universität Stuttgart, Universität Würzburg, University of Oxford

6769 SECOND

Sensory controlled dextrous robots

INRIA, Katholieke Universiteit Leuven, Universita di Genova, Universität Karlsruhe, University of Oxford

6809 SEMANTIQUE

Semantics-based program manipulation techniques

Århus Universitet, Caimens, Imperial College, Københavns Universitet, University of Glasgow

6810 COMPULOG 2

Computational logic 2

CWI, DFKI, Disroma, European Computer-Industry Centre, Imperial College, Katholieke Universiteit Leuven, RWTH Aachen, Universidade Nova de Lisboa, Universita di Pisa, Universita di Roma II-Tor Vergata, Université d'Aix-Marseille, University of Bristol, University of Edinburgh, University of Uppsala

6811 CLICS-II

Categorical logic in computer science II

Århus Universitet, Caimens, Chalmers University of Technology, GMD, Imperial College, Technische Hochschule Darmstadt, Universita di Genova, University of Cambridge, University of Manchester, University of Sussex

6846 POSSO

Polynomial system solving

Fern Universität Hagen, Research Institute for Symbolic Computation, Universidad de Cantabria, Universita di Genova, Universita di Pisa, Université Pierre et Marie Curie, University of Bath, University of Stockholm, UNSA

6849 TAMPFETS

Technology for advanced microwave power FET structures

Universität Ulm, University of Wales, Ustlfa

6852 DYANA-2

Dynamic interpretation of natural language

Ludwig Maximilians Universität, Universität Stuttgart, Universität Tübingen, Universiteit van Amsterdam, Universiteit van Utrecht, University of Edinburgh, University of Olso

6854 BLES

Buffer layer engineering in semiconductors

CNM, Optronics Ireland, UCA, Universidad Politécnica de Madrid, University of Liverpool, University of Surrey

6855 LINK

The necessary link between low-level and high-level synthesis

Avions Marcel Dassault-Breguet Aviation, Compass, IMEC, INPG, Technische Universiteit Eindhoven, Universität Dortmund, Universität Karlsruhe, Université catholique de Louvain

6863 POPAM

Parallel optical processors and memories

FORTH, Institut d'optique théorique et appliquée, King's College London, Risø National Laboratory, Technische Hochschule Darmstadt, Thomson-CSF

6878 EASI

Epioptics applied to semiconductor interfaces

INFM, MLU Halle, Technische Universität Berlin, Trinity College Dublin, UCC, UMIST, Universita di Messina, University College Cardiff, University of Liverpool

6881 AMUSING

Algorithms models user and service interfaces for geography

Algotech, CNR, Eidgenössische Technische Hochschule, Fernuniversität Hagen, IGN, INRIA, NTUA, Technische Universität Wien, Universita di Roma-La Sapienza, Universität Freiburg

6885 HIGH TC SUPERCONDUCT

Influence of local structure on the superconducting properties for samples in Y Ba Cu O and related systems

CNRS, Eidgenössische Technische Hochschule, Instituto Superior Técnico-ADIST, NCSR Demokritos, Risø National Laboratory, Technische Hochschule Darmstadt, Technische Universiteit Delft, Trinity College Dublin, Université de CAEN-ISMRA, Universidad Complutense, Universita di Parma, University of Antwerp, University of Birmingham

6891 ELENA - NERVES 2

Enhanced learning for evolutive neural architectures

École polytechnique fédérale de Lausanne, INPG, Thomsons, Universidad Politécnica de Cataluña, Université catholique de Louvain

6904 **INCIDE**

Integrated circuit design for signal processing

Philips, Technische Universität Berlin, Technische Universiteit Delft, Universita di Pavia, Universität Ulm

6934 **QUINTEC**

Quantum optics for information technology

British Telecommunications, CNET, CNRS, Defence Research Agency, INF, Konstanzun

6961 **SSS**

Smart sensory systems

CNR, CNRS, Loughborough University of Technology, Universita degli Studi di Genova, University of Bristol, University of Cambridge

6975 **SPEECH MAPS**

Sound-to-gesture inversion in speech mapping of action and perception in speech

Dublin City University, IEC, INPG, KTH, Laboratoire d'analyse informatique de la parole, Telecom Paris/Arecom, Universita di Genova, Universität Köln, Université de Strasbourg II, University of Leeds, University of Lund, University of Southampton

6993 **NODES**

Non-linear and active optical devices on electronic substrates

CEO, GEEO, Imperial College, INESC, INPG

7035 **LOGIC AND CHANGE**

Logic and change

CNRS, European Computer-Industry Centre, Imperial College, Linköping University, Technische Universität München, Universidade Nova de Lisboa, Universita di Roma-La Sapienza, Universita di Torino, Universität Karlsruhe, Université de Paris-Nord

7040 **AMODEUS 2**

Assaying means of design expression for users and systems

Københavns Universitet, Medical Research Council, Rank Xerox, Risø National Laboratory, Universita di Pisa, Université Joseph Fourier-Grenoble, University of York

7053 **ROC**

Research organization cooperation in advanced training and research in integrated circuit design

CEA, CERN, Forschungszentrum Jülich, Rutherford Appleton Laboratory, Scherrer Institute

7070 **PHOTONS**

Physics, optoelectronics and technology of novel microresonator structures

CNET, CNRS, IMEC, IOR, Trinity College Dublin, UCC, Universität Duisburg, University College London, University of Sheffield

7071 **PROCOS II**

Provably correct systems

Danmarks Tekniske Højskole, Universität Kiel, Universität Oldenburg, University of Oxford

7082 **PROMOTER**

Process modelling techniques

ADR-CRISS, CRIN, Imperial College, Politecnico di Milano, Rijksuniversiteit Leiden, SINTEF, Universita di Pisa, Universität Dortmund, University of Manchester

7093 **ELP**

Extensions of logic programming

Ludwig Maximilians Universität, Swedish Institute of Computer Science, Universität Tübingen, University of St Andrews

7097 **RAND**

Randomized algorithms

CNRS, Université Paris-Sud, Institut für Informatik der Universität Bonn, University of Edinburgh, University of Leeds for Computer-Based Learning, University of Lund, University of Oxford

7098 **ACCOR**

Articulatory-acoustic correlations in coarticulatory processes: a cross-language investigation

CNR Fonetica, CNRS, IEC, Ludwig Maximilians Universität, Siemens, Trinity College Dublin, Universidad Politecnica de Valencia, University of Reading, University of Stockholm

7100 **HTSC-GBJ**

Grain boundary Josephson junctions and circuits in the high-temperature superconductors

CEA, Chalmers University of Technology, Danmarks Tekniske Højskole, Universita di Salerno, Universität Tübingen, University of Strathclyde

7107 **ARCHIMEDES**

Architectural methodologies for advanced testing of VLSI systems

INESC, INPG, Universidad Politécnica de Cataluña, Universita di Bologna, Universität Hannover, Universität Karlsruhe, Université de Montpellier

7108 **VAP II**

Vision as process II

Ålborg Universitet, INPG, Linköping University, Royal Institute of Technology, University of Surrey

7118 **TONICS**

Transverse non-linear optics

Aden, Alenia, British Telecommunications, CNR, Istituto Nazionale di Ottica, Physikalisch-Technische Bundesanstalt, University of Strathclyde

7128 **SI/GE MIST**

Ultrathin silicon/germanium microstructures

Daimler-Benz, IESL/FORTH, Johannes Kepler Universität, Risc Linz, Technische Universität München, University of Lund, University of Newcastle

7130 **NAT**

Non-linear and adaptive techniques in digital image processing, analysis and computer vision

Aristoteles University of Thessaloniki, Tampere University of Technology, Technische Universität Hamburg, Universita di Trieste, University of Strathclyde

7141 **ALCOM II**

Algorithms and complexity

Århus Universitet, Computer Technology Institute, EHESS-CAMS, Freie Universität Berlin, INRIA, Max Planck Institut für Informatik, Universidad Politécnica de Cataluña, Universita di Roma-La Sapienza, Universität Paderborn, Universiteit van Utrecht, University of Warwick

7166 **CONCUR**

Calculi and algebras of concurrency extensions, tools and applications

Ålborg Universitet, Chalmers University of Technology, CWI, European Computer-Industry Centre, INPG, INRIA, Sharp Laboratories of Europe, Swedish Institute of Computer Science, Technische Universiteit Eindhoven, Universiteit van Amsterdam, University of Edinburgh, University of Oxford, University of Sussex, University of Warwick

7183 **COMPUGRAPH**

Computing by graph transformation

Rijksuniversiteit Leiden, Technische Universität Berlin, Universita di Pisa, Universität Bremen, Université de Bordeaux, Vrije Universiteit Brussel

7193 **PARTNERS**

Physics and application of resonant tunnelling for novel electronic, infrared and optical devices

Chalmers University of Technology, CNRS, IMEC, Linköping University, Max-Planck-Institut für Festkörperforschung, University of Nottingham

7195 **ACCLAIM**

Advanced concurrent constraint languages: application, implementation and methodology

DFKI, INRIA, Katholieke Universiteit Leuven, Paris Research Laboratory for Digital Equipment, Swedish Institute of Computer Science, Universidad Politecnica de Madrid, Universita di Pisa

7213 **CATHODE**

Computer algebra tools for handling ordinary differential equations

GMD, Katholieke Universiteit Nijmegen, Queen Mary College, Swiss Federal Institute of Technology, Université Joseph Fourier-Grenoble, Université Libre de Bruxelles

7225 **ACID-WG**

Asynchronous-circuit design

Danmarks Tekniske Højskole, IMEC, INESC, Philips, Technische Universiteit Eindhoven, Universidad del Pais Basco, Universidad Politécnica de Cataluña, Universiteit van Groningen, University of Manchester, University of Nottingham, University of Oxford, University of Surrey

7227 **SUPERDEV**

Superlattice devices

CNET, CNRS, Defence Research Agency, National Microelectronic Research Centre, Tampere University of Technology

7228 **EOLIS**

Emission of light in silicon

CNET, CNRS, Defence Research Agency, Forschungszentrum Julich, LPICM-Ecole Polytechnique, NCSR Demokritos, Universita di Modena

7232 **CFFLP**

Common foundations of functional and logic programming

NTUA, Universita di Roma-La Sapienza, Universität Kaiserslautern, Université de Paris-Sud, University College Swansea, Warsaw University of Technology

7238 **PROTIOS**

Optically triggered proton and ion switches

Instituto Nacional Investigaço Cientifica, Universität Bayreuth, Université Joseph Fourier-Grenoble, Université Louis Pasteur Strasbourg

7260 **SOLDES**

Self-organizing low-dimensional electronic structures

CNRS, GEC Marconi, Philips Universität, Sissa, Thomson-CSF, University of Manchester

7269 **QMIPS**

Quantitative modelling in parallel systems

CWI, Imperial Cancer Research Fund-London, INRIA, Universita di Torino, Universität Erlangen-Nürnberg, Université René Descartes LAA, University of Newcastle

7274 **B-LEARN II**

Behaviour learning combining sensing and action

Katholieke Universiteit Leuven, Universidad Politécnica de Cataluña, Universidade Nova de Lisboa, Universita di Genova, Universita di Torino, Universität Dortmund, Universität Karlsruhe

7282 **TOPFIT**

Tailored oligomers and polymers for information technology

Max Planck Institut Polymer, Philips, Université de l'état à Mons-Informatique, University of Durham, University of Glasgow

7307 **MEDCHIP**

Catch-up action for the development of VLSI design training capabilities in Portugal, Spain, southern Italy and Greece

Instituto Superior Técnico, Universidad de Sevilla, Universita di Pavia, University of Patras

7315 **ACQUILEX II**

Acquisition of lexical knowledge

Biblograf, Cup, PSA ILC, Universidad Politecnica de Cataluña, Universiteit van Amsterdam, University of Cambridge, Van Dale Lexicografie

Open microprocessor systems initiative (OMI)

6060 **OMI/DOMUS**

Domestic appliances open microprocessor unified system

Etnoteam, Inmos, Zeltron

6062 **OMI/GLUE**

Global language support and uniform environment

Bull, DDC, Defence Research Agency, Etnoteam, Harlequin, INESC, Inmos, OSF-RI

6084 **MOVE**

Microprocessor open vision environment

GEC Marconi, INPG, INRIA, ITMI, Universita di Genova, University of Sheffield

6142 **SMILE**

SPARC macrocell and interface library elements

Ericsson Radio Systems, Force Computers, Gipsi, Matra MS21, Matra-MHS, Meiko Scientific, Philips, Sun Microsystems Europe, Tecnologia Grupo INI, University of Sussex

6143 **EXACT**

Exploitation of asynchronous circuit technologies

EDC, IMEC, Philips, Technische Universiteit Eindhoven, University of Manchester, University of Oxford

6175 **OMIDIS**

OMI dissemination project

CITI, Etnoteam, Hellenic Esprit Club, Parsytec, PDV, Technische Universiteit Eindhoven, TECMIC, Toditec, Transcend Technology, Universidad Politécnica de Madrid

6258 **OMI-MMI**

Modular microprocessor implementation

Digital, Entwicklungszentrum für Mikroelektronik, Siemens

6271 **BENCHMARK**

Benchmarking for embedded control and real-time applications

Siemens, Thomson-CSF, Universität Hannover

6347 **DIPSAP**

Flexible digital signal processor for space and industrial applications

MBB, Thomson-CMS, Thomson-CSF

6603 **OUVERTURE**

An industry project to progress micro-kernel-based open operating systems for the 1990s

Alcatel Alsthom Recherche, Alcatel Austria-Elin, Alcatel, Chorus systèmes, Inmos, Olivetti Systems & Networks, Siemens, Siemens Nixdorf, Unix Systems Laboratories Europe

6610 **OPUS**

Open process control unified systems

Etnoteam, Ilva, Sema Metra Group

6666 **FAST**

Future automotive supercomputer technology in developing system, hardware and software blocks using super-modular structures ultimately leading to RISC integration

BMW, Motorola, VW

6909 **OMI/DE**

Deeply embedded applications

ARM, Iris, Philips, Plessey Company, Universität Hannover, University of Manchester, VLSI Technology

7249 **OMI/HORN**

Highly optimized reusable nucleus

ACRI, Aceet, Bull, Computer Technology Institute, Inmos, Thomson-CSF, Universität Karlsruhe, University of Bristol, University of Manchester, University of Oxford

7250 **OMI/TMP**

Transputer macrocell project

Alcatel Austria — Elin, Alcatel, Bell Telephone, Inmos, Mietec, Thomson-CSF

7252 **OMI/HIC**

High-performance heterogeneous interprocessor communication

Bull Italia, Bull, Dolphin, Inmos, Thomson-CSF

7253 **HARMONY**

Integrated real-time and Unix systems for transputers

Archipel, CERN, Chorus systèmes, Inmos

7267 **OMI/STANDARDS**

Standards methodology and standards harmonization

Alcatel Bell Telephone, ARM, Bull, Chorus systèmes, Defence Research Agency, Etnoteam, Formal Systems, Inmos, Kontron Elektronik, Matra-MHS, OMI Management, Philips, Plessey Semiconductors, Siemens, Tasking, Thomson-CSF

7283 **ARCHIE**

A reliable computer-human interface environment

Bertin & Cie, Ciavkilon, GEC, Sofreavia, University of Dundee

7325 **OMI/DEBUG**

Development and debugging tools for applications with OMI processors

Inmos, Kontron Elektronik, Matra-MHS, Philips, Siemens Aktiengesellschaft, Tasking

Information exchange system

33 **ROSE**

Research open systems for Europe

Bull, GEC, Ing. C. Olivetti, Siemens, STC-ICL

130

The Unix-united aspects of the IES

Mari Group, SG2

700 **ELAN**

ESPRIT/European local area network

Bull, ICL Belgium, Olivetti, Siemens Data

706 **EUROKOM**

Computer conferencing and electronic mail

University College Dublin

710

Information exchange system (IES) support services

IEGI, Expertel, Noveau Medias, GRS, Longman-Cartermill, IOS

717 **HERMES**

Message-handling survey and trends for the IES user community

Fischer Madsen & Lorenz Petersen

718 **CARLOS**

Communications architecture for layered open systems

Fischer Madsen & Lorenz Petersen, RC International, Universidad Politécnica de Madrid, CASE Communications, INESC, PMC, Universidad Politécnica de Cataluña

719 **THORN**

The obviously required name-server

Bull, CERN, DFN, GEC, Ing. C. Olivetti, INRIA, Siemens, STC-ICL, Systems Wizards, University College London

5700 **Y-NET**

Y-Net

Teleo, Bull, Olivetti Systems and Networks, Siemens-Nixdorf Informationssysteme

Industry participants and sites

02 Technology
Versailles

2I Industrial Informatics
Freiburg

3-Net
Basingstoke

3D Scanners
London

7-Teknologi
København

Ålborg Shipyard
Ålborg

ABB Industria
Milano

ABB Muratori
Ariccia; Roma

ABB Robotics
Vasteras

ABC Systems & Software
Athinai

ABC Tecniche Avanzate
Milano

Abstract Hardware
Uxbridge

ABSY
Bruxelles

ACE
Amsterdam

ACEC
Charleroi

Acerli
Fontenay-aux-Roses

Acknowledge
Paris

Acorn Computers
Cambridge

ACRI
Lyon; Paris-la Défense

Acropol Association
Nancy

Acset
Louvain-la-Neuve

ACT
Paris; Sainte-Geneviève

Actir-Santé
Louveciennes

Actis
Stuttgart

Active Memory Technology
Reading

Addax
Athinai

Adec Robot
Schlieren; Zürich

Adepa
Montrouge

ADL Automation
Malissard

Administracão do Porto de Lisboa
Lisboa

ADR-CRISS
Grenoble

ADV/ORGA F. A. Meyer
Wilhelmshaven

Advanced Computing Systems
Milano

Advanced Mechanics & Engineering
Guildford

Advanced Semiconductor Materials
Bilthoven

Advanced Software Technology
Milano

Advanced System Architectures
Camberley

AEG
Berlin; Böfingen; Frankfurt; Ulm

AEG Automatisierungstechnik
Selinenstadt

AEG Electrocom
Konstanz

AEG Ibérica de Electricidad
Rubí

AEG Olympia
Konstanz; Wilhelmshaven

AEG-ATM
Konstanz

Aeritalia
Napoli; Roma; Torino

Aérospatiale
Chatillon; Les Mureaux; Paris

Afia
Porto

Afnor
Paris-la Défense

Agence de l'informatique
Paris-la Défense

Agfa Gevaert
Edegem; München

Agusta Sistemi
Milano; Tradate

Ahlstrom
Helsinki

AHP Havermann und Partner
Planegg

AIC Management
Torino

AIIT
Gerrards Cross

AIS
Milano

AITEC
Genova; Milano

Aixtron
Aachen

Akzo
Arnhem

Albert Nestler Electronics
Lahr

Alcatel
Amsterdam; Chilly-Mazarin; Colombes; Evry; Lannion; La-Ville-du-Bois; Les Ulis; Malakoff; Massy; Morangis; Paris; Puteaux; Toulouse

Alcatel Alsthom Recherche
Marcoussis

Alcatel Austria — Elin
Wien

Alcatel Face Standard
Milano; Pomezia

Alcatel Portugal
Cascais

Alcatel Standard Eléctrica
Madrid

Alcatel Telephone
Antwerpen

Alenia
Roma

Algosystems
Athinai

Algotech Sistemi
Frosinone; Roma

Alpha
Athinai

Alsys
Henley-on-Thames

Ambit
Athinai

Amper
Lykovrisi; Madrid

AMS
Wien

Anacad Computer Systems
Ulm

Analog Devices
Limerick

Analyse de systèmes et informatique
Fontenay-sous-Bois

Andersen Consulting
Madrid

Ansaldo Impianti
Genova

Antwerp Telephone and Electrical Works
Herentals

APD
Madrid

Apollonia
Genova

Applied Logic Research
London

APS
Aachen

Apsis
Meylan

Aptor
Meylan

APW
Athinai

Archipel
Cran-Gevrier

Architecture Projects Management
Cambridge

ARG
Milano; Vimodrone

Argumens
Duisburg

Aritex
Badalona

ARM
Cambridge; Swaffham-Bulbeck

Arnex
Göteborg

ARS
Milano

Artificial Intelligence
Watford

Artificial Intelligence Systems
Bruxelles

Artix
Durham; Peterlee

Ascom Holding
Bern

Asea Brown Boveri
Heidelberg; Ladenburg

ASM International
Bilthoven; Utrecht

ASM-Lithography
Veldhoven

ASM/FICO
Gelderland; Herwen

Asociación de la Industria Navarra
Cordovilla-Pamplona

Assolari Nuove Tecnologie
Bergamo; Seriate

AST Elektronik
Kirchheim

Astilleros Españoles
Madrid

Atek NC-Systems
Aargau; Brugg

Athens Technology Centre
Athinai

Atlas Elektronik
Bremen

AT Kearney
London

ATT Nederland
Hilversum

ATT Télécommunications
Bruxelles

Audi
Ingolstadt

Audiovisual
Athinai

August Systems
Crawley

Autograph International
Lyngby

Autonomous Port of Barcelona
Barcelona

Autophon
Levallois-Perret

Avions Marcel Dassault-Breguet Aviation
Saint-Cloud

AWV
Frankfurt

Axion
Birkerød

AXON
Porto

Ayuntamiento de Sevilla
Sevilla

Azienda Servizi Municipale Comune di
Brescia
Brescia

Baan Info Systems
Barneveld

Babcock
Glasgow

Babcock & Wilcox Española
Bilbao; Vizcaya

BAE
Hatfield

Bailey Esacontrol
Genova

Bailey Sereg
Massy

Baileys, Shaw & Gillett
London

Baker & Mackenzie
London

Baltea
Leini

Banco Bilbao Vizcaya
Madrid; Tres Cantos

Banco Debadell
Barcelona; Sabadell

Banco Herrero
Asturias

Banercio
Madrid

Bang & Olufsen
Struer

Banque La Henin
Paris

Banque nationale de Paris
Paris

Barclays Bank
Northampton

Barco Industries
Kortrijk

Barr & Stroud
Glasgow

BASF
Ludwigshafen

Bassani Ticino
Varese

BATS
Angleur

Battelle Institut
Frankfurt am Main

BBC
London

BCT
Dortmund

BDH
Poole

Bell Telephone
Antwerpen

Benati Macchine
Bologna; Imola

Bennetts Associates
Burridge

Bense
Coesfeld

BER Dessindus
Colmar

Berghof Labor
Eningen

Bertin & Cie
Les Milles; Plaisir

Bias
Bremen

Biblograf
Barcelona

BICC Technologies
Hemel Hempstead

Biffi Italia
Fiorenzuola Arda

Big Dutchman
Vechta

BIM
Everberg

Bisiach & Carru
Torino; Venaria

Biss
Wilhelmshaven

BLOBIS
Almassera

BMC
Amsterdam

BMP Plasmatechnologie
Garching-Hochbruck

BMW
München

BNR Europe
Harlow

Bogen Electronic
Berlin

Boko
Esslingen

Bonnscript
Bonn

Boro
Landsbro

Bosch
Reutlingen; Stuttgart

BP International
Sunbury-on-Thames

BPA-Technology and Management
Dorking

Braghenti
Malnate; Varese

Brainware
Berlin

Brameur
Aldershot

Brameur Germany
Berlin

Bremer Vulkan
Bremen

British Aerospace
Bracknell; Broughton; Filton; Hatfield; London; Preston; Stevenage

British Airways
Hounslow

British Library
London

British Maritime Technology
Tyne and Wear; Wallsend

British Rail
Doncaster

British Steel
London

British Telecommunications
Ipswich; London

Bronkhorst High-Tech
Ruurlo

Brown Boveri & Cie.
København

BSO
Utrecht

BSR Consulting
München

Bull
Angers; Échirolles; Hemel Hempstead; Köln; Les-Clayes-sous-Bois; Louveciennes; Madrid; Massy; Milano; Nanterre; Paris; St.-Martin-d'Hères

Bureau Van Dijk
Bruxelles

Busch-Jäger-Elektro
Lüdenscheid

BYG Systems
Nottingham

Cabinet Bensoussan
Paris

CAD Modelling
Firenze

Caesar Systems
London

Caja de Ahorros del Mediterráneo
Alicante

Caja Insular de Ahorros de Canarias
Las Palmas de Gran Canaria

Calabrese Engineering
Bari

Cambashi
Cambridge

Cambridge Consultants
Cambridge

Cambridge Control
Cambridge

Cambridge Instruments
Cambridge

Cameca
Courbevoie

CAP
New Malden

CAP Gemini Europe
Bruxelles; Rijswijk

CAP Gemini Innovation
Paris

CAP Gemini Logic
Stockholm

CAP Gemini Sogeti
Grenoble; Paris

CAP Sesa Industrie
Boulogne-Billancourt

CAP Sesa Telecom
Puteaux

CAP Sogeti Innovation
Meylan

CAPTEC
Dublin

Caption
Chantepie; Rennes

Cariplo Caridata
Milano

Carl Zeiss
Oberkochen

Carlo Gavazzi Systems
Milano

CASA-Construcciones Aeronáuticas
Madrid

CASEG
Watford

Catsaros Automation
Athinai

CBL
Cranfield

CCD Videometrie
Unterschleissheim

CCE
Luxembourg

CCIP
Noisy-le-Grand

CCS
Madrid

CEGB
Leatherhead

CEGELEC
Levallois-Perret

CEGELEC Projects
Rugby

Cellware
Berlin

CEM Systems
Antrim; Belfast

Centra Burkle Honeywell Europe
Schönaich

Centrisa
Barcelona

Centro de Cálculo de Sabadell
Barbera del Valles

Centunión
Madrid

Cepsa
Madrid

Cerci
Fontenay-sous-Bois

Cerilor
Maxeville

Ceselsa
Madrid

Cesia
Marseille

CET
Aveiro

Cetena
Calata Grazie; Genova

CGE
Aix-les-Milles; Chilly-Mazarin

CGED
Bath

CGP
Orléans

CHAM
London

Chantiers de l'Atlantique Gec Alsthom
Paris

Charles Clark
London

Charmilles Technologies
Meyrin

Cheshire Henbury
Macclesfield

Chorus Systemès
Saint-Quentin-en-Yvelines

Ciavkilon
London

Cida de Bologna
Bologna

Cifa Institut
Luxembourg

CIG
Bruxelles

CIM
Aachen; Hannover

CIMAF
Porto

Cimdata
Berlin

Cimio
Elham

CIMSA
Vélizy-Villacoublay

Cirrus Computer
Fareham

CISE
Milano; Segrate

CISI
Rungis; Toulouse

Cisigraph
Vitrolles

CITI
Milton Keynes

Citroën
Neuilly-sur-Seine

CITSA
Santiago de Compostella

Citymax
London

CJS Consultancy
Harpenden, Herts

Clarinet Systems
Blackwater, Camberley

CLB Electronics
Amsterdam

Clemessy
Metz; Mulhouse

CLS Computer Lernsysteme
Bonn

CML
Paris

Cockerill Sambre R&D
Liège

COGECO
Milano

Comatec
Paris

COMAU
Beinasco; Grugliasco; Torino

Combitech Electronics
Jonkoping

Comconsult Communication Technologies
Aachen

Comex
Marseille

Community of European Railways
Bruxelles

Compañia Sevillana de Electricidad
Sevilla

Compass
Sophia Antipolis

Competence Center Informatik
Meppen

Compugraphics International
Glenrothes

Computas Expert Systems
Hovik

Computational Mechanics International
Southampton

Computer Logic R&D
Athinai

Computer Systems Development
London

Computer Technology Co
Athinai

Concentration Heat and Momentum
London

Concept Logiciels Expert
Boulogne

Construcciones Aeronáuticas
Madrid

Construnaves
Madrid

Consuldata Nederland
Amsterdam

COPS
Dublin

Corelis Technologie
Boulogne; Bourg-la-Reine

Coretech International
Les Ulis

Correlative Systems International
Bruxelles

Corte Inglés
Madrid

Cossor Electronics
Harlow

Cosytec
Orsay

Cotec Computing Services
Tyne and Wear

Courseware Europe
Zaandam

CPE
Aosta Valley; Pont-St-Martin

CPRM
Lisboa

CRAI
Rende

CRAM
Catania

Credito Italiano
Milano

CRI
Birkerød; København

CRIL
Colombes

Crosfield Electronics
Hemel Hempstead

CSC
Amstelveen; Bruxelles

CSEE
Les Ulis; Toulon

CSELT
Torino

CSI
Piemonte; Torino

CTA
Barcelona

Custo
København

D-Tech
Athinai; Luxembourg

DAF
Eindhoven

Daimler-Benz
Berlin; Frankfurt; Stuttgart; Ulm

Daltek
Borlange

Dancomp (Decanter, Richter & Rosenstand)
København

Danish Agricultural Advisory Centre
Århus

Danish Meat Research Institute
Århus

Danish Parsim Consortium
Charlottenlund

Danish Welding Institute
Brøndby

Dannet
Birkerød

Danobat
Elgoibar

Dansk Ingeniør System
Glostrup

Dantec
Skovlunde

Dassault Automatismes et Télécom
Plaisir

Dassault Aviation
Vaucresson

Dassault Électronique
Saint-Cloud

Dassault Systèmes
Suresnes

Data Borough
Weybridge

Data Collection Systems
Cork

Data Logic
Harrow

Data Management
Milano

Datacentral
Hvidovre; Valby

Datamat Ingegneria dei Sistemi
Roma

Datamont Feruzzi Group
Milano

Datatronic
Roubaix

Datenzentrale Schleswig-Holstein
Kiel-Altenholz

Davy McKee
Poole

Dazix
Newbury

DDC-I
Lyngby

Debis
Fellbach

Decibac
Paris

Decision International
Toulouse

Decision Systems
Dublin

Deister Electronic
Barsinghausen

Delcam
Birmingham

Delga International
Madrid

Delphi
Lucca; Viareggio

Delta Industrie Informatik
Waiblingen

Delta T
Hamburg

Deltacam Systems
Birmingham

Denac
Hoboken

Desarrollo de Software
Barcelona

Det Norske Veritas
Hovik

Deutsche Thomson-Brandt
Villingen

Dialogic
Paris

Didatel
Milano

Digicash
Amsterdam

Digital Equipment
Ayr; Bruxelles; Galway; Kaufbeuren; München

Digital Kienzle
Villingen

Disc
Gent

Disel
Madrid

Diseño y Metodología
Madrid

DMT Marinetechnik
Hamburg

Doimak
Elgoibar; Uipuzcoa

Dolphin
Oslo

Domino
Milano

Dornier System
Friedrichshafen;
Weissling/Oberpfaffenhofen

Dosis
Dortmund

Dow Benelux
Terneuzen

Dr Jens Grumann Daten-
Kommunikation
Bad Homburg

Drägerwerke
Lübeck

Dresdner Anlagen Systeme
Dresden

DSA
Aachen

DSM Research
Geleen

DST
Bremen

DT2
Meylan

Du Pont de Nemours Deutschland
Dreieich Sprendlingen

Dunaiturria y Estanconia
Durango

Dupont de Nemours Luxembourg
Luxembourg

E & E
St-Quentin-en-Yvelines

E2S
Gent

EASAMS
Camberley

EASL
London

East Asiatic Company
København

EB Industry and Offshore
Oslo

EB Teknologi
Billingstadsletta

EBO
Athinai

ECC Couture
Twente; Oldenzaal

ECT
Rotterdam

EDC
Heverlee

EDF
Chatou; Clamart; Paris

EDP
Lisboa

Eeidetics
Blackrock

EFACEC
Porto

Eicas Automazione
Torino

EID
Monte de Caparica

Eigner
Karlsruhe

Eikon
Roma

Elabodater
Caserta

Electricidade de Portugal
Sacavem

Electricity Association Services
Chester

Electrolux Mecatronik
Malmö

Electrónica Básica
Esparreguera

Électronique Serge Dassault
Saint-Cloud

Electrotécnica Arteche
Munguia; Vizcaya

Elektronikcentralen
Hørsholm

Elektroson
Le Liempde

Elettronica Communicazioni
Roma

Eleusis Shipyards
Elefsina

Elf Aquitaine
Saint-Symphorien-d'Ozon

Elgelec
Fontenay-les-Briis

Eliop
Madrid

Elios Informatique
Lannion

Elisa
Bures-sur-Yvette

Elkron
Torino

Ellemtel
Stockholm

Elltec
Athinai

Elmos
Dortmund

Elorduyncho
Bilbao

Elsa Software
Meudon-la-Forêt

Elsag Bailey
Genova; Sestri Ponente

Elsevier
Amsterdam

Eltec Elecktronik
Mainz

Emit
Bremerhaven

Emmepi
Milano

Empirica
Bonn

Empresa Fabril de Máquinas Eléctricas
Guarderios

ENA Telecomunicaciones
Getafe; Madrid

Endress & Hauser
Maulburg

Enel
Roma

Engineering-Engegneria Informatica
Padova

Enidata
Bologna; Milano; Roma

Eniricerche
Milano; S. Donato Milanese

Enosa
Madrid

Ensidesa
Asturias; Avilés

Envirotech International
Athinai

EO Computer Limited
Cambridge

EPEC
Bruxelles

Epichem
Bromborough; Merseyside; Wirral

Epitaxial Products International
Cardiff

EPM Consultants
Oslo

Epsilon Software
Athinai

Ergon
Athinai

Ericsson Radio Systems
Stockholm

Eritel
Madrid

Erno Raumfahrttechnik
Bremen

EROV
Barcelona

ESF
Bruxelles

ESI
Athinai; Eschborn; Rungis

Espasa Calpe
Madrid

Estec-Europeance Agency
HG Noordwijk

Etnoteam
Milano

ETRA
Valencia

Eucad
Cheltenham

Eurodisk Technologies
Deeside

Euroexpert & Partners
Aldershot; London; Paris-la Défense

European Educational Software
Cambridge

European Home Systems Association
Eindhoven

European Silicon Structures
Rousset

Eurosil Electronic
Eching

Eurosoft Systems
Suresnes

Everly
Valbonne-Sophia Antipolis

Exapt-Systems
Aachen

EXIS
Pisa

Experteam
Slough

Extech
Galway

Exxon
Cowdenbeath; Fife

F. L. Smidth & Co
Valby

Fábrica de Vidros Barbosa & Almeida
Vila Nova de Gaia

Fábrica Escola Irmãos Stephens
Marinha Grande

Face
Veldhoven

Fag
Frankfurt

Fagor
Mondragón

Falcon Informatica
Roma

Falko Standard EDV Software
Wien

Farran Technology
Cork

Fatronik System
Elgoibar Guipúzcoa

FEGS
Cambridge; Oakington

Femview
Leicester

Ferranti Computer Systems
Chadderton; Cwmbrân; Manchester

FIAR
Milano

Fiat Aviazione
Torino

Fiat Ferroviaria
Cuneo; Savigliano

Fiat Sepa
Torino

Fichtel & Sachs
Schweinfurt

Fidia
San Mauro; Torino

Fincantieri
Trieste

First Informatics
Patras

Fisher & Lorenz
Rickmansworth

Fomesa
Valencia

Fondazione Ugo Bordoni
Roma

Force Computers
Neubiberg

Fordesi
Lisboa

Formal Systems
Oxford

Foxboro Nederland
Soest

Framasoft & CSI
Île-de-France; Paris-la Défense

Framatome
Paris-la Défense

Framentec-Cognitech
Paris-la Défense

France Cables et Radio
Paris

Freemans
London

Fuigi Italiana
Milano

Futuremedia
Arundel; Bognor Regis

Gaas Code
Cambridge

Game Ingenieri France
St-Quentin-en-Yvelines

GEC
Chelmsford; Coventry; London; Rochester; Wembley; Whetstone

GEC Alsthom
St-Ouen

GEC Marconi
Borehamwood; Chelmsford; London; Stanmore

GEC Marconi Materials Technology
Towcester

GEC Plessey Telecommunications
Coventry

GEC Software
London

GEEO
Grenoble

GEI
Aachen

Gemetec
München

Gemplus Card International
Aix-en-Provence

General Construction Company
Athinai

Generaldirektion PTT Forschung und Entwicklung
Bern

Generics Software
Dublin

Gepro
Aachen

Gesellschaft zur Entwicklung von EDV Methoden
München

GESI
Roma

Gespac
Genève; Plan-les-Ouates

GFI
Paris-la Défense

GFS
Aachen

GIE-Emeraude
Louveciennes; Suresnes

GIE-Recherche Haussmann
Paris

Gildemeister Automation
Hannover

Gipsi
Saint-Quentin-en-Yvelines

GIT
Essen

Glaverbel
Jumet

Globalsis Engenharia Sistemas
Lisboa

GN-Great Nordic
København

Grau
Schwäbisch Gmünd

Greater London Enterprise
London

GRS
Garching

Grupo Apd
Madrid

Grupo de mecánica del vuelo
Madrid

GSE
München

GSI Tecsi Software
Charenton; Paris-la Défense

GTS
Darmstadt

Gühring Automation & Co
Frohnstetton; Stetton

H. F. Jensen
København

HAKO
Bad Oldesloe

Harlequin
Barrington; Cambridge

Harmonic Drive Antriebstechnik
Offheim

Hartmann & Braun
Minden

HCS
Apeldoorn

Head Acoustics
Herzogenrath

Helgeco
Athinai

Hellaslex
Athinai

Hellenic Aerospace Industry
Schimatari

Hellenic ESPRIT Club
Athinai

Hellenic Information Systems
Athinai

Hellenic Management Association
Athinai

Helmut Hund
Wetzlar

Hema Elektronik
Aalen

Heptacon
London

Heraeus Quarzschmelze
Hanau

Hewlett-Packard
Böblingen; Bristol; Wokingham

Hewlett-Packard France
Villefontaine

HIMT
Heidelberg

Hitec
Athinai; Kallithea

Hoechst
Wiesbaden

Hoechst Ceramtec
Marktredwitz

Honeywell Europe
Bruxelles

Hotrasoft
Horst

Howaldtswerke-Deutsche Werft
Kiel

HS Elettronica
Bologna; Villanova du Castenaso

HUA-IDS
Paris

Human-Centred Systems
Hemel Hempstead

Hunting Technical Services
Hemel Hempstead

Huron
Illkirch-Graffenstaden

Hyperion Energy System
Cork

I & T Kalogeridis
Piraeus

I&ME
Wolfenbüttel

I2S
Bordeaux

IABG
Ottobrunn

IAD
Worthing

IASA
Huesca

IBA
Winchester

IBC-Danica
Rødovre

Iberdrola
Bilbao; Vizcaya

Iberduero
Bilbao; Vizcaya

Iberia
Madrid

Ibermática
Guipuzcoa; Madrid; San Sebastián

IBK
München

IBM Deutschland
Sindelfingen; Stuttgart

IBM France
Paris

IBM Zürich
Ruschlikon

IBP Pietzsch
Ettlingen

IC&M
Paris

Icetech
Reykjavik

ICI
Billingham, Cleveland; London; Manchester; Northwich; Winnington

ICI Imagedata
Welwyn Garden City

ICI Wafer Technology
Milton Keynes; Tongwell

ICL
London

ICS
Enschede

ICT
Barcelona

Idate
Montpellier

Ideko
Elgoibar; Guipuzcoa

IDPS Consortium
Nijmegen

IDS
Madrid

IDS Prof. Scheer
Saarbrücken

IEZ
Hessen

IFAD
Odense

Ifatec
Versailles

IGC
Madrid

IGDA
Novara

IGN
Paris

Ihirmer Verlag
München

IIC
Madrid

Ikoss Software Service
Aachen

Il Tridente
Mestre; Venezia

ILOG
Gentilly

Ilva
Genova; Roma

Imperial Software Technology
Cambridge

Implex
North Shields

INA
Herzogenaurach

INCA
Ascot

Incom
St.-Martin-d'Hyères

Indecon Advanced Technology
Athinai

Index-Werke
Esslingen am Neckar

Indumat
Reutlingen

Industrias de Telecomunicación
Madrid

Industrie Zanussi
Pordenone

Induyco/Investrónica
Madrid

Infologics
Sollentuna

Informabel
Bruxelles

Informatica Sistemi (FIAR Group)
Baranzate; Milano

Infosys
Puteaux

Infotap
Luxembourg

Infratest Industria
München

Ing. C. Olivetti & C.
Ivrea; Pisa; Torino

Ingeciber CAE
Madrid

Ingegneria Informatica
Ratingen

Ingenico
Puteaux

Inisel
Madrid

Initec
Madrid

Inmos
Bristol

INSOS
Barcelona

Institut Cerda
Barcelona

Intecs Sistemi
Pisa

Integro
Paris

Intelligent Applications
Livingston Village

Intelltech
Athinai

Integrated Circuit Testing
Heimstetten

Interface Concilium
München

Intermetall
Freiburg

Interprogram
Diemen

Intersis Automação
Lisboa; Paço d'Arcos

Intersys Graphic
Bruxelles

Intervisie Strategie & Organisatie Advies
Leiden

Intes
Stuttgart

Intesa
Torino

Intracom
Athinai; Peania

Intron
Sittard

Investil
Pontevedra; Vigo

Iona Technologies
Dublin

IOT
München

IPACRI
Roma

Ipsys Software
Macclesfield

IRI
Roma

Iris
Frosinone; Paliano

Irish Medical Systems
Dublin

ISA
Stuttgart

ISA Riber
Rueil-Malmaison

Isardata
Wolfratshausen

Iselqui
Ancona

Isoft
Paris; Orsay

Isomag
München

Isomet Laser Systems
Cwmbrân

Isra Systemtechnik
Darmstadt

Issi
Paris

Istel
Redditch

Isykon Software
Bochum

Italcad Tecnologie e Sistemi
Genova

Italsiel
Roma

Italsoft Ingenieri di Sistemi
Roma

Italtel Telematica
Milano; Santa Maria Capua Vetere

ITMI
Meylan

ITS
Madrid

J&J
Berlin

J-S Telecom
Puteaux

J. L. Automation
Tyne and Wear; Whitburn

Jaime Brull
Madrid

James Martin Associates
Bruxelles

Jansen Microwave
Ratingen

JBE
Clydebank

Jenni International User Group
London

Jenoptik Carl Zeiss
Thurlingen; Jena

John Bell Technical Systems
Fleet

Johnson Matthey Chemical
Herts; Royston

Joseph Vogele Mannheim
Mannheim

Joyce-Loebl
Tyne and Wear; Gateshead

Jydsk Datasystemer
Ålborg

Jydsk Telefon
Århus-Tranbjerg

Kade-Tech
Ecully

Kaleidoscope Consultants
Dublin

Kalk Schencking
Wadgassen

Kapsch
Wien

Kask
Hoefn

KCS
Malmö

Kendu S Coop
Guipuzcoa; Segura

Kentree
Kilbrittain

Keon
Las Arenas; Vizcaya

Kern & Co
Arrau

Kewill Systems
Walton-on-Thames

KFA
Jülich

Kjærgård Industri Automatic
Loesning

Knossos Technologies
Heraklion

Knowledge
Patras

Kommunedata
København

Koninklijke PTT Nederland
Groeningen

Kontron Elektronik
Eching

KPMG-Peat Marwick Consultants
Frankfurt am Main

KPMG-Peat Marwick McLintock
London

Kronimus
Iffezheim

Krüger Engineering
Søborg

Krupp
Essen

Krupp Atlas Elektronik
Bremen

KTAS
København

Kuka Schweissanlagen & Roboter
Augsburg

L-Cube Information Systems
Athinai

La Camocha
Asturias; Gijon

Laben
Vimodrone

Lagerwall
Bandol

Land-Data
Visselhoevede

Landis & Gyr
Clichy; Zug

Langton
London

Lasarray Holding
Heidelberg; Thundorf

Laser-Scan Laboratories
Cambridge

Lawrence Graham
London

LCIE
Fontenay-aux-Roses

LDRA
Liverpool

Leas Industrie
Saint-Issmier

Legrand
Limoges

Leica
Knowhill; Milton Keynes

Leico
Löhnberg

Leonhardt Andrae und Partners
Paris; Stuttgart

LEP
Limeil-Brevannes

Lerea
Illkirch

Lernout & Hauspie Speechproducts
Ieper

Lexicon
Salerno

Leybold Heraeus
Hanau

LGMI
Ivry-sur-Seine

LH Agro
Åbybro

Linak
Nordborg

Lips Unibed
Drunen

Lissmac
Bad Würzach

Little Big One
Bruxelles

Littlewoods Organization
Liverpool

Lloyd's Register of Shipping
London

LMS International
Heverlee

Logic Programming Associates
London

Logica UK
Cobham; London

Logimatic
Ålborg

Logos Progetti
Milano

Lombardia Informatica
Milano

Longman Cartermill
St Andrews

Lucus
Antrim; Birmingham

LVD Company
Wevelgem

Lyonnaise des Eaux
Compiegne; Paris

M Torres Disenos Industriales
Navarra

Maatschappij voor Informatica Diensten
Zeist

Machine Intelligence
Cambridge

Maconde
Porto; Vila do Condo

Magistratsdirektion Wien
Wien

Magnemag
Skovlunde

Magneti Autronica
Pavia

Magneti Marelli
Milano

Mague
Alverca

Maintenance & Automation
Liège

Manager Software Products
Pinneberg

Mandelli
Piacenza

Mannesmann Hartmann & Braun
Frankfurt am Main

Mannesmann/Digital
Düsseldorf; Karlsruhe; Ratingen; Wetter

Maps Informática Industrial
Barcelona

Maptel
Madrid

Marben
Paris

Marconi
Camberley; Genova; Leicester; Lincoln; Portsmouth

Marconi Automazione
Monza

Marconi Underwater Systems
St Albans

Marel
Reykjavik

Mares
Barcelona

Mari Group
Gateshead; Tyne and Wear

Marsilio
Venice

Masa-Yards
Turku

Matcon
Herlev

Mathrizk
Rhode-St-Genèse

Matra
Bois d'Arcy; Les Ulis; Montrouge; Nantes; Toulouse; Val-de-Reuil; Velizy-Villacoublay

Matra MS21
Guyancourt; St-Quentin-en-Yvelines

Maxwell Multi-Media
London

Mayer
Laupheim

MB Data
Kamp-Lintfort

MBB
München; Ottobrunn; Putzbrunn

MBB/Erno Raumfahrttechnik
Bremen

MBP Software & Systems
Dortmund

MC2
Grenoble

MCTS
Boulogne-Billancourt

Mecánica de La Pena
Bilbao

Mecof
Alessandria

Medimatica
London

Meiko
Bristol

Melte
Paris-la Défense

MEMC
Novara

Memory Computer
Dublin

Memziken Automation Mat
Memziken

Mental Images
Berlin

Mentec International
Dublin

Mercedes-Benz
Stuttgart

Merck
Darmstadt

Merlin Gerin
Meylan

Messer Griesheim
Frankfurt am Main

Metalworks of Attika
Athinai

Metek
Halandri

Meterquest
London

Metis
Borre; Horten

Michel van de Wiele
Kortrijk

Micro
Evry

Micro Focus
Newbury

Micro Tech
Newcastle

Microin R&D
Montgat

Micrologg
Bargteheide

Microparts
Karlsruhe

Microprocessor Engineering
Southampton

Microtecnica
Torino

MID
Nürnberg

Mietec
Oudenaarde

Mikron
Eching/München

Mimetics
Paris

Ministry of Defence
London

Miniwatt
Barcelona

MMS
Paris

MO Valve Company
London

Modular Computer Services (Modcomp)
Wokingham

Modulex
Billund

Mono Light Instruments
Weybridge

Monotype Corporation
Redhill

Montefibre
Porto Marghera

Moog
Cork

Moog Controls
Tewkesbury

Morpho Systèmes
Avon

Motor Industry Research Unit
Norwich

Motor Oil
Athinai

Motorola
East Kilbridge; Genève

MTG
Dresden

Myfra
Montrouge

NA Software
Liverpool

Nada Consulting Group
Gateshead

NAG
Oxford

Namur
Leverkusen

National Software Centre
Dublin

NCC
Manchester

Ncode International
Sheffield

NEA-Lindberg
Ballerup

NEH Technology
København

Neptune Freight
Dublin

NHS
Birmingham

Nixdorf Computer
Milano

Nixdorf Computer Software
Dublin

NKT
Brøndby

Noesis
Versailles

Nokia Graetz
Esslingen

Nokia Head Office
Helsinki

Nokia Research Centre
Espoo

Non-Standard Logics
Paris

Norcontel
Dublin

Norsk Data
Kongsberg; Mühlheim-an-der-Ruhr

Norsk Forsvarsteknologi
Kongsberg

Norsk Jetmotor
Kongsberg

Novabase-Sistemas Informação Base
Dados
Lisboa

Novosoft
Madrid

NTE
Barcelona; Llissa d'Amunt; München

Num
Argenteuil

Nuovo Pignone
Bari

O Dati Española SL
Barcelona

O2
Versailles

OA
Athinai

OC Consulting Engineers & Planners
Birkerød

Océ-Nederland
Venlo

OCN-PPL
Sarnardo d'Ivrea

ODAV
Düsseldorf

Odense Steel Shipyard
Odense

ÖVA-Versicherungen
Mannheim

Office Workstations
Edinburgh

Officine Gallileo di Sicilia
Messina; Milazzo

Olivetti I. S. Ricerca Scpa
Milano

Olivetti Information Services
Bari

Olivetti O. Group
Milano; Seston Giovanni

Olivetti Office
Ivrea

Olivetti Research
Cambs; Cambridge

Olivetti Systems & Networks
Ivrea; Milano; Torino

Omega Generation
Bologna

On-Campus Technology
Burjassot

Opsis
Villebon-sur-Yvette

Optec
Rho

Orbis
Saarbrücken

Orce
De Meern

Organon International
Oss

Origin
Veldhoven

Oros
Meylan

OSI
Torino

Ositel
Meudon-Bellevue

Otter Online
Mühlheim-an-der-Ruhr

Ove Arup & Partners
London

Ovum
London

Oxford University Press
Oxford

Oxim
Resinghurst; Oxford

Oxley
Cumbria

Oy Saab-Valmet
Uusikaupunki

PA Consulting Group
London

Pacer Systems
Nottingham

Pafec
Nottingham

Page & Moy
Leicester

Page Ibérica
Madrid

Pallas
Bonn

Paris Research Laboratory for Digital Equipment
Rueil-Malmaison

Parseq
Chandlers Ford

Parsys
London

Parsytec
Aachen

PCK and Associates
Athinai

PCS Computersysteme
München

PDV
Bremen

Pegard Productics
Andenne

Pegaso/Enasa
Madrid

Penburg
Esplugas de Llobregat; Barcelona

Pergamon Compact Solution
London

Philips
Aachen; Bruxelles; Eindhoven; Hamburg; Kassel; Le Plessis-Robinson; Limeil-Brevannes; Louvain-la-Neuve; Nürnberg; Wien

Philips Composants
Dreux

Philips Composants
Issy-les-Moulineaux

Philips Consumer Electronics
Mitcham

Philips Dupont Optical
Apeldoorn; Eindhoven; Hilversum

Philips EGP
Suresnes

Philips Electronics
London

Philips International
Nijmegen

Philips ITCL
Leuven

Philips Research Laboratories UK
Redhill

Philips Semiconductors
Hamburg

Phoenix VLSI Consultants
Towcester

Piaggio
Finale Ligure

Picogiga
Les Ulis

Picotron
Aartselaar

Pili Carrera
Pontevedra; Porrino

Pilkington
Lathom; St Asaph

Piraeus Graduate School
Piraeus

Piraiki-Patraiki
Athinai

Pirelli
Milano

Planet
Athinai

Plasma Technology
Avon; Bristol; Yatton

Plasmos
München

Plessey Company
Beeston; Christchurch; Nottingham; Swindon; Towcester

Pliroforiki
Athinai

Pluricom
Aveiro; Lisboa

Polydata
Athinai

Polyflow
Louvain-la-Neuve

Polymer Laboratories
Church Stretton

Polymotor
Casella

Porsche
Weissach

Primeur
Genova

Prism
Athinai

Prisma Informatica
Perugia

Procad
Karlsruhe

Procos
Birkerød

Project Management Consultants
Holte

Prolog Development Centre
Brøndby

Prologia
Marseille

Promodes
Levallois-Perret

Pross
Madrid

Protexarms
Paris

PSA
Neuilly-sur-Seine; Paris

PSI
Berlin

PSL
Shepton Mallet

PTT-DNL
Amsterdam

PTT Research Neher Laboratories
Groeningen; Leidschendam

Putzmeister-Werke-Maschinenfabrik
Aichtal

Quinary
Milano

Racal Research
Reading

RAI
Roma

Ramboll & Hannemann
Virum

Rank Xerox
Cambridge

Rauma-Repola
Tampere

RC-Computer
Åbyhøj

RCE
Cergy-Pontoise

RDM
Rotterdam

RDP Technology
London

RE Technology
København

Realace
Dublin

Red Electrica de España
Madrid

Redac
Tewkesbury

Redar Nah-Ortungstechnik
Darmstadt

Reis & Co Maschinenfabrik
Obernburg

Renault Automation
Boulogne-Billancourt; Le Chesnay

Renault DIO
Boulogne-Billancourt

Renault Rnur
Rueil-Malmaison

Repsol
Madrid

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Darmstadt; Erbach; Gerlingen-Schillerhöhe; Hildesheim; Reutlingen; Stuttgart

Robosoft
Asnières

Robotec
Bilborough; Nottingham

Robotiker
Bizkaia; Mungia

Rodime Europe
Glenrothes

Roke Manor Research
Romsey

Rol
Orsay

Rolls-Royce
Derby; Watford

Rovsing
København

RSCG
Issy-les-Moulineaux

RTC
Paris

RTL-Productions
Bertrange

RTM
Vico Canavese

Ruhrkohle
Essen

RWE-DEA für Mineralöl und Chemie
Hamburg

RWT
Coventry; Essen

Rytrak
Liverpool

Saab-Scania
Jonkoping

Sagantec
Eindhoven

Sagem
Paris

Saint Gobain Recherche
Aubervilliers

Sait Electronics
Bruxelles

Sandretto Industrie
Collegno; Torino

SAP
Walldorf/Baden

Saritel-Sarin Telematica
Pomezia; Roma

SAST
Brentford

SAT
Paris

Scaitech
Ballerup; Lyngby

Scamoni, Chiavegatti e Associati
Milano

Scanray
Hvidovre

Scantest System
Værløse

SCBF
Boulogne

Schiffko
Hamburg

Schlumberger Industries
Montrouge

Schmidt Schicketanz und Partner
München

Schwitter
Allschwill

Scicon
London

Scott Wilson Kirkpatrick & Partners
Basingstoke

Scottish Power
Glasgow

SCS Informationstechnik
Hamburg

Seat
Madrid

SECRE
Paris

Seeber
Leifers

SEGET
Barcelona

Seiaf
Genova

Seifert
Ahrensburg

Sekas
München

Seleco
Pordenone

Selenia
Roma

Selisa
Chilly Mazarin; Essonnes; Wissous

Sema Group
London; Madrid

Sema Group Belgium
Bruxelles

Sema Metra Group
Fontenay-sous-Bois; Montrouge; Paris

Semilab
Derby

Semisa
Barcelona

Semisystems
Fruthwilen

SENER-Sistemas Marinos
Madrid

SEP
Puteaux

Serete Productique
Paris

Servifran
Madrid

Servotrol
Lisboa

SES
Neubiberg

SESA
Puteaux; Rennes

Sesam
Torino

Seso
Aix-en-Provence

Sextant Avionique
Velizy-Villacoublay

SFGL
Boulogne

SGN Graphael
St-Quentin-en-Yvelines

SGS-Thomson Microelectronics
Agrate Brianza; Cornaredo; Gentilly; Grenoble

Sharp Laboratories (Europe)
Abingdon

SIAP Sistemi
Milano; Baranzate

SIC
Paris

Sican
Hannover

SID
København

Sidac
Roma; Pomezia

Siemens
Erlangen; Karlsruhe; München; Regensburg; Unterscheissheim

Siemens Austria
Wien

Siemens Automotive
Toulouse

Siemens Nixdorf (SNI)
Berlin; München; Paderborn

Siemens Plessey Controls
Poole

SIG Services
Utrecht

Sigma-C
Ottobrunn

Signum Computer
München

Silicomp
Montbonnot; Zirst

Silicon
Neuchâtel

Silicon & Software Systems
Dublin

Silmag
Grenoble

Silogia
Paris

Silvertech
Horsham

Simint
Modena; Paggiovara

Simulog
St-Quentin-en-Yvelines

Sinapse
Paris

Sincon
Roma

Sinorg
Paris

SIPA
Vittorio Veneto

Sipe Optimation
Pratica di Mare

Sirti
Milano

SIS
Milano

Siscog
Lisboa

Sistemas Multiposto e Distribuidos
Lisboa

Sistemas y Tratamiento
Madrid

Sistemi e Telematica Porto di Genova
Genova

Site
Velizy-Villacoublay

Sitesa Addax
Montbonnot

Sligos
Paris

SLS-Cap Gemini
Hamburg

SM
Pisa

Smiths Industries Aerospace & Defence Systems
Cheltenham

SNCF Direction R
Paris

SNEA
Courbevoie

Snecma
Paris

SNIA-Fiat Group
Milano

Société des outils du logiciel
Paris

Société générale de techniques et d'études
Puteaux

Sofemasa
Madrid

Sofistik
Athinai

Sofreavia
Paris

Soft International
Den Haag

Softing
München

Softlab
München

Software Científico y Técnico
Madrid

Software de Base
Madrid

Software Engineering Service
Ottobrunn

Software España
Madrid

Software Ireland
Belfast

Software Italia
Cassina de'Pecchi; Milano

Software Sciences
Cheshire

Software Sciences
Macclesfield

SOGEA
Rueil-Malmaison

SOGEI
Roma

Sogitec
Boulogne-Billancourt

Solam-CAM
Barcelona

Solari
Udine

Solvay
Bruxelles

Sophiatec
Valbonne-Sophia Antipolis

Sorefame
Amadora

Søren T. Lyngsø
Hørsholm

Sorep
Chateaubourg

Souriau
Boulogne-Billancourt

Space Applications Services
Bruxelles

Space Software Italia
Taranto

SPAG
Bruxelles

Special Analysis & Simulation Technology
Brentford

Speroni
Pavia

SQL Databanksysteme
Berlin

STAF
Le Mans

Standard Elektrik Lorenz
Stuttgart

Statoil
Trondheim

STC-ICL
Bracknell; London; Manchester; Paignton; Reading; Sidcup; Stevenage; Stoke-on-Trent; Sunbury-on-Thames; Wokingham

STE Seferiades & Associates
Athinai

Steinbeis Foundation Stuttgart
Stuttgart

Step-informatique
Paris

Steria
Velizy-Villacoublay

Stewart Hughes
Southampton

Stichting Centra voor Mikroelektronica
Delft

STM-SGS-Thomson Microelectronics
Agrate Brianza

Stollmann
Hamburg

Storebæltsforbindelsen
København

Stork Demtec
Amersfoort

Straco
Compiègne

Strategic International
Athinai

Studiornini
Bologna

STZ
Dortmund

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Bagshot

Suprenum
Bonn

SWIFT
La Hulpe

Swindon Silicon Systems
Swindon

SWN
Namur

Sybase
Bracknell

SYD
Paris

Symbionics
Cambridge

Synergia
Milano

Synergie
Puteaux

Syntax Factory Automation
Torino

Syntax Sistemi Software
Milano

Syntax Software Sistemi
Bari

Sypro København
København

Syseca
Labège; Rennes; Saint-Cloud

Systeam
Karlsruhe

System Software Factors
Caversham; Reading

Systems & Management
Milano; Torino

Systems Designers Europe
Camberley

Systems Wizards
Torino

Systex
Gif-sur-Yvette

TA
Fürth; Nürnberg

Taighdeclar Genesis Teoranta
An Spideal

Talbot
Aachen

Tampelle
Tampere

TAO
Barcelona

TAP (Air Portugal)
Lisboa

Tasking
Amersfoort

Taywood Engineering
Southall

TDF — Cerlor
Metz

TDS Dextralog
Blackburn

Team
Roma; Ispra; Varese

Teamco
Skelleftea

Techforce
Leiden

Techniques nouvelles d'informatique
Brest

Technisystems
Piraeus

Technology Applications Group
Alnwick

Tecinno
Kaiserslautern

Teclab
La Spezia; Ceparana

TECMIC
Lisboa

Tecnation per l'Innovazione Tecnologica
Torino

Tecnatom
Madrid

Técnicas Reunidas
Madrid

Tecnirob
Alfragide

Tecno T&G
Madrid

Tecnologia Grupo
Madrid

Tecnomare
Venezia

Tecnomatix Europe
Antwerpen

Tecnopolis CSATA NOVUS ORTUS
Valenzano

Tecograf Software
Milano

Tecsiel
Napoli; Pisa

Teice Control
Madrid

Teknecomp
Vercelli; Cavaglia

Teldat
Madrid

Telefánica
Madrid

Telefunken Electronic
Heilbronn

Telefunken Systemtechnik
Ulm

Telelogic
Farsta

Télémécanique
Nanterre; Rueil-Malmaison

Telenorma Bosch Telecom
Frankfurt am Main

TELES
Berlin

Telesincro
Cerdanyola

Telesoft
Stockholm; Farsta

Télésystèmes
Paris

Teletek
Bizkaia; Muguia

Telettra
Bologna; Cinisello Balsamo; Milano

Telettra España
Madrid

Televas
Milano

Telmat Informatique
Soultz

Teseo
Milano

Textware
Bagsvard

Think Systems
Rennes

Thomson-CMS
Courbevoie

Thomson Composants Microondes
Massy

Thomson Consumer
Illkrich-Graffenstaden

Thomson-CSF
Bagneux; Boulogne-Billancourt; Cagnes-sur-Mer; Cesson-Sevigne; Isle et Vilaine; Meudon-la-Forêt; Moirans; Orsay; Paris; Puteaux; St-Egrève; Toulon

Thomson Sintra
Valbonne

Thorn EMI
Hayes

Thot Informatique
Angers

Time-sharing
Lisboa

TLP
Lisboa

TMTED
Dieren

TNC
Hemel Hempstead

TOC
Barcelona

Toditec
Antwerpen

Tolsys
Dublin

Tool
Annecy-le-Vieux

Touche Ross Management Consultants
London

Track One
Louvain-la-Neuve

Trademco
Athinai

Transcend Technology
Rugby

Transmodul
Saarbrücken

Transtools
Madrid

Traub
Reichenbach

Trialog informatique
Paris

Trion Präzisionselektronik & Co
Berlin

Tritech
Dublin

Trut — Kykloforiaki
Thessaloniki

TSI
Roma

TSOL
Teddington

TÜV
München

TXT
Milano

UCB Electronics
Bruxelles

Uitesa
Madrid

UNI-C
København

Unibanque
Paris

Unisoft
Lisboa

Unisys España
Madrid

Unix Systems Laboratories Europe
Ealing

URW
Hamburg

UTI-Services
Paris

Valtronic France
Gif-sur-Yvette

Valvo Unternehmensbereich
Hamburg

Van Dale Lexicografiee
Utrecht

VDO Luftfahrtgeräte Werk
Frankfurt am Main

Vecsys
Bièvres

Vector Fields
Oxford

VEGLA
Aachen

Veridatas
Paris-la Défense

Verilog
Toulouse

Video Display Systems
Firenze

Vision Computing
Dublin

Visitec
Seraing

VLSI Technology
München

VLSI Vision
Edinburgh

VOEST Alpine
Linz

Voice Input
Cambridge

Volkswagen
Ingolstadt; Wolfsburg

Volmac Nederland
Utrecht

VTE-Videotechnik & Elektronik
Braunschweig

Wacker-Chemie
Burghausen

Waldrich Siegen
Siegen

Wavefront Europe
Gent

Weld
Helmond

Westland
Yeovil

Whitechapel
London

Wiener Städtische
Wien

Wild Leitz Instruments
Heidelberg

Wilhelm Karmann
Osnabrück

Wilhem Fette
Schwarzenbek

Winterthur Versicherungen
München

Wohlenberg
Hannover

Wolters Kluwer
Deventer

WTCM/CRIF Mechanical Engineering
Heverlee

X-Tel Services
Nottingham

Yard Software Systems
Chippenham

Zeltron
Campoformido

Zenon
Athinai

University and research institute participants and sites

3IT
Toulouse

Ålborg Universitet
Ålborg East

Århus Universitet
Århus

Academisch Ziekenhuis Rotterdam
Rotterdam

Aden
Falicon

Aderfrance
Marseille

Adersa
Essonne; Verrières-le-Buisson

Adetti
Lisboa

Aentec Microelectronica
Madrid

Aitemin
Madrid

AMTRI
Macclesfield

Ariai
Wien

Aristoteles University of Thessaloniki
Thessaloniki

Armines
Palaiseau; Paris

Athinai School of Economics
Athinai

Baerische Staatsgemadesammlungen
München

BAZIS
Leiden

Benaki Museum
Athinai

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Wuppertal

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Bremen

BIKIT
Gent

BMT
Teddington

Brighton Polytechnic
Brighton

Bristol Polytechnic
Bristol

Brunel University
Uxbridge

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Gieres

Caimens
Paris

CCETT
Cesson-Sevigne

CEA
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CEC-JRC. Ispra Establishment
Varese; Ispra

Cefriel
Milano

Cemota
Vernaison

CENA
Orly-Aerogare

Centre de robotique intégrée
Île-de-France;
Paris

Centre d'Estudis Avancais de Blanes
Girona Catalunya; Blanes

Centre d'études du management
Puyricard

Centre for Software Reliability
London

Centre microélectronique
Rennex

Centre régional Innovation/Transf.
Limoges

Centre scientifique et technique de la construction
Bruxelles

Centro di Cultura Scientifica — A. Volta
Como

Centro Nacional de Microelectrónica
Bellaterra; Madrid

CEO
Campi Bisenzio

CERICS
Valbonne

CERN
Genève

CESI
Milano

CETE Méditerannée
Les Milles

CETIM
Senlis

CGFT
Bern

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Göteborg

Citer
Modena; Carpi

City University London
London

CMSU
Athinai

CNAM
Paris

CNET
Bagneux; Caen; Issy-les-Moulineux; Lannion; Meylan

CNR
Firenze; Genova; Milano; Pisa; Roma

CNR Fonetica
Padova; Roma

Cnr Istituto Lamel
Bologna

Cnr Ladseb
Padova

CNR Linguistica Computaziona
Pisa

CNRG
Athinai

CNRS
Aix-en-Provence; Bagneux; Ecully; Grenoble; Marseille; Mulhouse; Orléans; Orsay; Paris; Sophia Antipolis; Strasbourg; Talence; Toulouse; Valbonne; Villetaneuse

Computer Technology Institute
Patras

Conphoebus
Piano d'Arci

Consorzio Milano Ricerche
Milano

Consorzio Roma Ricerche
Roma

COSI
Milano

Coventry Polytechnic
Coventry

CPR
Pisa

CRAI
Rende

CRAN/LACR
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Cranfield Institute of Technology
Central Milton Keynes; Cranfield, Bedford

Cretan Computer Institute
Iraklion

CRIAI
Napoli

CRIF/WTCM Industrial Automation
Bruxelles

CRIIF
Paris

CRIN
Vandoeuvre-les-Nancy

CSEA
Torino

CSEM
Neuchâtel

CSIC
Cantoblanco; Madrid

CSTB
Paris

CUNFM
Genova

CUP
Cambridge

CWI
Amsterdam

Danish Maritime Institute
Lyngby

Danmarks Tekniske Højskole
Lyngby

Dansk Teknologisk Institut
Tåstrup

Defence Research Agency
Malvern

Defence Research Agency
Worcestershire; Great Malvern

Deiupd
Padova

Delft Hydraulics
Delft

Deutsche Forschungsanstalt
Köln

Deutsches Herzzentrum
Berlin

DFKI
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Dimes/TU Delft
Delft

Direction des musées de France
Paris

DISROMA
Roma

Dörner Institut
München

Dorset Institute
Dorset

Dublin City University
Dublin

ECN
Petten

École centrale de Lyon
Ecully

École des mines de Saint-Etienne
Saint-Etienne

École nationale supérieure
Fontainebleau

École nationale supérieure d'électronique
Grenoble

École nationale supérieure des télécommunications
Brest

École normale supérieure
Paris

École normale supérieure de Lyon
Lyon

École polytechnique
Palaiseau; Paris

École polytechnique fédérale de Lausanne
Lausanne

École supérieure d'électricité
Cesson Sevigne

Education Technology Institute
Milton Keynes

EFQM
Eindhoven

EHESS-CAMS
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Zürich

ELAB-UNIT
Trondheim

ENEA
Bologna; Roma

ENS
Mulhouse

ENSEA
Cergy

Enseeiht
Toulouse

ENSPS
Strasbourg

ENSTA-LIES
Paris

Entwicklungszentrum für Mikroelektronik
Villach

EOQ
Bern

EPFL
Lausanne

Ergonomic Institut
Berlin

ESAT
Leuven

ESIEE
Noisy-le-Grand

ESME Institute
Marseille

ETHZ
Zürich

European Centre for Weather Forecasting
Reading

European Computer Irc
München

European University Institute
Firenze

EWH Koblenz
Koblenz

Fachhochschule Augsburg
Augsburg

Fachhochschule Ulm
Ulm

Faculté polytechnique de Mons
Mons

FAW
Ulm

FBA
Ambleside

Fern Universität Hagen
Hagen

FHG/IFT
München

FIM-FGAN
Ettlingen

FISW
Stuttgart

Forschungszentrum für Informatik
Karlsruhe

FORTH Research Centre of Crete
Iraklion

FORWISS
München

Frauenklinik
*

Fraunhofer
Erlangen; München; Dortmund

Fraunhofer AIS
Erlangen

Fraunhofer IAO
Stuttgart

Fraunhofer IFT
München

Fraunhofer IITB
Karlsruhe

Fraunhofer IMS
Duisburg

Fraunhofer IMT
Berlin

Fraunhofer Institut für Graphische Datenverarbeitung
Hessen; Darmstadt

Fraunhofer IPA
Stuttgart

Freiburg Universität
Freiburg

Freie Universität Berlin
Berlin

Friederich Alexander Universität
Erlangen
Erlangen

FTT
Nijmegen

Georg-Simon-Ohm Fachhochschule
Nürnberg
Nürnberg

Gesellschaft zur Förderung der Angewandten
Berlin

GIP Altair
Le Chesnay

Glasgow College
Strathclyde; Glasgow

GMD
Berlin; Darmstadt; Karlsruhe

Groningen University
Groningen

Harwell Laboratory
Didcot; Hatfield; London

HC Ørsted Institut
København

Heinrich Hertz Institut
Berlin

Helsinki University of Technology
Espoo

HERIE
Nimes

Heriot-Watt University
Edinburgh

Hochschule Saint-Gallen
Saint-Gallen

HUSAT Research Centre
Loughborough

IAB
Ottobrunn

IAI
Madrid; Arganda Del Rey

ICP-Speech Communication Institute
Grenoble

ICS — FORTH
Iraklion

IDSIA
Lugano

IEC
Barcelona

IESL/FORTH
Crete; Heraklion

IFP
Brandenburg; Potsdam

IHP
Brandenburg; Frankfurt an der Oder

IIA
Espoo

IIRIAM
Marseille

IKERLAN
Guipuzcoa; Mondragon

IKP Universität Bonn
Bonn

Ilford
Knutsford

ILSP
Athinai

IMAG
St-Martin-d'Hères

IMEC
Heverlee; Leuven

Imperial Cancer Research Fund
London

Imperial College
London

IMS Stuttgart
Stuttgart

IMT
Neuchâtel

INESC
Lisboa; Porto

INFHIL
Hildesheim

INFM
Genova

Informacio Cartografica I de Base
Barcelona

INIC
Porto

INP Lorraine
Nancy; Vandoeuvre

INPG
Grenoble; Saint-Martin-d'Hères

INRIA
Le Chesnay; Rennes; Sophia Antipolis; Valbonne; Vandoeuvre-les-Nancy

INRIA-Lorraine
Villers-les-Nancy

INSA
Villeurbanne

Institiuid Teangeolaiochta Eireann
Dublin

Institut d'optique théorique et appliquée
Orsay

Institut de recherche de construction navale
Paris

Institut für Arbeitswissenschaft & Technik
Stuttgart

Institut für Deutsche Sprache
Mannheim

Institut für Informatik der Universität Bonn
Bonn

Institut für Sozialforschung
Frankfurt

Institut Jozef Stefan
Ljubljana

Institut méditerranéen de technologie
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