Esprit

European Strategic Programme for Research and Development in Information Technology

The Project Synopses

Index of Projects and Programme Overview

Volume 1 of a series of 7

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INFORMATION TECHNOLOGY
A STRATEGIC SECTOR FOR EUROPE'S ECONOMY

Information Technology (IT) is one of the fastest developing areas of industrial activity, with annual growth rates in IT markets expected to continue at 15-25% into the 1990s. It is not only a major industry in itself but contributes significantly to the competitive status of most economic activities.

In world trade, electronic equipment will overtake the automobile sector in the 1990's. With worldwide R&D spending on information technologies rising from $35 billion in 1986 to some $90 billion in 1990, IT will remain one of the dominant sources of technological advance until the end of the century.

The convergence of IT with the increasingly deregulated telecommunications and broadcasting sectors is enabling an intangible product - information, in all its forms - to become both one of the leading international commodities in itself and a vital element of economic activity in general. And IT is rapidly becoming a driving force for social change, with far-reaching applications in such areas as education, health care and transport. Information technology is therefore of key importance to the economy, both in renewing the competitiveness of established sectors and in the new opportunities it offers for a Europe rich in information skills.

For Europe to make the most of the opportunities offered by information technology requires strategic action. The Commission in close consultation with national administrations, industry and research institutions throughout the EC, is providing both a framework comprehensive enough for such strategic action and the mechanisms for successful transnational teamwork.

The blueprint for this emerging European Technology Community has been established in the 1980s with the European Strategic Programme for Research and Development in Information Technology - ESPRIT.

ESPRIT - A STRATEGY FOR EUROPEAN IT

Although national European markets represent a substantial segment of world demand for IT, European suppliers have been in a weak position in several sectors. ESPRIT was defined after an assessment undertaken by the Community in close liaison with industry in 1982. This analysis proposed action to overcome specific handicaps: scattered R&D efforts; lack of university/industry cooperation; sub-optimal size of markets and enterprises, due to fragmentation into national markets and the practice of national preferences, resulting in insufficient economies of scale.

Deterioration of the competitive situation in IT was linked with increasing requirements for scale unattainable at national level, in particular large-scale investments, coupled with very short product life cycles. The initiatives required included the mobilization of resources on a large scale, in particular by public R&D funding, and the promotion of inter-industry and industry/university cooperation in projects of common interest.

In adopting ESPRIT the Community took into account both the European and the international situation by organizing, at Community level, a cooperative drive in pre-competitive R&D and in the preparation of standards.

Officially launched on 28th February 1984, the ESPRIT programme was conceived for a 10-year period with three main objectives :

- to provide European IT industry with the basic technologies to meet the competitive requirements of the 1990s;

- to promote European industrial cooperation in IT;

- to contribute to the development of internationally accepted standards.

For the first five-year phase of the programme an overall effort of ECU 1,500 million was foreseen, 50% (ECU 750m) allocated from the research budget of the Community. Esprit research partners provide the other half of the funding.

The programme is implemented by projects selected from public calls for proposals and based upon a work programme updated annually. The programme comprises collaborative pre-competitive research and development projects, carried out across frontiers by Community companies, universities and research institutes. ESPRIT contributes to the coordination of R&D activities carried out under the programmes of the Member States and of the Community.

The programme is concentrated on:

- Microelectronics;

- Information processing services, including software technology and advanced information processing;

- IT application technologies including computer integrated manufacturing and office systems.

ADVANCED MICROELECTRONICS

Introduction

Advanced Microelectronics in the context of this subprogramme, encompasses all research and development aspects concerning the provision of the physical elements for the acquisition, processing, storage, transmission and display of data required by modern informatic products. It is therefore the hardware foundation of the Information Technology (IT) industry.

This subprogramme concentrates on the priority areas needed to ensure that Europe maintains a competitive position regarding the supply of these essential ingredients for her IT manufacturing industry with the required capability, in sufficient quantity and at competitive prices.

Overview of the Sub-Programme Areas

The major thrust of the research and development programmes within Microelectronics is to push the silicon based technologies of MOS and Bipolar towards their limits of capabilities whilst pursuing the possibilities afforded by the compound semiconductor materials, such a Gallium Arsenide, which have potential capabilities in key areas beyond those possible using silicon.

Apart from a capability to produce high function count chips, it is also necessary to deal with the problems posed by the complexity of their design. Managing this design complexity effectively is the main goal of the work on Computer Aided Design (CAD) of VLSI Systems.

Optoelectronic devices offer many possibilities especially in the data transmission field, these will be investigated.

An investigation of advanced display technologies offers the possibility of replacing the ubiquitous CRT, as the main vehicle for large scale display, by more compact solid state based counterparts.

Research themes which are more innovative or longer term than those contained in the first six topic areas as well as critical areas of technology and techniques with a common thread are brought together under the heading of General Supporting Topics. These include packaging, device modelling and special processing materials and techniques.

Submicron MOS

The requirement is to develop all the individual process steps to achieve submicron feature size in MOS (such as lithography, etching and doping). The target is a process capable of making several million components of logic and memory per chip. It is envisaged that below about 0.7 um tools other than

optical lithography will be used. Process and device modelling will be included.

The main objectives of the broad 5-year programme are :

- At 18 months: design and evaluation of test vehicle of more than 1000 transistors based on 1 um design rules with a pitch (metal plus spacing) of 3 um.

- At 3 years: first samples of demonstration circuit with 0.5 million transistors, 1 um design rules, with data on figure of merit and delay time.

- At 4 years: statistical data on homogeneity on a slice and yield for 1 um design rules; and test vehicle with more than 1000 transistors with 0.7 um design rules and a pitch of 2 um.

- At 5 years: first samples of circuits with more than 1 million transistors, 0.7 um design rules, with data on figure of merit and delay time.

Submicron Bipolar

The overall objective is to develop specific bipolar submicron process steps, leading to a complete processing sequence for very high performance ICs.

To realize this objective the following developments are included in the project area:

- Overall circuit concepts which must evolve together with the technology.

- A vertical device structure appropriate to submicron lithography.

- A convenient multilayer interconnection technology.

- A suitable contact and multilayer interconnection technology.

- Appropriate high dissipation, high pin count, electrically matched leads, packages.

- Process and device modelling.

The critical techniques needed to support the submicron MOS and bipolar areas are covered in area of general supporting topics.

The main objectives of the programme over 5 years are :

- At 1 year: initial process design; evaluation and choice of critical equipment.

- At 2 years: establish final design rules at 1 um.

- At 3 years: demonstrate 1 um 10/20K gates, 100 ps gate delay circuits.

- At 4 years: establish final design rules for 0.7 um structures.

- At 5 years: Availability of first samples of 20/50K gate circuits in 0.7 um process.

Computer Aided Design (CAD)

The two primary objectives are :

(a) To develop advanced CAD techniques to manage the ever increasing circuit complexities within microelectronics.

(b) To provide a capability for complex VLSI design which is widely accessible to the EEC IT community.

The overall aim is to develop within a common framework an integrated set of portable tools capable of handling VLSI circuits containing up to several million components. This set of tools should :

- Provide a fast response, user friendly design facility that is readily adaptable to changes in technology.

- Allow designers to achieve a rapid turnaround of valid and testable designs and associated test information.

- Provide facilities for reliability and performance optimisation of circuits.

- Include methodologies of cell-based design and libraries of adaptable building blocks.

- Assimilate relevant results of CAD projects under microelectronics regulation (EEC) 3744/81.

The strategy for this R & D area is that:

(a) A positive attempt should be made to encourage the emergence of an overall CAD infrastructure such that the majority of tools developed under existing programmes together with future tools can be combined to provide an integrated widely accessible tool capability.

(b) As far as possible, complex demonstrator chips will be used as a focus for each stage of the programme.

(c) Device and process modelling is not considered as part of the CAD projects but is included in the projects concerned with the development of new VLSI processes however compatibility with CAD is required.

(d) Care should be taken to promote cooperative development between

universities, industrial groups and research institutions in order to transfer know-how and make CAD available to a broader community.

(e) Care will be taken to interface with, support and employ the results of other ESPRIT activities.

(f) The application of knowledge engineering techniques to CAD should be emphasised.

(g) Dedicated CAD hardware should be incorporated where appropriate.

(h) There is a vital need to incorporate the results of current European projects which are in most cases difficult to quantify.

Compound Semiconductor Integrated Circuits

Integrated digital circuits in III-V compound semiconductor materials offer potential speed and/or speed/power product advantages over silicon circuits because of higher electron mobility. The degree of understanding of the technological complexity of these materials is less advanced than for silicon and considerable materials and process research is necessary. Because of the increasing market for high-speed, low-power circuits, many problems need to be tackled in order to bring forward knowledge in this area.

The technology encompasses GaAs circuits based on Field Effect Transistors (FET's) as well as GaAs/GaAlAs heterojunction structures using high electron mobility transistors (HEMT) or the heterojunction bipolar transistors (HJBT's). Basic research is required in materials preparation, ion implantation, and IC process technologies.

The specific objectives of this programme are:

- At 1 year: demonstrate feasibility of MESFET based circuits with 1000 gates and gate delay (tpd) of less than 100 ps. Also, demonstrate basic HJBT and/or HEMT circuits (other than ring oscillators).

- At 2 years: Demonstrate at least 1K memory (less than 1 ns access time, less than 500 mW dissipation) and/or equivalent complexity circuits.and demonstrate feasibility of 100 gates HEMT and/or HJBT circuits.

- At 3 years: Evaluate yield on a demonstrator circuit of 1K or equivalent complexity, on at least 10 wafers. Demonstrate feasibility of 1K HEMT memory and /or comparable HJBT circuit. Comparison of various technologies (if possible with the same circuit for each technology). Decision for selecting one out of them.

- At 4 years: Demonstrate 16K memory (or equivalent) in the selected technology.

- At 5 years: Demonstrate large circuit of 10 to 20K gates complexity, gate

delay of less than 50 ps with figure of merit less than 100 femtojoules. This demonstrator could be a 16K memory with an access time in the order of few nanoseconds or it could be defined during year 3 to fulfil needs of other ESPRIT areas (especially high speed data bus) or of telecommunication industry (signal processing circuits for instance).

Optoelectronics

Optoelectronic devices will be increasingly required for telecommunication type transmission ultra wide band image processing and switching. Future generations of mono-mode communications systems may use coherent detection and multi-channel wavelength multiplexing and may be phase modulated. This will provide improved performance and be compatible with integrated optical logic. It will allow processing, combining and routing at very high speeds. In semiconductor form it will also be compatible with III-V integrated circuits, providing a fast electrical interface. This programme is not aimed at optically-based computers, but rather at providing components and subsystems for large bit rate transmissions.

The total achievement of the objectives of this programme needs very large resources which may not be available within the framework of ESPRIT. On the other hand these objectives represent a minimum target to remain globally competitive.

The objectives are as follows:

(a) Integrated electronic and optical components on the same chip:

At 1 year: demonstrate a monolithic photodetector with internal amplification.

At 2 years:demonstrate a monolithically integrated receiver with bandwidth greater than or equal to 2.5 GHz.

At 3 years: demonstrate an integrated transmitter with a bandwidth greater than 2.5 GHz.

After year 3, further optimisations of receiver, transmitter, and perhaps also repeaters have to take into account the progress and needs of the telecommunications industry and of the other ESPRIT areas.

(b) Wavelength multiplexing (WDM) with integrated optics:

At 1 year: demonstration of DFB laser with threshold current lower than 50 mA; demonstration of waveguide fed photodetector; low loss monolithic waveguide (smaller than 1dB/cm).

At 2 years: demonstration of 2.5 GHz bandwidth modulators in semiconductors.

At 3 years: demonstrate an integrated transmitter with a bandwidth greater than 2.5 GHz.

At 4 years: demonstrate integrated WDM transmitter and receiver modules.

At this point, some inputs from other ESPRIT areas and telecommunications industry are needed to implement a demonstration link at a several gigabit rate.

Advanced Display Technologies

In many product areas, eg workstations, electronic office equipment etc. there is an urgent need in Europe for new advanced display systems to replace and supercede the conventional CRT. Such displays would need to be of large size (A4 and above) and of medium to high definition. Colour capability would also be desirable/necessary.

Many approaches are currently being investigated. A technology definition effort in which major existing community practitioners would combine their knowledge and experience is required to define within a short time period the most adequate way to tackle this problem.

General Supporting Topics

This area covers :

(a) Research themes not already identified in the previous microelectronics areas.

(b) Topics which support one or more of the other areas.

(c) Research themes which look forward beyond the early stages of the microelectronics programme towards the submicron goals.

SOFTWARE TECHNOLOGY

Introduction

This directory contains information on forty seven projects supported within the Software Technology area of the ESPRIT programme. The entry against each provides a summary of its objectives together with information on the progress made and results obtained. Further information can be obtained from the person indicated on the project sheet.

From its outset in 1984, the objective of this part of the ESPRIT programme has been to encourage the development of a scientific basis for software engineering from which a range of industrial practices can be designed and implemented.

The approach has been primarily one of viewing the software development process in the wider context of complex system development. This has ensured that the collaborative, pre-competitive research and development actions of the ESPRIT programme have addressed the real problems faced by to-day's software industry in Europe, particularly the production of high-quality software products and improving the productivity of the software development process.

To achieve these dual goals, the Software Technology programme has concentrated on four key sub-areas:

(i) Theories, Methods and Tools

The definition and development of rigorous design methods and the development of the appropriate support tools. The work covers formal methods (formal in the mathematical sense) and informal techniques, and the appropriate use of the knowledge engineering techniques.

(ii) Management and Industrial Aspects

The development of techniques for project management and production management. The complexity of many software development projects is such that they require the coordination of large development teams, the production and revision of large amounts of documentation and code, the use of distributed computing facilities, etc. Appropriate techniques are therefore needed for resource management, documentation control, configuration management and version control.

(iii) Common Environment

Clearly, the information which is generated during each phase of the development process needs to be stored in a relevant form not only for easy access by the design team and the project managers, but also for the appropriate relationships to be maintained between the various design descriptions produced as the design proceeds. To provide the mechanism for

this "object management", a common utility is necessary which provides the relational database mechanism and the relevant common interfaces for design tools, project management tools, user access etc. This common environment provides the framework within which many of the results of the Software Technology programme can be integrated to form industrial systems. Within the sub-area the first generation environment, based on the entity relationship model has already produced common interface definitions which have entered the international standardisation process, and industrial systems are available. Next generation systems eg. incorporating knowledge engineering techniques, are under development.

(iv) Evaluation and Demonstration

Proper evaluation of the environments, methods and tools within industrial contexts is crucial for the industrial take-up of the results of the programme. Therefore a number of projects have been launched to provide cost/benefit data on the use of these systems in industry.

ADVANCED INFORMATION PROCESSING

Introduction

This directory contains information on forty five of the projects supported within the Advanced Information Processing area of the ESPRIT programme. The entry against each provides a summary of its objectives together with information on the progress made and results obtained. Further information can be obtained from the persons named on the project sheets.

The objective of this part of the ESPRIT programme has been to develop the necessary technologies for the implementation of the next generation of computing systems, by supporting three main action lines:

- the development and application of knowledge engineering techniques;
- the development of new computer architectures for symbolic and numeric processing, and fault tolerant systems; and
- the development of advanced system interfaces for effective communication between computing systems, the computer and its environment, and the computer and the user.

Priority has been given to consolidating and accelerating the industrialisation of the results emerging from the projects. Results have been achieved particularly in the knowledge engineering and computer architecture projects where a firm base is being built for the future enhancement and exploitation of these technologies and techniques by European industry.

The Advanced Information Processing programme has concentrated on three key sub-areas:

i) Knowledge Engineering

The development and application of knowledge-based systems. The approach adopted has been to:

- develop the methods and techniques for knowledge acquisition and knowledge representation;
- develop application independent knowledge-based system shells, supporting languages and user interfaces;
- develop domain specific systems; and
- evaluate knowledge-based systems in the industrial environment.

(ii) New Computer Architectures

The development of high-performance computers capable of processing symbolic and numerical information, concentrating on highly parallel architecture machines.

Such computers will provide the computing capacity needed as the results of knowledge engineering work and advanced man-machine interfaces become embedded into a wide range of applications, eg. CAD and office systems.

(iii) Advanced Systems Interfaces

The work has concentrated primarily on image processing, natural language understanding and speech processing, and is complemented by studies of multi-sensor operation.

OFFICE SYSTEMS

Introduction

Information is an important instrument of competition. This concept is now widely recognised. Office Systems provide a major vehicle through which information can be applied as an aid to navigation through the present turbulent changes in business, technology, commerce and government.

While the potential contribution of information technology to improve effectiveness can be easily recognised, the delivery of solutions to the information problem areas is an entirely different matter. The problems are "fuzzy" and frequently the solution processes appear to be artistic rather than scientific. The users of information frequently have little or no knowledge of the technological content and necessary technical processes that are involved in processing information.

The majority of users require total solutions and not isolated products. These solutions have to be reasonably complete and this implies that integrated systems must be provided, not only in the sense of the inter-relationship of the technical components (both hardware and software) but also in terms of the functions that these components perform as a support to the day-to-day operations, planning and strategy development of organisations.

The challenges facing Office Systems development include:

- Providing integrated information system architectures and scenarios for their implementation that will allow rapid, economic and reliable adaptation to the changing needs of a great variety of private and public enterprises.

- Understanding and supporting the non-deterministic tasks of a wide range of office workers and not just providing a technological update of traditional and limited office functions.

- Achieving major improvements in human-system interfaces that realistically allow effective use of office systems by a wide range of office workers.

- The development of solution oriented approaches to office problems. Delivering product elements and some services and expecting the user to create the total own solution cannot continue.

The key European opportunity relates to the development of system solutions. The implications of European requirements must be that these solutions have an adaptability, flexibility and inbuilt interworking capability that will be a real strength outside Europe. This will only be true if the application of technology reflects a degree of user sensitivity ahead of our major competitors.

Research work in the field of Office Systems can be characterized as follows: on the basis of fundamental and methodological developments in VLSI, software technology, knowledge representation and some other fields. Integrated and applied system solutions are developed which take into consideration user requirements and foreseeable evolutions in the technical, social and economical field.

The Office Systems programme provides the key elements and concepts that mark the development from classical data processing to integrated information processing in administrations and industrial and service enterprises, by which the future work environment will be characterised. For that purpose, systems architectures, functional modules and communication networks with standardised interfaces are necessary.

In developing these systems, which are essential for the survival of our industrial companies, human and social factors have to be considered in the early stages of planning. Only in this way can we ensure that the systems will eventually be accepted by the users and that economic expectation will also be met.

Taking into account the above mentioned integrated approach, the subprogramme has been divided into five research areas. The aims are:

Office system science and human factors

To analyse current and predicted office activities to determine how information technology might be applied to improve the effectiveness of office work and organisation of the enterprise as a whole. Besides automation of various functions and the use of knowledge management methods, this means better support particularly for administrators, professional and managerial staff in executing their judgmental tasks.

To improve understanding of human, social and cultural factors in the office and to ensure high performance of users when interacting with the systems, whilst at the same time offering optimal working conditions and ensuring adequate organisation and individual acceptance.

Advanced workstations and human-machine interface

To establish major new human-machine interface technologies, peripheral technologies document representation technologies and information manipulation relevant to the development of office workstations for use in advanced office systems.

Communication systems

To create the basic technologies required for advanced office communication systems including technical fundamentals in communication systems architecture, optical technologies as a particularly significant technology, the management of resources connected by networks, and system aspects of value added services.

Advanced multi-media information storage and retrieval systems

To acquire the system and applications expertise related to storage and retrieval of all forms of office information in electronic storage systems in a user organisation in an adequate way.

Integrated office information systems

To create flexible, reliable and economical total information system architectures and implementation scenarios, and to check the validity of the total information concepts in environments that are realistic and allow quantitative evaluation.

Priority is given to integration projects throughout, especially in this area.

Office Systems Science and Human Factors

This research programme has been devised to give a better understanding of the office environment. Offices are the "nervous system" of any enterprise. These must be organised, staffed and equipped for effective and efficient operation, and interfaced with other branches of the enterprise (such as research laboratories and manufacturing) and the external environment.

At present the understanding of this field is patchy. There is no formal science of office automation, as there is for example for production automation. This programme, however, makes possible coherent approaches to the problems, ranging from empirical studies to consistent operational classifications and definition of computer based analysis and design tools.

Consistent with this approach, the main topics identified are (a) office systems analysis, (b) office systems design, (c) human factors and (d) the possible application of knowledge based methods. The analysis part of the programme delivers useful input for the design oriented phases.

It is evident that the incorporation of human factors, especially into a technology-oriented programme is an essential pre-requisite for effective use and a broad acceptance of the envisaged systems and thus for their final economic success. The research programme therefore includes specific research projects on human factors related to the office environment. This leads to programmes for cognitive aspects together with work structuring, qualification and training. Human factors laboratories are also seen as key competence centers and catalysers, offering the possibility of unbiased judgment about experimental systems and on commercial products.

The topics to be studied in this area include:

Office systems analysis

(a) Operational and functional analysis of office requirements

(b) Cost benefits analysis
(c) A glossary of agreed terminology
(d) Analysis of human tasks within the office

Office systems design

(a) Office system design methodology
(b) Modelling and simulation of office information systems
(c) Transaction monitor
(d) Deterministic and judgmental function
(e) Techniques for user interface design

Human factors

(a) Human factors laboratories
(b) Human-machine cognitive compatibility
(c) Qualification and work
(d) User aids and learning tools
(e) Human-machine interface specification languages
(f) Natural language interpretation and production

Advanced Workstations and Human-Machine Interfaces

The workstation is the user's gateway to the office system. User acceptance and user performance depend on the design of the corresponding human-machine interface.

The most important channel for information input to the human user is the visual channel. This channel, as well as the bi-directional vocal channel, has evolved to provide information for motoric activities which should be adequately integrated in operating the interface. In consequence, VDU's and touch keyboards and speech receptors will emerge to form an integrated input/output device suitable to manipulate text and images by direct manual and vocal control. Preferably the screens should have the dimensions and portability of paper (electronic paper). Another approach to a more comfortable 'visual input' will be the large screen display. The need for multi-functional capabilities will require the development of devices which allow graphic input and editing, on line handwriting and ideogrammatic conversation.

As long as there is no portable paperlike display, printing will be necessary and the need will be growing for faster, more versatile (text, graphic, colour) printers at lower cost. The provision of human-machine interfaces which support the complete range of functions traditionally carried out by pen or paper is necessary.

A high proportion of telephone or face-to-face communication indicates that visual and spoken information will be preferred whenever it is applicable. Visual communication will require the development of high definition colour video scanning devices with the necessary processing capabilities for

efficient storage and transmission and the use of the multifunction flat panel display.

The voice channel cannot handle as much information as the vision channel but is our most efficient carrier of natural language. Voice communication will require the development of sophisticated processing for improving the acoustic environment, and the development of coding schemes. Voice communication between man and the office system will require the development of efficient speech recognition and of a natural speech synthesizer.

An important aspect of facilitating the standardisation of the interface with the human world and the paper world is the use of formalised languages. These are to be designed in a way which allows the user, rather than the computer professional, to specify his needs directly to the system.

The implementations and testing of user decision support functions are considered to be embedded in the workstation. Availability of these functions is supposed to be a key-factor in the competition among office products.

The development of specific system interface components should lead to a general architecture which will allow the integration of the subsystems in an architecturally homogenous solution. Although the work items are phased in terms of integration into a physical workstation, projects are not necessarily confined to assume that all the associated functionality is resident in the workstation. Solutions involving distributed functionality accessed over communication links are equally relevant.

Much of the software that supports the user will reside in the workstation. Any rules that are, or will be, agreed upon in order to improve portability of software, should be implemented. This applies as well to rules and agreements with respect to other aspects of the system.

The following R & D topics are identified:

System aspects

(a) system aspects of workstation design
(b) workstation security

Vision

(a) vision interface
(b) flat panel workstation design
(c) high resolution video imager
(d) image coding

Paper

(a) paper interface
(b) advanced scanner
(c) advanced printer

(d) microfilm interface
(e) graphics coding
(f) graphics recognition
(g) intelligent graphics recognition

Speech

(a) speech interface
(b) speech coding
(c) speech recognition
(d) intelligent user function support
(e) user to user multimedia communication

Office languages and procedures

(a) office document architectures and languages
(b) office interface languages
(c) multi-media document manipulation
(d) intelligent user function support
(e) user to user multimedia communication

Communication Systems

Office communication presents a number of possible long lead time research topics. Technological advances are needed in microelectronics and in fibre optics, and research is necessary on the principles of future communication systems such as wideband local area networks (LAN), the interconnection of LAN's and the gateway facilities for multimode functionality . R & D should lead to new systems and to standards consistent with the ISO reference model for open systems interconnection (OSI). Besides these technical problems, there are non-technical problem areas which have to be addressed in order to support the progress of office communication systems. The requirements of office communication have to be explored more systematically to get a more solid basis of future telecommunication system design. The special aspects of human interface with communication have to be studied, and the future relationship of the PTTs to new local communication systems has to be considered. New languages and operating system facilities are necessary in connection with distributed sytems.

Within this scope of possible research activities, four main topics which cover some key issues have been determined.

The first topic is dedicated to the fundamental question - how to provide a common communication system for all office communication needs. This question becomes more and more urgent, since non-voice communication will

be needed at almost every desk in the future and video communication is on its way.

The second topic addresses the wide band LAN, including the application of optical fibres, and all the technical problems related to this. It is also concerned with the role of switched communication in the office. It addresses the problems of advancing from current single services switching techniques towards multiservice variable bandwidth switching which will allow the interconnection of all office peripherals and resources.

The third topic deals with resource management in a distributed environment.

The fourth topic intends to advance the standardisation of value added communication services in the office e.g. in the form of mail box messaging for text, image and voice, and for multi-media information systems such as advanced videotex.

Architecture

(a) communication system architectures
(b) security in communications
(c) harmonisation issues in communication

Technology

(a) optical wideband
(b) advanced switching techniques

Resource management

(a) distributed systems

Services

(a) multi-mode messaging
(b) ISDN-based advanced videotex
(c) teleconferencing
(d) advanced services

Advanced Multi-media Storage and Retrieval Systems

Information technology and office automation are fundamentally concerned with the storage, accessing and movement of information, covering data, text, graphics, voice, images and other forms. Investigations leading to the definition of an advanced data-base model for office applications and studies of the security, privacy, authority of access and information distribution are fundamental to a wide range of office systems research.

The proposed research is oriented toward construction of a number of experimental prototype office information servers, and the operation of these in realistic conditions, alone and in association with each other, to gain

practical experience in the systems implications of building these servers, loading them with practical information and using them in a realistic way. The work is therefore divided into three general classes: systems issues, usage and needs, and components.

Systems issues: these cover the design and operation of office information servers, including high-performance filters and investigations of new information models and the development of metrics relating to these. Servers must be considered in relation to the other components of a comprehensive office system including other information servers and the distribution of information and functions between them. Work on the filing interface-related aspects of query languages and declarative content languages is identified.

Usage and needs: this topic addresses the nature of the information (data, text, graphics, images etc....) that will be held in office information servers in terms of quality, quantity and combination and the usage of that information. An internal adaptive interface is to be investigated that responds to the needs and experience of users.

Components: the development of hardware, software and systems elements that will be incorporated into advanced filing systems, primarily in information servers, but also in advanced workstations. These include filters, the sytems management issues relating to using optical discs in advanced office systems, the systems techniques required to achieve very high perceived reliability, and the application of advanced information processing techniques to advanced filing and retrieval systems.

The topics covered by this R & D area include:

File server architectures

(a) office information server design and evaluation
(b) very high security systems

System issues

(a) new information models
(b) file query and declarative content languages

Usage and needs

(a) nature and usage of filed information
(b) user-file adaptive interface
(c) performance of office information servers

Components

(a) file filters
(b) optical storage systems concepts

Integrated Office Information Systems

The research and the prototype development of components for office systems has to be supplemented by the research and evaluation of integrated office systems concepts for a variety of office environments. In an industrial R & D programme the testing of prototypes against requirements that are representative for market conditions, is the most important check on the relevance of the research done.

The architecture for distributed systems is a major area of concern. Distribution of functional units networked together can be considered the fundamental concept not only for office systems, but for all future information systems. Elaboration and implementation of this concept is by no means trivial, and requires many new ideas as well as the development of reference models and standards.

A particular aspect, system security, should be considered throughout the design process on the total system level as well as on component level.

Two topics are identified in the sub-area test and evaluation that are complementary but not necessarily mutually dependent.

1) The creation of test and evaluation environments for office system components and integrated office system prototypes, that allow qualitative and quantitative validation in a variety of simulated offices and enterprises. This work would also use the products of the work on office system science and human factors as well as other standards, performance and integration work.

2) The design, development and evaluation of advanced office systems prototypes based upon state-of-the-art components developed in Europe, possibly under the ESPRIT programme, and based upon the results of structures analysis in the office systems science and human factors areas.

The following R&D topics to be studied in this area include:

Information system architecture

(a) system architectures
(b) systems security

Test and evaluation

(a) office system test and evaluation facilities
(b) office systems application test beds

COMPUTER INTEGRATED MANUFACTURING (CIM)

Introduction

This area relates to the total range of computer integrated manufacturing activities including computer aided design (CAD), computer aided engineering (CAE), computer aided manufacturing (CAM), flexible machining and assembly systems, robotics, testing, and quality control. The area has been selected for its potential impact on the methods and economies of production, which are strongly geared to success specifically for the IT industries, and for manufacturing industry in general.

This is an area where the potential for significant advances through a unified approach are high, and it is therefore particularly suitable for effort on a Community scale.

The objectives in CIM are to create an environment in which multi-vendor systems can be implemented in a progressive manner, and in which Community IT suppliers can compete effectively. To achieve this, effort is concentrated in two main streams. Firstly, work on infrastructure, which concentrates on the development of design rules, systems architectures and communications which will lead to a common reference frame. Relevant international standards activity are supported. The second stream involves action on those sub-systems, interfaces and tools whose development or refinement is judged to be of strategic value for European Community industry (both users and vendors).

INFRASTRUCTURE ACTION : INFORMATION EXCHANGE SYSTEM

The Esprit Communications Infrastructure - IES

The Council decision on ESPRIT required that in addition to the work defined in the main technical areas, supporting infrastructural actions be taken, particularly that an Information Exchange Services (IES) be implemented to ensure that the execution and management of the research and development projects be properly supported, and that appropriate dissemination be given to their results.

The general policy adopted hinges around the gradual development and availability of Open Systems Interconnection, (OSI), conformant computer communications products and is split into 3 fairly discrete parts :

1) The provision of services to the ESPRIT community.

2) Support for developments conforming to the International Standards Organisation (ISO) standards for OSI.

3) Harmonisation of standards implementations and other related Europe-wide research networking activities, in order to allow for interworking.

As part of the policy of supporting and accelerating migration to OSI, development activities were actively stimulated by the IES in order to provide OSI-conformant tools for IES users and service providers and to encourage the acceptance of OSI amongst European manufacturers. The overall objective was set, that in those areas where standards were sufficiently mature, products which would be of potential benefit to IES would be available in a time-frame allowing support to be given to other ESPRIT R & D projects.

The IES infrastructural actions were also intended to supply working services to be used by the IT R & D Community. Within one month of the initial Pilot Projects starting (the first project started work on 12/07/1983), ESPRIT had an operational electronic mail and conferencing system available called EUROKOM, based on work under the COST 11 programme. Four years later, the system is used regularly by a significant proportion of the ESPRIT community and is growing rapidly as a means of:

- Projects communicating amongst themselves.

- Projects coordinating with the CEC.

- Dissemination of information about ESPRIT norms, standards, institutional news and conference calendars in many different fields.

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INDUSTRY

AALBORG SHIPYARD LTD.	DK	CIM	595
ABSY	B	AIP	1005
ACEC S.A.	B	OS	73
ACORN COMPUTERS LTD	UK	OS	291
ADERSA GERBIOS	F	CIM	504
ADVANCED SYSTEM ARCHITECTURES	UK	ST	1033
AEG A.G.	D	MEL	10
	D	AIP	26
	D	OS	64
	D	CIM	179
	D	OS	295
	D	ST	300
	D	OS	367
	D	CIM	384
	D	AIP	415
	D	MEL	456
	D	MEL	491
	D	MEL	519
	D	CIM	688
	D	MEL	802
	D	MEL	833
	D	CIM	932
	D	CIM	1561
AERITALIA	I	CIM	812
	I	AIP	865
	I	CIM	955
AGFA-GEVAERT	B	OS	1051
AGUSTA SPA	I	AIP	1133
AIXTRON	D	MEL	927
ALCATEL ESC	UK	OS	234
ALCATEL STANDARD ELECTRICA SA	E	ST	390
	E	ST	835
ALPHA S.A.I.	GR	ST	1598
AMTRI	UK	CIM	504
	UK	CIM	909
ANALOG DEVICES BV	IRL	MEL	962
ANSALDO IMPIANTI	I	AIP	820
APSIS	F	AIP	1085
ARG-APPLIED RESEARCH GROUP S.P.A.	I	OS	834
	I	AIP	1542
ARS SPA	I	AIP	932
	I	CIM	1133
AT.T & PHILIPS TELECOM.BEDR.	NL	CIM	432
	B	ST	688
ATM COMPUTER GMBH	D	OS	395
BABCOCK POWER	UK	CIM	9

BRITISH TELECOM PLC	UK	OS	43
	UK	OS	169
	UK	MEL	244
	UK	MEL	271
	UK	AIP	387
	UK	MEL	554
	UK	OS	563
	UK	MEL	802
	UK	MEL	824
	UK	MEL	958
	UK	MEL	991
	UK	AIP	1015
	UK	MEL	1043
	UK	OS	1057
BROWN, BOVERI & CIE.	D	AIP	857
	D	ST	1094
BROWN, BOVERI & CIE.	DK	ST	315
BSO.BUR.V.SYSTEEMONTWIKKELING	NL	ST	348
	NL	ST	814
BULL S.A.	F	MEL	10
	F	ST	32
	F	OS	43
	F	OS	82
	F	OS	231
	F	AIP	311
	F	OS	367
	F	OS	385
	F	AIP	393
	F	ST	410
	F	AIP	415
	F	MEL	554
	F	CIM	688
	F	AIP	818
	F	OS	831
	F	OS	834
	F	MEL	887
	F	ST	951
	F	CIM	955
	F	OS	956
	F	AIP	957
	F	MEL	958
	F	AIP	973
	F	OS	1024
	F	AIP	1532
	F	OS	1533
	F	ST	1535
	F	OS	1573
BUREAU MARCEL VAN DIJCK N.V.	B	OS	901
CAMECA	F	MEL	1056
CAP INDUSTRY LIMITED	UK	ST	1262

	UK	ST	1277
CAP SOGETI INNOVATION	F	ST	302
	F	AIP	316
	F	ST	401
	F	ST	814
	F	AIP	820
CAPTEC-COMPUTER APPL.TECHNICS	IRL	AIP	419
CCS/SCYT	E	ST	1609
CERCI	F	ST	1527
CERILOR	F	ST	1520
CGE.LAB DE MARCOUSSIS	F	OS	64
	F	MEL	263
	F	CIM	293
	F	AIP	393
	F	ST	432
	F	AIP	440
	F	OS	954
CGP-COMP.GEN.DE PRODUCTIQUE	F	CIM	293
CHORUS SYSTEMES	F	ST	1535
CHRISTIAN ROVSING A/S AF 1984	DK	OS	998
CIG-CENTRE D'INFORMATIQUEGEN.	B	CIM	418
	B	ST	1520
CIMAF	P	CIM	338
	P	CIM	909
CIMSA-SINTRA	F	AIP	96
	F	OS	612
	F	AIP	967
	F	AIP	1588
CISE	I	AIP	256
	I	AIP	820
CISE S.P.A.	I	MEL	255
CISI/II	F	OS	73
	F	ST	300
	F	ST	1598
CISIGRAPH	F	CIM	322
CIT ALCATEL	F	CIM	688
	F	MEL	887
	F	OS	925
	F	ST	974
CIT-ALCATEL/CERSI	F	ST	282
CIT-ALCATEL/SESA	F	ST	282
CIT/ALCATEL	F	MEL	802
CITSA	E	AIP	1592
CITYMAX INTEGR.INF.SYSTEMS LTD	UK	AIP	1558
CLETT	F	OS	563
COGNITECH	F	AIP	1063

COMAU SPA	I	CIM	118
	I	CIM	338
	I	CIM	477
COMPUTER SYSTEMS DEVELOPMENT	UK	CIM	319
COMPUTER TECHNOLOGIES CO.	GR	ST	1520
COPS (EUROPE) LTD	IRL	ST	432
	IRL	OS	998
COSSOR ELECTRONICS LTD	UK	OS	870
COURSEWARE EUROPE B.V.	NL	AIP	280
CRAI	I	AIP	1117
CRANFIELD INST.OF TECHNOLOGY	UK	AIP	107
	UK	CIM	322
	UK	CIM	338
CRI	UK	ST	1609
CRI A/S	DK	AIP	280
	DK	AIP	857
	DK	ST	1094
	DK	ST	1262
	DK	ST	1598
CRI-COMPUTER RESOURCES INTL.	DK	AIP	599
	DK	CIM	688
CRIAI	I	OS	831
CRIL	F	AIP	1133
	F	AIP	973
	F	ST	1257
CRISS	F	AIP	530
CSEA	I	CIM	850
CSEE	F	MEL	491
CSELT S.P.A.	I	AIP	26
	I	OS	43
	I	OS	64
	I	AIP	96
	I	OS	169
	I	MEL	263
	I	MEL	271
	I	ST	283
	I	AIP	316
	I	OS	367
	I	AIP	415
	I	OS	563
	I	MEL	802
	I	AIP	967
	I	OS	1057
	I	OS	1541
DANISH MARITIME INSTITUTE	DK	AIP	1074
DANISH WELDING INSTITUTE	DK	CIM	595
DANOBAT S.COOP	E	CIM	504

DANSK DATAMATIK CENTER	DK	OS	59
	DK	AIP	280
	DK	ST	315
	DK	ST	390
	DK	AIP	1117
DANTEC ELEKTRONIK	UK	CIM	534
DATA MANAGEMENT SPA	I	ST	282
DATAMAT SPA	I	AIP	1613
DATAMONT SPA	I	OS	1573
DELPHI	I	AIP	440
	I	ST	1256
	I	ST	1535
DIGITAL EQUIPMENT CORP.GMBH	D	CIM	477
	D	CIM	688
DORNIER GMBH	D	CIM	688
	D	OS	813
	D	AIP	867
	D	ST	974
	D	ST	1550
E2S-EXPERT SOFTWARE SYSTEMS NV	B	ST	1265
	B	ST	1598
ELECTRONIQUE SERGE DASSAULT	F	ST	937
ELEKTRONIK CENTRALEN	DK	ST	300
ELSAG SPA	I	CIM	812
	I	AIP	865
	I	AIP	940
EMPIRICA	D	OS	1030
ENIDATA SPA	I	AIP	973
	I	AIP	1117
	I	ST	1271
ERDISA	E	CIM	322
ERIA S.A.	E	OS	28
	E	CIM	850
	E	ST	1262
ERLI	F	AIP	1015
ERNO RAUMFAHRTTECHNIK GMBH	D	ST	1033
ESA CONTROL	I	ST	300
ESI	F	ST	974
EUROPEAN SILICON STRUCTURES	F	MEL	1563
EUROSOFT SYSTEMS S.A.	F	ST	266
	F	CIM	850
	F	ST	951
EXAPT SYSTEMTECHNIK GMBH	D	CIM	409
FABRIQUE NATIONALE HERSTAL S.A.	B	CIM	418
FARRAN TECHNOLOGY LTD.	IRL	MEL	522
	IRL	MEL	843
	IRL	MEL	971

FERRANTI ELECTRONICS LTD.	UK	AIP	818
	UK	MEL	1043
	UK	ST	1535
FIAR SPA	I	CIM	623
	I	CIM	932
FINCANTIERI	I	OS	449
FOXBORO NEDERLAND N.V.	NL	ST	937
FRAMENTEC	F	AIP	256
	F	AIP	387
	F	AIP	820
FRAUNHOFER IAO	D	AIP	107
	D	OS	385
FRAUNHOFER IM	D	MEL	574
FRAUNHOFER INSTITUT	D	CIM	118
	D	CIM	278
	D	AIP	393
	D	OS	834
	D	OS	954
FRAUNHOFER IPK	D	CIM	75
	D	CIM	293
	D	CIM	384
	D	CIM	623
FRAUNHOFER-IITB	D	CIM	1556
FRAUNHOFER-IPA	D	CIM	932
FUIGI ITALIANA SRL	I	ST	1527

GEC RESEARCH LABORATORIES	UK	MEL	10
	UK	MEL	14
	UK	ST	32
	UK	OS	43
	UK	OS	234
	UK	MEL	245
	UK	OS	249
	UK	MEL	263
	UK	MEL	305
	UK	MEL	370
	UK	CIM	384
	UK	OS	395
	UK	ST	401
	UK	MEL	514
	UK	MEL	519
	UK	MEL	522
	UK	OS	612
	UK	MEL	833
	UK	MEL	843
	UK	AIP	866
	UK	AIP	898
	UK	OS	925
	UK	OS	954
	UK	MEL	958
	UK	MEL	962
	UK	MEL	971
	UK	MEL	986
	UK	AIP	1035
	UK	AIP	1063
GEC SOFTWARE LTD	UK	ST	951
	UK	ST	1282
GENERAL ELECTRIC COMPANY	UK	CIM	179
	UK	AIP	415
	UK	CIM	688
	UK	AIP	867
	UK	AIP	940
	UK	CIM	955
	UK	CIM	1062
GFI	F	ST	892
GFS-GES.FUR STRUKTURANALYSE	D	CIM	322
GIE EMERAUDE	F	ST	1277
	F	ST	1520
GLAVERBEL S.A.	B	AIP	957
GN DATA	DK	OS	59
GPP-GES.F.PROZESSRECHNERPROGR.	D	ST	267
GREATER LONDON ENTERPRISE	UK	CIM	1199
GRUPO DE MECANICA DEL VUELO SA	E	ST	1520
GTS GMBH	D	CIM	496
HARLEQUIN LTD	UK	ST	1256
HITEC LTD	GR	AIP	26

	GR	ST	1252
HUNTING TECHNICAL SERVICES LTD	UK	AIP	867
HUSAT RESEARCH CENTRE	UK	OS	385
I/S DATACENTRALEN AF 1959	DK	OS	831
IBM DEUTSCHLAND GMBH	D	CIM	293
	D	CIM	688
ICI PLC	UK	MEL	443
ICL	UK	ST	32
	UK	OS	231
	UK	AIP	280
	UK	ST	302
	UK	ST	315
	UK	OS	385
	UK	ST	410
	UK	OS	449
	UK	CIM	688
	UK	CIM	809
	UK	OS	834
	UK	MEL	887
	UK	MEL	888
	UK	ST	891
	UK	ST	938
	UK	ST	951
	UK	CIM	955
	UK	OS	956
	UK	OS	1024
	UK	ST	1520
	UK	OS	1533
ICL NETWORK SYSTEMS	UK	AIP	304
ICS HOLDING B.V.	NL	MEL	991
II	F	ST	1609
IKERLAN	E	CIM	504
IMEC V.Z.W.	B	MEL	97
	B	MEL	369
	B	MEL	370
	B	MEL	509
	B	MEL	519
	B	MEL	554
	B	MEL	962
	B	MEL	1043
	B	OS	1051
	B	MEL	1056
	B	MEL	1058
IMPERIAL SOFTWARE TECHNOLOGY	UK	ST	1041
INCA	D	AIP	107
INDEPENDENT BROADCASTING AUTH.	UK	OS	563
INDUSTRIE PIRELLI SPA	I	CIM	932

INDUSTRY FACE STANDARD SPA	I	OS	249
	I	OS	1057
INFORMATIQUE INTERNATIONALE	F	ST	510
INMOS LTD.	UK	AIP	1085
INST.ORGANISATIONS TECHNOLOGIE	D	OS	285
INTERPROGRAM B.V.	NL	ST	1252
INTERSYS GRAPHIC	B	OS	853
IRAM	F	AIP	898
ISA RIBER	F	MEL	305
IST.PER AUTOMAZIONE RISPARMIO	I	OS	285
ITAL TELEMATICA SPA	I	OS	367
	I	MEL	802
	I	OS	813
ITALCAD	I	AIP	865
ITALSIEL SPA	I	CIM	595
	I	CIM	688
ITMI	F	AIP	940
ITT INDUSTRIES LTD	UK	AIP	527
	UK	AIP	1613
JAMES MARTIN ASSOCIATES	B	ST	928
JEUMONT-SCHNEIDER	F	AIP	818
	F	AIP	874
	F	OS	1059
JOHN BELL SYSTEMS	UK	ST	1258
JOYCE LOEBL LIMITED	UK	CIM	278
JUDEX DATASYSTEMER APS	DK	AIP	599
JUTLAND TELCO (JTAS)	DK	OS	1541
KRUPP ATLAS ELEKTRONIK GMBH	D	AIP	387
	D	CIM	809
	D	AIP	1074
	D	CIM	1199
	D	AIP	1560
KTAS	DK	OS	563
KUKA SCHWEISSANL.&ROBOTER GMBH	D	CIM	623
	D	CIM	1561
LAB DE PHYSIQUE APPLIQUEE	F	MEL	843
	F	MEL	927
	F	MEL	1128
LABORATOIRES DE MARCOUSSIS	F	AIP	112
LANGTON LIMITED	UK	OS	1573
LEUVEN MEASUREMENT & SYSTEMS	B	CIM	322
	B	CIM	1561
LEYBOLD HERAEUS GMBH	D	MEL	334
	D	MEL	574
	D	MEL	1563
LIVERPOOL DATA RESEARCH ASSOC.	UK	ST	1258
LLOYD'S REGISTER OF SHIPPING	UK	AIP	1074

LOGICA UK LIMITED	UK	CIM	92
	UK	CIM	418
	UK	AIP	599
	UK	OS	901
	UK	ST	1261
LOGOS PROGETTI SRL	I	OS	234
LUCAS STABILITY ELECTRON.	UK	MEL	544
M.O.VALVE COMPANY LTD.	UK	MEL	830
MAPS INFORMATICA INDUSTRIAL	E	AIP	1560
MARBEN	F	ST	1265
MARCONI DEFENCE SYSTEMS LTD.	UK	ST	1261
MARI ADVANCED MICROELECTRONICS	UK	OS	237
	UK	CIM	278
	UK	AIP	818
	UK	AIP	874
MATRA	F	CIM	409
	F	CIM	418
	F	AIP	940
	F	ST	974
	F	AIP	1560
	F	ST	1609
MATRA HARRIS SEMI-CONDUCTEURS	F	MEL	369
	F	MEL	509
	F	MEL	554
	F	MEL	802
MC 2	F	OS	831
MEDICAL RESEARCH COUNCIL	UK	CIM	234
	UK	OS	534
MEDIMATICA LTD	UK	AIP	1592
MEDIPRINT	DK	AIP	1560
MEMORY COMPUTER PLC	IRL	AIP	527
	IRL	OS	1030
MENTEC INTERNATIONAL LTD	IRL	CIM	319
	IRL	CIM	909
MESSER GRIESHEIM	D	CIM	9
MESSERSCHMITT BOLKOW BLOHM	D	OS	1051
MICRO FOCUS LTD	UK	ST	928
MICROTECNICA SPA	I	CIM	1136
MIETEC N.V.	B	MEL	370
	B	MEL	1563
MNEMONICA COMPUTER SERVICES	GR	OS	28
	GR	AIP	1542
MODULEX A/S	DK	MEL	833
	DK	OS	878
MYFRA S.A.	F	OS	612
N E H ENGINEERING	DK	CIM	322
	DK	CIM	1199
NATIONAL SOFTWARE CENTRE LTD.	IRL	OS	59
NEA-LINDBERG A/S	DK	AIP	820
NIXDORF COMPUTER A.G.	D	ST	32

	D	OS	43
	D	OS	64
	D	AIP	311
	D	OS	395
	D	AIP	415
	D	OS	563
	D	OS	834
	D	CIM	955
	D	OS	956
	D	OS	1533
	D	OS	1573
NKT	DK	OS	169
	DK	OS	870
NOESIS	F	AIP	940
NON STANDARD LOGICS	F	ST	891
	F	AIP	967
	F	ST	1256
NUMERICAL ALGORITHMS GROUP LTD	UK	ST	1072
O DATI ESPANOLA S.L.	E	ST	1527
OCE-NEDERLAND B.V.	NL	OS	43
	NL	OS	82
	NL	OS	612
	NL	OS	813
	NL	ST	1283
ODENSE STEEL SHIPYARD	DK	CIM	595
OLIVETTI	I	OS	28
	I	ST	32
	I	CIM	118
	I	ST	125
	I	OS	291
	I	OS	295
	I	AIP	311
	I	OS	385
	I	OS	395
	I	ST	401
	I	CIM	418
	I	AIP	532
	I	OS	831
	I	OS	834
	I	OS	853
	I	OS	855
	I	ST	951
	I	CIM	955
	I	OS	956
	I	OS	1024
	I	OS	1032
	I	OS	1533
OLYMPIA AG	D	OS	855
ORGANON INTERNATIONAL B.V.	NL	AIP	1570
OROS	F	OS	64

PACTEL	UK	ST	814
PCS-PERIPHERE COMPUTER SYSTEMS	D	MEL	991
	D	ST	1094
	D	AIP	1588
PEUGEOT	F	CIM	955
PHILIPS & MBLE ASSOCIATED	B	AIP	316
	B	ST	432
	B	CIM	688
	B	CIM	812
PHILIPS GLOEILAMPENFABR. N.V.	NL	MEL	412
	NL	ST	432
	NL	MEL	1058
	NL	CIM	1062
PHILIPS GLOEILAMPENFABRIEKEN	NL	MEL	97
	NL	OS	295
	NL	MEL	369
	NL	OS	385
PHILIPS GLOIENLAMPENFABR.N.V.	NL	AIP	415
	NL	MEL	887
	NL	OS	901
	NL	MEL	962
	NL	ST	1041
	NL	AIP	1117
	NL	ST	1158
PHILIPS GMBH	D	OS	237
	D	CIM	932
PHILIPS INTERNATIONAL BV	NL	OS	43
PHILIPS RESEARCH LABORATORIES	UK	MEL	1056
PHILIPS/LEP	F	MEL	232
	F	ST	1535
PLASMA TECHNOLOGY LTD.	D	MEL	971
	UK	MEL	1043
	UK	MEL	1563
PLESSEY COMPANY PLC	UK	MEL	10
	UK	MEL	14
	UK	OS	43
	UK	AIP	96
	UK	MEL	232
	UK	OS	237
	UK	MEL	243
	UK	ST	266
	UK	ST	267
	UK	OS	295
	UK	MEL	843
	UK	MEL	971
	UK	OS	1059
	UK	MEL	1270
POLYDATA GMBH	GR	CIM	975
PRAXIS SYSTEMS PLC	UK	ST	1283
PROCOS A/S	DK	CIM	418

PROTEXARMS	F	OS	998
PYE UNICAM LTD.	UK	AIP	1570
R & D ADVISORY SERVICES	UK	CIM	1199
REDAR NAH-ORTUNGSTECHNIK GMBH	D	CIM	975
RENAULT AUTOMATION	F	CIM	75
	F	CIM	338
	F	CIM	477
	F	CIM	623
RIADA & CO.	IRL	AIP	1558
ROBERT BOSCH GMBH	D	AIP	1106
ROBERT BOSCH GMBH	D	CIM	278
ROLLS ROYCE PLC	UK	CIM	1199
RTC-RADIO TECHNIQUECOMPELECTR.	F	MEL	281
RTM	I	CIM	418
RWTUEV	D	ST	1257
SAGANTEC B.V.	NL	ST	881
SAGEM	F	MEL	334
	F	AIP	1133
	F	CIM	1136
SARIN S.P.A.	I	OS	367
	I	AIP	1015
SCAITECH A/S	DK	OS	878
SCANRAY A/S	DK	AIP	898
SCICON LTD.	UK	AIP	107
	UK	AIP	1098
SCS-SCIENTIFIC CONTROL SYSTEMS	D	AIP	107
	D	AIP	304
	D	ST	892
	D	AIP	1098
SELENIA SPA	I	CIM	688
	I	AIP	866
	I	AIP	867
SEMA METRA	F	ST	282
	F	ST	348
	F	OS	813
SEP	F	OS	901
SESA	F	OS	43
	F	CIM	812
	F	AIP	1015
SFGL-SOC.FR.DE GENIE LOGICIEL	F	ST	1261
SFGL.SOCIETE FRANCAISE DE GENIE	F	ST	1262
SGI-SOC.GENERALE D'INFORMATICA	I	OS	831
SGN GRAPHAEL	F	CIM	932

SGS MICROELETTRONICA SPA	I	MEL	509
	I	MEL	554
	I	MEL	802
	I	MEL	887
	I	OS	956
	I	MEL	962
	I	MEL	1007
	I	MEL	1551
SGTE	F	CIM	1062
SIEMENS	D	ST	125
SIEMENS A.G.	D	ST	32
	D	MEL	42
	D	MEL	97
	D	AIP	112
	D	CIM	118
	D	OS	121
	D	MEL	232
	D	MEL	255
	D	ST	283
	D	OS	385
	D	MEL	412
	D	CIM	688
	D	MEL	843
	D	MEL	887
	D	MEL	888
	D	CIM	955
	D	OS	1024
	D	OS	1032
	D	MEL	1043
	D	MEL	1056
	D	ST	1072
	D	AIP	1532
SILVAR-LISCO N.V.	B	MEL	97
	B	MEL	1058
SIMULOG	F	AIP	957
	F	AIP	1133
SINCON SPA	I	CIM	118
SIS AV	I	CIM	932
SNIAS-SOC.NAT.IND.AEROSPATIALE	F	CIM	688
	F	AIP	820
SOBEMAP S.A.	B	OS	367
SOFEMASA	E	ST	282
	E	ST	1527
SOFT INTERNATIONAL B.V.	NL	AIP	1074
SOFTLAB GMBH	D	ST	1261
SOFTWARE ENGINEERING SERVICES	D	ST	1258
SOFTWARE SCIENCES LTD.	UK	ST	1277
SOREN T.LYNGSOE A/S	DK	AIP	96
	DK	AIP	1074
STANDARD ELEKTRIC LORENZ AG	D	MEL	263

STC IDEC	UK	ST	300
STC TECHNOLOGY LTD	F	OS	56
	UK	MEL	263
	UK	ST	300
	UK	ST	315
	UK	MEL	522
	UK	MEL	843
	UK	OS	1030
	UK	OS	1057
	UK	AIP	1098
STE ANONYME TELECOMMUNICATIONS	F	OS	925
STEWART HUGHES LTD	UK	CIM	504
STOLLMANN & CO GMBH	D	OS	73
	D	AIP	415
SYNERGIE INFORM.& DEVELOPPEMENT	F	OS	237
SYSECA LOGICIEL	F	ST	283
	F	ST	390
	F	ST	835
	F	ST	951
	F	AIP	1005
	F	ST	1282
	F	CIM	1556
SYSTEAM KG	D	ST	937
SYSTEM AND MANAGEMENT SPA	I	AIP	530
	I	OS	813
	I	ST	951
TDS DEXTRALOG LTD.	UK	CIM	809
TE.KA.DE.	D	OS	925
TEAM SRL	I	CIM	1556
TECHNOPOLIS CSATA NOVUS ORTUS	I	OS	291
	I	ST	1262
TECSI SOFTWARE	F	OS	831
	F	ST	937
	F	ST	1550
TECSIEL SPA	I	ST	125
	I	ST	401
TEKNOLOGISK INSTITUT	DK	CIM	1199
TELECOM.RADIOELEC.& TELEPH.	F	OS	1057
TELEFONICA CTNE	E	OS	925
	E	OS	1057
	E	ST	1252
TELEFUNKEN ELECTRONIC GMBH	D	MEL	14
	D	MEL	243
	D	MEL	522
TELEMECANIQUE	F	CIM	384
TELENORMA (TN)	D	OS	1059

VALVO RHW	D	CIM	1572
VECTOR FIELDS LTD.	UK	CIM	1062
VERILOG	F	ST	938
	F	ST	1265
	F	ST	1527
VIDEO DISPLAY SYSTEMS SRL.	I	AIP	419
VISITEC	B	CIM	1136
VOICE SYSTEMS INTERNATIONAL	UK	OS	449
VOLKSWAGEN AG	D	CIM	409
	D	CIM	688
WACKER CHEMITRONIC	D	MEL	927
	D	MEL	1128
WESTLAND HELICOPTERS LTD.	UK	CIM	534
WHITECHAPEL COMPUTER WORKS LTD	UK	OS	1032
WORK RESEARCH CENTRE LTD.	IRL	OS	1030
WTCM/CRIF	B	CIM	909
ZELTRON	I	AIP	532

LIST OF PARTICIPATING ORGANISATIONS
UNIVERSITIES AND RESEARCH ESTABLISHMENTS

AARHUS UNIVERSITY	DK	MEL	554
AERE-ATOMIC ENERGY RES.ESTABL.	UK	MEL	369
	UK	MEL	554
	UK	MEL	574
ATHENS SCHOOL OF ECONOMICS	GR	CIM	1062
BRUNEL UNIVERSITY	UK	MEL	244
	UK	ST	1094
CEA LETI IRDI	F	CIM	1136
CEA-DEIN/SIR	F	OS	64
	F	CIM	932
	F	ST	1609
CEA/LETI	F	MEL	244
	F	MEL	245
	F	MEL	824
	F	AIP	957
CENTRE D'ETUDES DU MANAGEMENT	F	OS	285
CENTRE D'ETUDES RECH. TOULOUSE	F	AIP	316
	F	ST	510
	F	ST	1598
CESIA	F	OS	831
CETE MEDITERANNEE	F	ST	938
CNAM	F	ST	1271
CNET	F	MEL	245
	F	MEL	263
	F	MEL	271
	F	MEL	443
	F	MEL	491
	F	MEL	522
	F	MEL	554
	F	MEL	802
	F	MEL	833
	F	MEL	971
	F	ST	974
	F	AIP	1015
	F	OS	1057
	F	MEL	1270
	F	OS	1541
CNR-IEI	I	OS	28
	I	OS	813
	I	AIP	818
	I	OS	834
CNR-INSTITUTO LAMEL	I	MEL	554
CNR/IESS	I	MEL	1007

	F	ST	302
	F	ST	348
	F	OS	367
	F	AIP	940
	F	OS	956
	F	AIP	1117
	F	AIP	1133
INST.SUP.TECNICO DE LISBOA	P	CIM	293
IROE	I	CIM	197
KATHOLIEK UNIVERSITEIT LEUVEN	B	MEL	71
	B	CIM	322
	B	OS	853
	B	AIP	857
	B	CIM	1561
KATHOLIEK UNIVERSITEIT NIJMEGEN	NL	OS	291
	NL	AIP	419
	NL	ST	881
	NL	AIP	1570
	NL	OS	82
KERFORSCHUNGZENTRUM KARLSRUHE	D	CIM	322
KING'S COLLEGE LONDON	UK	MEL	1007
LABORATOIRE GENIE INFORMATIQUE	F	OS	834
LGIL	F	CIM	1556
LIFIA	F	AIP	415
	F	AIP	940
LINGUISTICS INST.OF IRELAND	IRL	AIP	527
NAT.TECHN. UNIVERSITY ATHENS	GR	OS	73
	GR	OS	64
	GR	CIM	278
	GR	AIP	1074
NIHE	IRL	ST	938
NORDJYDSK UDVIKLINGS CENTER	DK	AIP	599
PAISLEY COLLEGE OF TECHNOLOGY	UK	ST	1609
POLITECNICO DI MILANO	I	OS	169
	I	OS	249
	I	CIM	623
	I	CIM	812
	I	OS	813
	I	AIP	867
	I	CIM	932
	I	CIM	1556
POLITECNICO DI TORINO	I	AIP	26
	I	OS	855
	I	AIP	1015
POLYTECHNIC OF CENTRAL LONDON	UK	AIP	867
POLYTECHNIC OF HATFIELD	UK	ST	266

POLYTECHNIC OF THE SOUTH BANK	UK	AIP	304
	UK	AIP	1098
	UK	OS	1573
QUEEN MARY COLLEGE INTERACTIVE	UK	AIP	387
	UK	OS	1024
	UK	OS	1032
RISO NATIONAL LABORATORY	DK	CIM	534
	DK	OS	878
ROYAL SIGNALS & RADAR EST	UK	AIP	1085
RUHR UNIVERSITAT BOCHUM	D	MEL	97
	D	OS	291
RUTHERFORD APPLETON LABORATORY	UK	CIM	322
	UK	MEL	962
RWTH AACHEN	D	CIM	9
	D	CIM	418
	D	CIM	688
	D	CIM	812
	D	MEL	927
SNS PISA	I	OS	64
ST. PATRICK'S COLLEGE	IRL	AIP	527
ST.MATHEMATISCH CENTRUM	NL	ST	1283
TECH. HOCHSCHULE DARMSTADT	D	MEL	244
	D	MEL	824
TECH. UNIVERSITEIT EINDHOVEN	NL	ST	937
	NL	MEL	991
TECHNICAL UNIV. OF DENMARK	DK	CIM	1199
TECHNISCHE HOCHSC.DARMSTADT	D	CIM	504
TECHNISCHE UNIVERSITAT BERLIN	D	MEL	243
TECHNISCHE UNIVERSITAT BERLIN	D	AIP	311
	D	AIP	415
TECHNISCHE UNIVERSITAT MUNCHEN	D	AIP	107
	D	AIP	415
	D	OS	878
	D	AIP	973
TECHNISCHE UNIVERSITEIT DELFT	NL	CIM	809
	NL	ST	881
	NL	MEL	991
THE CITY UNIVERSITY	UK	ST	1258
THE PIRAEUS GRADUATE SCHOOL	GR	OS	385
THE TURING INSTITUTE	UK	ST	814
TRENT POLYTECHNIC	UK	OS	295

TRINITY COLLEGE DUBLIN	IRL	OS	231
	IRL	MEL	271
	IRL	CIM	319
	IRL	AIP	419
	IRL	CIM	496
	IRL	CIM	496
	IRL	ST	510
	IRL	OS	834
	IRL	MEL	962
	IRL	CIM	1062
	IRL	CIM	1561
UK ATOMIC ENERGY AUTHORITY	UK	ST	300
	UK	ST	1527
UNIV. DEGLI STUDI DI MILANO	I	OS	285
UNIV. NACIONAL EDUCACION DIST.	E	OS	291
UNIV.POLITECNICA DE CATALUNYA	E	AIP	1560
	E	ST	1609
UNIV.POLITECNICA DE MADRID	E	CIM	623
UNIVERSIDADE DO MINHO	P	OS	385
UNIVERSIDADE NOVA DE LISBOA	P	CIM	278
	P	CIM	623
	P	AIP	973
UNIVERSITA DI BOLOGNA	I	AIP	311
	I	AIP	818
	I	MEL	833
	I	AIP	874
	I	MEL	962
UNIVERSITA DI GENOVA	I	AIP	419
	I	CIM	595
	I	AIP	940
	I	CIM	1062
UNIVERSITA DI PISA	I	AIP	527
	I	AIP	530
UNIVERSITA DI ROMA	I	AIP	1117
UNIVERSITA DI TORINO	I	AIP	26
	I	AIP	311
UNIVERSITAIRE INST.ANTWERPEN	B	AIP	1117
UNIVERSITAT BREMEN	D	CIM	1199
UNIVERSITAT DES SAARLANDES	D	ST	390
UNIVERSITAT DORTMUND	D	ST	266
	D	ST	390
	D	AIP	530
	D	AIP	898
	D	ST	1520
UNIVERSITAT FRANKFURT	D	ST	892
UNIVERSITAT HANNOVER	D	CIM	1136
UNIVERSITAT KAISERSLAUTERN	D	AIP	1005
	D	ST	1033
UNIVERSITAT KARLSRUHE	D	CIM	75
	D	ST	266

	D	CIM	322
	D	CIM	623
	D	ST	1072
UNIVERSITAT KASSEL	D	AIP	857
UNIVERSITAT PASSAU	D	ST	390
	D	ST	432
UNIVERSITAT STUTTGART	D	AIP	393
	D	MEL	456
	D	OS	954
UNIVERSITE C.BERNARD DE LYON	F	AIP	530
UNIVERSITE CATHOLIQUE LOUVAIN	B	ST	510
	B	MEL	554
	B	MEL	1128
	B	ST	1520
	B	ST	1598
UNIVERSITE DE BORDEAUX I	F	CIM	418
UNIVERSITE DE GRENOBLE	F	ST	401
	F	AIP	1085
UNIVERSITE DE LIEGE	B	OS	73
	B	OS	890
	B	ST	1158
	B	ST	1535
UNIVERSITE DE NAMUR	B	MEL	443
UNIVERSITE DE NANCY-CRIN	F	OS	121
	F	OS	901
	F	ST	1520
UNIVERSITE DE PARIS SUD/LRI	F	ST	432
	F	AIP	973
	F	AIP	1063
UNIVERSITE DE PARIS VI & VII	F	OS	169
	F	ST	1158
UNIVERSITE DE SAVOIE	F	CIM	932
UNIVERSITE DE STRASBOURG-LSIT	F	AIP	26
UNIVERSITE PARIS 1 SORBONNE	F	OS	813
UNIVERSITEIT VAN AMSTERDAM TNO	NL	OS	64
	NL	AIP	280
	NL	AIP	304
	NL	CIM	384
	NL	CIM	623
	NL	AIP	1098
	NL	OS	1541

UNIVERSITEIT VAN TWENTE	NL	OS	43
	NL	ST	410
	NL	OS	612
	NL	CIM	809
	NL	OS	890
	NL	ST	891
	NL	ST	1158
UNIVERSITEIT VAN UTRECHT	NL	MEL	369
UNIVERSITY COLLEGE DUBLIN	IRL	OS	59
UNIVERSITY COLLEGE GALWAY	IRL	CIM	75
	IRL	CIM	623
UNIVERSITY COLLEGE LONDON	UK	OS	395
	UK	AIP	866
	UK	OS	1541
	UK	AIP	1558
	UK	AIP	1588
UNIVERSITY COLLEGE SWANSEA	UK	MEL	962
UNIVERSITY OF CAMBRIDGE	UK	MEL	245
	UK	AIP	940
UNIVERSITY OF EAST ANGLIA	UK	OS	998
UNIVERSITY OF EDINBURGH	UK	AIP	393
UNIVERSITY OF ESSEX	UK	MEL	991
UNIVERSITY OF LANCASTER	UK	ST	1550
UNIVERSITY OF LEEDS	UK	AIP	280
	UK	AIP	527
	UK	AIP	1592
UNIVERSITY OF LEICESTER	UK	ST	1283
UNIVERSITY OF LIVERPOOL	UK	ST	1258
UNIVERSITY OF MANCHESTER	UK	ST	928
	UK	CIM	1199
	UK	ST	1252
UNIVERSITY OF NEWCASTLE	UK	CIM	278
UNIVERSITY OF OXFORD	UK	AIP	1560
UNIVERSITY OF PATRAS	GR	OS	169
	GR	OS	291
UNIVERSITY OF SOUTHAMPTON	UK	MEL	986
	UK	AIP	1085
UNIVERSITY OF STIRLING	UK	ST	302
	UK	ST	937
UNIVERSITY OF STRATHCLYDE	UK	CIM	197
	UK	ST	390
	UK	AIP	532
	UK	AIP	857
UNIVERSITY OF SUSSEX	UK	OS	1032
UNIVERSITY OF THESSALONIKI	GR	MEL	833
VRIJE UNIVERSITEIT AMSTERDAM	NL	OS	1032

VRIJE UNIVERSITEIT BRUSSEL	B	OS	82
	B	AIP	440
	B	CIM	534
	B	AIP	1035
	B	AIP	1570
WILHELMS UNIVERSITAT WESTFAHL.	D	OS	385

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