

The IST Programme is working towards a vision of the future that places the needs of the user, whether at home, at work, at leisure or on the move, at the centre of IST development. Underpinning the realisation of an "ambient intelligence landscape" are a set of key technologies and approaches that will provide the main building blocks for this user-centred intelligent world.

One of the most important phenomena here is network convergence. The explosive growth of the internet and of mobile and multimedia services demand new approaches to network technologies. End-users require access to broadband services through an increasing variety of interfaces and service environments (home, car, office etc), and to be able to roam seamlessly across different networks. Increasingly, these networks will be all IP-based, reflecting the convergence of fixed, mobile and wireless technologies around internet standards. In addition, Europe has the opportunity to build on its strength in mobile and wireless technologies by developing and integrating next generation internet technologies with future mobile networks.

Multimodal and multilingual interfaces is another key technology cluster. People will find IST applications easier to use if the interfaces through which they access them are more natural and intuitive. Technologies such as speech and gesture recognition, simulation, visualisation, displays, and virtual and augmented reality are important in this respect.

In software, new paradigms are emerging aimed at improving the flexibility of both the development process and the resulting IST applications. These include continuing developments in distributed systems and middleware, component-based architectures and service engineering, together with an increased emphasis on open source software.

Trust, confidence and security is a general requirement for all technologies, applications and services. Developments here focus on technologies and applications to support information security, privacy, suppliers and users rights, and the dependability of systems and infrastructures.

Embedded intelligence is another key theme. Continuing the trend of the last forty years, microprocessors will continue to become smaller and more powerful. In addition to data processing functions, sensing and storage capabilities are being added to microdevices to produce hugely powerful and versatile microsystems, which have important applications from medicine to motor vehicles. These technologies, together with related developments in embedded software, are being integrated within an increasing array of "smart" devices and products to enhance their functionality and performance.

While there is much scope for further integration of processor technologies, there are signs we are approaching the end of the electronic age. Extensive effort is already being devoted to alternative technologies, such as opto-electronics, nano-technologies and, for the longer term, quantum computing and bio-computing.

ENABLING TECHNOLOGIES



Securing Europe's lead in smart cards

Smart cards are emerging as one of the key building blocks of the Information Society. They enable secure access to electronic services and are a vital element in building trust and confidence in e-commerce. Together with secure network infrastructures and appropriate legislation, smart cards provide the privacy and confidentiality necessary for the widespread acceptance of new electronic services by individuals and businesses.

Smart cards are already widely used in Europe but the market is fragmented between countries and sectors. European suppliers market many high quality security products and lead the world in many areas of smart card technology. The challenge now is to integrate these products into widely accepted operating systems and applications software that will ensure Europe is as successful in smart cards in the future as it is already in areas such as mobile communications. In particular, further efforts are needed to accelerate, consolidate and harmonise use across the EU and other European countries.

The European Commission's eEurope initiative, in which smart cards are one of the priority areas, stresses the need to encourage the use of all forms of smart cards for secure access to e-services. In April 2000 in response to eEurope, the European smart card industry endorsed the Smart Card Charter setting out a detailed action plan for developing smart card markets in the EU. The Charter provides a framework for future collaborative actions, in areas such as standardi-

A common platform for smartcards

The smart card industry currently works on a series of different development platforms: JavaCard, Multos from Mastercard and Smart Card for Windows. IST's ISOP1 project is defining solutions which will allow smart card developers to converge on one common, open platform that will operate with these existing architectures.

The work, which is being closely coordinated with European standards agencies, involves definition of an architecture for interoperability and specification of critical interoperability components. A detailed review of business models and security needs is also being undertaken for three leading user sectors: banking, payTV and GSM. Key deliverables will be a series of protection profiles together with tools and APIs for a secure open platform environment. A set of demonstrators will be fully tested in each of the three end-user sectors.

sation, research, demonstration and legislation. A high-level Task Force will build on existing activities and convene working groups on topics such as mobile solutions, e-business and security & trust.

One of the key barriers at present is the lack of common standards for smart cards across different platforms and applications. The ISO 7816 standard promotes smart card interoperability, defining key characteristics such as size, weight, power consumption and data-link protocols. Later industry standards, such as Global System Mobile (GSM) and specifications by the Europay/Mastercard/Visa association (EMV) embraced the ISO standard but set their own application-specific data and encoding rules. Under eEurope and the Smart Card Charter, agreement should be reached on a set of common specifications for smart card interoperability and security by the end of 2000.



Smart cards are a platform for many Information Society applications

Multi-applications smart cards

There is a growing need for a multi-application smart card architecture allowing targeted markets (mainly middle size European cities) to benefit from the numerous advantages of smart card environment without being tied to a unique proprietary application model. SmartCities will design such a smart card. The project also aims to prove the technical and commercial viability of multi-owner data sources gathered from the use of the smart card scheme.

SmartCities will demonstrate the technical feasibility of a plug-and-play management platform by defining an architecture that can support multi-industry standard interfaces. Associated to this standard architecture, SmartCities will also demonstrate how dynamic management of application at the card and scheme level can be achieved.

Another priority identified by eEurope is the usability of smart card systems. The multiplicity of cards and the variety of user terminal interfaces and security requirements hamper the wide acceptance of smart card technologies. Improved human interfaces for smart card terminals, including better usability for users with special needs and support for multiple languages is targeted by the end of 2001. This includes coherent use of contact and contactless cards and seamless use of multi-application cards and terminals.

IST's Cross-Programme Action on smart cards aims to complement the consensus-building and awareness measures being pursued under eEurope. Work focuses on holistic approaches to smart card systems with an emphasis on interoperability, security and mobility. Next generation smart cards are also targeted as well as stimulating the Europe-wide deployment of existing technologies across end-user sectors.

Further info
IST Action Lines:
Project References:

Commission Contacts:
Web:

IST-2000 CPA5
ISOP1
SMARTCITIES
Gérard Galler
www.cordis.lu/ist/cpt/2000cpa5.htm
www.ispo.cec.be/istka2/c4

Smart cards
IST-1999 12619
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Open systems for educational technology

Information and communication technologies (ICTs) are now widely used in education and training, enabling the implementation of new pedagogical paradigms (e.g. distance learning, sharing of course materials, virtual laboratories). While there are many practical benefits in the use of ICT, the production of learning content is expensive. At the same time new learning requirements are emerging, with a shift towards personalised learning services flexibly delivered. Thus, more cost-effective learning environments are required based on open standards and reusable learning objects.

Significant contributions to reusable, interoperable and platform-independent approaches have already been made under previous EU RTD programmes. For example, ARIADNE, a TAP FP4 project, developed a distributed repository of learning objects based on open platforms and metadata standards. Project participants share their educational resources through interconnected educational databases known as the Knowledge Pool System (KPS). Teachers can

combine content selected from the KPS with their existing materials to create courses online relatively quickly and easily. Learners and authors can work from anywhere provided there is Internet access to the nearest KPS node.

ARIADNE, together with other FP4 projects such as REM, has been closely involved with the Instructional Management Systems (IMS) project, an international forum addressing standardisation issues in educational ICT. IMS is focusing on standards for locating and operating interactive platform-independent materials; for the support of collaborative learning; and for the development and sharing of educational content. These IMS standards and tools will enable teachers, learners, software developers and content providers to create, manage and access online learning materials and environments.

This work is being continued under IST's action line on Open Platforms and Tools for Personalised Learning. This aims to prove the

With open systems educational resources are reusable



concept of IMS as a cost-effective way of implementing and maintaining flexible learning services. It also aims to further develop an open architecture for building education and training applications and services. Active contributions to international standardisation activities and to European best practice are also key objectives.

The work focuses on the development and validation of reusable components, and is closely linked to component software engineering. New tools and processes are being developed for producing and maintaining reusable learning objects at different levels of detail ("granularity"). Tools and processes for locating and sharing learning objects are also being developed, including solutions for operational issues such as intellectual property rights, accreditation and payments. Another area of interest is the assembly and maintenance of new types of flexible

learning environments based on reusable learning objects. The work also feeds into longer term research on advanced learning environments and innovative pedagogical approaches.

In technological terms, the main development areas include: learning object manipulation (metadata generators and retrieval systems); learning object authoring systems; security and trust infrastructures (APIs, smartcards); knowledge repositories; and language translation.

The CODEX-IP project is researching tools to develop and maintain language-independent learning objects across IP-based networks. DERIVE is developing a distributed learning environment that allows teachers and students to build their own links between real on-site learning resources, such as PCs or lecturers, and virtual resources, such as simulations and animations. An advanced lecturing system that uses the high bandwidth available to academic institutions to deliver real-time, specialised courses to students in different locations is being developed by VIRTUAL BLACKBOARD.

A repository for learning resources

The EASEL project is addressing the standards-based provision of online learning based on state-of-the-art repository technologies. The objective is to offer educators an environment in which they can readily combine existing learning objects to create new online educational offerings. The work involves the development of an XML metadata repository for storing descriptions of learning objects, assessment modules for interrogating objects, a web-based search gateway and a construction kit. The project is working closely with the IEEE Question & Test working group, which is developing classification and management systems for learning objects.

Further info

IST Action Lines:

IST-1999 III.3.1

Project References:

IST-2000 III.2.2

ARIADNE

CODEX-IP

DERIVE

EASEL

VIRTUAL BLACKBOARD

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Open platforms and tools for personalised learning

The learning citizen

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IST-1999 12021

IST-1999 10417

IST-1999 10051

IST-1999 12670

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Towards all optical networks

All-optical communication networks represent the best means of meeting the bandwidth requirements of future multimedia applications and on-line services. In all-optical networks, the transmission, multiplexing and switching is done completely optically, without performing inefficient opto-electronic conversions. Migration paths to such an all-optical future will differ between operators and between countries. However, it is clear that optical (or photonic) technologies provide a technically-superior, cost-effective solution for meeting future demands on network performance.

Optical communications technologies, which use light as their basic transmission medium, are already widely deployed. Along with increased competition, the wide take-up of fibre optic networks has been a key driver in reducing the cost of long distance calls over the last decade. In addition to telecoms, current uses of optical networks include broadcasting, high-speed corporate networks, and as the backbone for the internet.

For existing installations, the costs of replacing copper networks has been a deterrent in deploying fibre to the home and has encouraged network operators to deliver enhanced bandwidth over existing infrastructure, using technologies such as xDSL. Nevertheless, on current predictions, within the next ten years we are likely to see broadband services delivered direct by fibre to the home in tandem with a WDM optical transport layer.

The IST Programme supports RTD into advanced technologies and architectures that will facilitate the transition to managed all-optical core networks. The work aims at exploiting advances in

optical signal processing, transmission, switching and routing as the basis for networks with capacities in the range of terabits. Emphasis is also given to interfaces with other fixed and mobile access networks and to network management functions.

In the METEOR project, for instance, the partners are designing and demonstrating a terabit metropolitan area network based on optical technologies. The network will be realised on an optical ring with 40 dense wavelength division multiplexing (DWDM) channels operating at bit rates up to 40 Gbit/s. LION addresses interoperability issues in optical networks, focusing on the interworking and interconnection between layer transport networks and domains (e.g. SDH, ATM, IP-based). ATLAS is studying WDM transmission in 1 terabit fibre links over a range of 500-1000 km. The results will help assess maximum signal distortions that can be tolerated in future all-optical networks.

A roadmap for European photonics research

OPTIMIST is a thematic network for IST projects in the areas of photonic technologies and optical networks. It facilitates the exchange of information and best practice across IST work areas related to photonics, in particular between projects focused on components and basic research, and those concerned with systems. It also leads interaction with industry and with international bodies on research requirements. Following on from work by the ACTS project HORIZON, OPTIMIST is developing a "Photonics Roadmap", setting out the development perspective for the medium to long term.

Further info
IST Action Lines:
Project References:

IST-2000 IV.2.4
ATLAS
LION
METEOR
OPTIMIST

Terabit core networks
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Building blocks for end-user services

In the vision of the future "ambient intelligence landscape", users have access to a whole variety of services through a new generation of "smart" information appliances, such as mobile phones, personal digital assistants, digital cameras, in-car navigation etc. A digital camera, for example, could have the ability to identify its position (using GPS data), to store that information with the image, and then transmit the image to a storage device or other destination (via UMTS). The introduction of new end-user services into networks and appliances presents major challenges for service engineering, however. Whereas users are looking for seamless services with a high level of functionality, the underlying building blocks are derived from many different infrastructures.

These include global positioning systems, mobile networks, micro-payment services, geographical information systems, web-based services etc.

In the past, service engineering was concerned predominantly with network management aspects, such as ensuring that networks provide the necessary resources (bandwidth and other elements of quality of service) to run an application. As new services are introduced, delivered through different devices and infrastructures, the emphasis is shifting to the integration of these networked services within user-friendly devices and appliances.

The IST Programme is supporting the extension of service engineering to include reference models of the overall services and of the activities they support. Reference models are open and extensible frameworks for meta-information on services and their components. They provide semantic information (what functionality the component or service has), as well as describing dynamic behaviour (how it interacts, collaborates and negotiates with other components or services). One potential application, especially relevant for Europe, is in localisation of devices and services to take account of factors such as languages or other service requirements. The automated brokering of service components within mobile environments is also likely to emerge.

Value chains are changing and in consumer sectors, in particular, intrinsic value lies increasingly in embedded services rather than in the products themselves. Equipping information appliances with the ability to assess the resources or service components available within a host network is critical for the new generation of adaptive, user-friendly mobile services.

Modular tools for audio recognition

A new, very fast and robust approach to the analysis of audio information is being investigated by RAA. The application within the project is in the field of intellectual property asset management, but the developed technology can set the basis for an end-user service building block. The system will be able to recognise audio titles based on a unique "fingerprint", derived automatically from an innovative recognition process. This fingerprint will be compared to a reference fingerprint held in a central database. Once registered a title can be identified every time it is available on one of the observed audio sources. The database of fingerprinted titles may be used to collect royalty payments, detect copyright violations, derive statistical information, law enforcement etc. The partners plan to apply the re-useable modular tools developed in the project within a commercial detection and recognition service.

Further info
IST Action Lines:

IST-1999 IV.3.2
IST-2000 IV.3.2
IST-2000 IV.3.3

Engineering of intelligent services
Software engineering for generic end-user services
User-centred interaction and functionality design
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Systems you can depend on

In the Information Society, an increasing range of industries, organisations and users depend on software-based control systems, communication systems, applications and services. As they become ever more essential to economic, commercial and social activities, interest in the trustworthiness of ICT systems is increasing.

The systems concerned are highly complex, widely distributed and may include legacy and/or off-the-shelf commercial software components. Increasingly, they are also characterised by high mobility and flexibility. They cover safety-, mission- and security-critical applications as well as applications critical to an organisation's day-to-day business. A broad range of emerging application areas are also covered, such as embedded systems in consumer goods, health, personal communications, e-commerce and transport. The novelty of the applications, the extensive deployment of the new technologies and their common characteristics raise new problems and challenges for dependability.

Dependability is a generic term that is difficult to define or measure. It embraces attributes such as: availability (readiness for usage); reliability (continuity of service); safety (non-occurrence of catastrophic or risky events); and security (avoidance of threats to privacy or loss of valuable assets).

As a common driver across many areas of the IST Programme, dependability is addressed through a Cross-Programme Action (CPA). The CPA aims to contribute towards raising and assuring trust and confidence in heavily connected systems and services by promoting dependability technologies. The goal is to foster a dependability-aware culture in Europe for ICT components, systems, applications and networks throughout their whole lifecycle.

Work under the 1999 Work Programme

Design tools for fault-tolerant architectures

Fault-tolerant (FT) circuits are required in several major application sectors. Although the circuit structures that allow developers to build fault-tolerant architectures have been well studied, CAD tools to support the design and evaluation of FT systems are lacking. As a consequence, these tasks have to be undertaken manually, resulting in reduced productivity, reliability and efficiency.

AMATISTA is developing a set of tools devoted to the design of FT digital circuits. The toolset will be technology-independent, based on real-time VHDL, and will be tested by integrating in the design flow of automotive and aerospace companies.

addressed the full range of dependability requirements, with an emphasis on risk and incident management tools, and infrastructures and services that are self-monitoring and/or self-healing. WP 2000 has focused on the vulnerabilities of large-scale systems emerging from the tight connectivity of critical service and information infrastructures, for e-commerce for example. Both aspects build on a wide variety of work undertaken previously under Esprit, ACTS and Telematics.

Interoperable trust frameworks and information assurance is a key interest. The open nature of the internet requires that key security issues, such as confidentiality, authentication and integrity, be resolved to provide users with a safe environment for web applications. HARP is integrating existing technologies and tools into a security platform based on trusted third parties. The security solution developed will be demonstrated in two applications: e-commerce and telemedicine.



Many aspects of our lives depend on computers

Attack tolerance in large-scale networks

MAFTIA is investigating the dependability of distributed applications for very large and heterogeneous computer networks, such as internet-based supply chain management, e-commerce auctions, and the IT infrastructure of large companies and administrations.

Current security paradigms aim to prevent malicious attacks from leading to any intrusions into the network. For example, most systems using a public key infrastructure (PKI) put all trust in a single trusted third party (TTP); if this party fails then security can no longer be guaranteed. And intrusion detection systems rarely consider or protect against the possibility of attacks from inside. MAFTIA is pursuing an attack-tolerance approach in which systems are able to automatically identify and respond to accidental faults or malicious attacks and continue to provide a full operational service.

Other areas supported under this CPA include: advanced design tools for aircraft systems and airborne software (SAFEAIR); new methodologies for the engineering of software-based critical systems in industry (MATISSE); and the evaluation of time-triggered architectures as a generic architecture for highly dependable real-time systems (FIT).

With the increasing global interconnection of critical IT infrastructures, dependability is an international concern. At a policy level, the EU has an active dialogue with the US, Japan, accession states and others countries on dependability issues and international co-operation is also an important element of RTD.

Further info

IST Action Lines:	IST-1999 CPA.2	Dependability in services and technologies Large scale systems survivability
	IST-2000 CPA.4	
Project References:	DSOS	IST-1999 11585
	HARP	IST-1999 10923
	FIT	IST-1999 10748
	AMATISTA	IST-1999 11762
	SAFEAIR	IST-1999 10913
	MATISSE	IST-1999 11435
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	www.cordis.lu/ist/cpt/1999cpa.htm	
	www.cordis.lu/ist/cpt/2000cpa4.htm	

Broadcasting goes interactive

Telecommunications and digital broadcasting are both sectors where Europe has acquired a significant technological and commercial leadership. Until recently, the two industries have followed parallel paths, with conventional telecommunications operators being mainly interested in the technology used for information transport and delivery, and traditional broadcasters being interested in content. Nowadays, despite the intrinsic technological differences between these two sectors, the question is being openly asked as to the likelihood of their convergence, not only at technological level, but also at service level.

Broadcasters are progressively introducing an element of interactivity in their traditional point-to-multipoint channels and telecommunications operators are confronted with traffic streams which are inherently asymmetric. Closely related to these developments are the phenomenal growth in mobile communications and the development of internet-based services. Broadcasters that have started to use internet as a delivery mechanism are contemplating the use of mobile communications systems, such as GSM and UMTS, to enhance their multimedia content. Similarly, mobile operators are seeking to offer users access to such content and in so doing provide a whole new range of value added services.

This service convergence raises a number of questions of a technological, regulatory and economic nature, perhaps requiring novel approaches for spectrum allocation. For local distribution, various wireless technologies have either been brought to the market or are the subject of experimentation, particularly from a technological and service perspective. A new market referred to as "interactive broadcasting" is about to be created.



Interactive broadcasting will bring consumers new services

Within FP4, the area of Interactive Broadcasting was the subject of innovative work by a number of projects, and major contributions were made to the development of both mobile and digital broadcasting technologies (e.g. ACTS projects ITTi, ISIS, MEMO, S3M, Interact).

The IST programme has provided further opportunities for addressing the technological and service dimensions of Interactive Broadcasting. For instance, the WITNESS project aims to upgrade, test, and validate equipment and planning algorithms to aid the standardisation of a digital terrestrial television return channel that can be implemented across Europe, and in other territories adopting the DVB standards (see box).

Based on fixed radio access technology, EMBRACE is developing low-cost and efficient broadband wireless access systems and services for the mass market, drawing on results obtained from successful LMDS trials carried out under ACTS. It will define a broadband cellular interactive system with very flexible frequency allocation schemes combining broadcast, data and telecommunication services.

The EMBRACE system can be used for both point-to-point and point-to-multi-point/broadcast operation. A prototype will be developed using MPEG-2 in the downlink and an uplink using multiple frequency time division multiple access, for both entertainment and professional uses, allowing for a return capacity of at least 25 Mbit/s. The return channel will use flexible solutions, regarding frequency allocation and efficient capacity sharing between uplink and downlink. Potential markets for such a system range from advanced residential users to small businesses, schools and local authorities. Interoperability scenarios including GSM and UMTS, both as actual delivery systems and return links, are items for study, for example in the Eastern European market.

Towards interactive digital TV

The WITNESS take-up action is developing complementary wireless technologies for mass personal connectivity to advanced multimedia communication networks. The technology developed by the DVB Return Channel Group (the iTTi terminal) is to be duplicated, adapted and upgraded to allow for low cost and standardisation in the DVB framework. This will benefit both the consumers and the network equipment manufacturers. Indeed, DVB-TRC technology is a major step towards the provision of an integrated seamless network, which has the potential to provide personal connectivity from anywhere at any time. This emerging DVB-TRC standard will be evaluated and results of the WITNESS field trials and planning recommendations will be made available to the ETSI DVB initiative.

The optimal allocation of the allowable bandwidth in the distribution of high quality interactive multimedia DVB/IP services is also the subject of MAMBO. The project will build a real-time demonstrator and implement relevant applications such as UMTS multicast channel, video messaging and distant learning. The system will be tested in different configurations, with DVB-T or UMTS in the downlink and LMDS, GSM or UMTS in the return channel.

IBIS proposes the definition and specification of a satellite system approach, where the broadcast and the interaction network parts are integrated. It will also provide a cost-effective solution to support Interactive TV, internet and multimedia services, as well as the inter-working with the terrestrial network.

Further info		
IST Action Lines:	IST-2000 IV.5.2	Terrestrial wireless systems and networks
		Satellite systems and services
Project References:	IST-2000 IV.5.3 WITNESS EMBRACE IBIS MAMBO	IST-1999 20051 IST-1999 11571 IST-2000 25091 IST-2000 26298
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Web:	www.cordis.lu/ist/ka4/mobile/index.htm	

Setting the multimedia standard

Standards are crucial building blocks for the Information Society. They allow products and services from different providers to work together, allowing consumers wider choice while assuring them that systems are technically compatible. Standards also have benefits for industry, minimising the risks that an innovation is heading towards a technological "dead end". In short, standardisation provides a level playing field.

Over recent years, European research has successfully influenced international ICT standardisation in a number of areas. The GSM standard, for example, has been a significant factor in the growth of the market for personal mobile communications in Europe. Euro-ISDN has also contributed to the high penetration of ISDN networks in European countries. The Digital Video Broadcasting (DVB) group was successful in adopting open, interoperable and market-driven specifications for the development of digital TV, with support from the EU's ACTS programme and its forerunner RACE.

In the area of multimedia, international standardisation is led by the Moving Picture Experts Group (MPEG), a working group of the International Standardisation Organisation (ISO). MPEG has developed a family of standards for compression, decompression, processing and coded representation of moving pictures, audio and combined media. These efforts have involved substantial contributions from RTD activities undertaken within ACTS, Esprit and Telematics, an involvement which is being continued under the IST Programme.

To date, MPEG has produced consolidated standards for the storage and retrieval of video and audio content (MPEG-1), and for digital television (MPEG-2). MPEG-4 is a new standard for multimedia applications that allows audiovisual objects to be described semantically i.e. according to their contents. Currently MPEG is also working on a new standard for open interfaces for audio-visual content (MPEG-7). Discussions are also underway to set up the next phase (MPEG-21) which will address the end-to-end delivery of multimedia services.

MPEG-4 and MPEG-7 specify advanced ways of coding and manipulating multimedia assets. MPEG-4 improves the coding efficiency by splitting up the audio and video content into a set of objects that behave in predictable ways. This means the objects can easily be extracted and combined with objects from other signals – either real or computer generated – to create something totally original. MPEG-4 also ensures backward compatibility and features provisions for intellectual property management and protection.

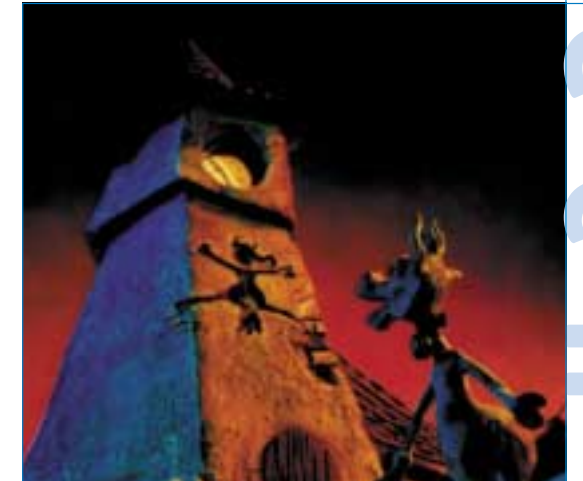
After pixel-based representation in MPEG-1 and 2, and object-based representation in MPEG-4, MPEG-7 represents a new conceptual jump towards semantic-based representation. It proposes a standard language for describing and labelling multimedia objects that is platform independent and will enable editors to identify, browse and select items from vast multimedia databases.

An important motivation behind the MPEG-7 initiative has been the increasing importance in managing and protecting digital content throughout its lifecycle. The benefits go beyond database search and retrieval. The objective is to make audio-visual material as accessible and manageable as text information is today and to design tools for media conversion, potentially transforming the way we access, manage, use and redistribute information.

With the management of multimedia content a widespread requirement, the new and emerging MPEG standards (MPEG-4, -7 and -21) underpin applications and systems development in many industries. In the broadcasting and music industries, for example, the new standards are the "glue" in the digitisation of the production chain. With strong search and retrieval capabilities for multimedia content, they also bring benefits for publishers and digital libraries and archives. Eventually the new standards will be applied in consumer markets too, such as digital video cameras and the multimedia home platform.

The diversity of the standards is reflected in the breadth of IST projects undertaking relevant work. OCCAMM is addressing the controlled access, including IPR management, of multimedia content, such as music, educational material and still digital images, based on the MPEG-4 framework. OPENISE is developing an open and scalable platform for the delivery of interactive services, based on MPEG-2 and MPEG-4 standards.

Other projects focus on the implications of new MPEG standards for the broadcast and internet industries. NexTV is investigating new business models for interactive digital television that



New standards will improve the management of audio-visual assets

incorporate the MPEG-2 and MPEG-4 standards. MyTV is designing a consumer platform for personalised digital TV services that utilises MPEG-4's content description capabilities. A consumer terminal that will enable interactive access to both digital TV and internet services is being developed by SAMBITS, a project which is a major European contributor to the MPEG-7 standard.

Further info		
IST Action Lines:	IST-2000 III.1	Interactive publishing, digital content and cultural heritage Information access, filtering, analysis and handling User and service interfaces and buffers for seamless end-to-end services
	IST-2000 III.4	
	IST-2000 IV.6.2	
Project References:	SAMBITS NexTV MyTV SoNG OCCAMM OPENISE	IST-1999 12605 IST-1999 11288 IST-1999 11702 IST-1999 10192 IST-1999 11443 IST-1999 11590
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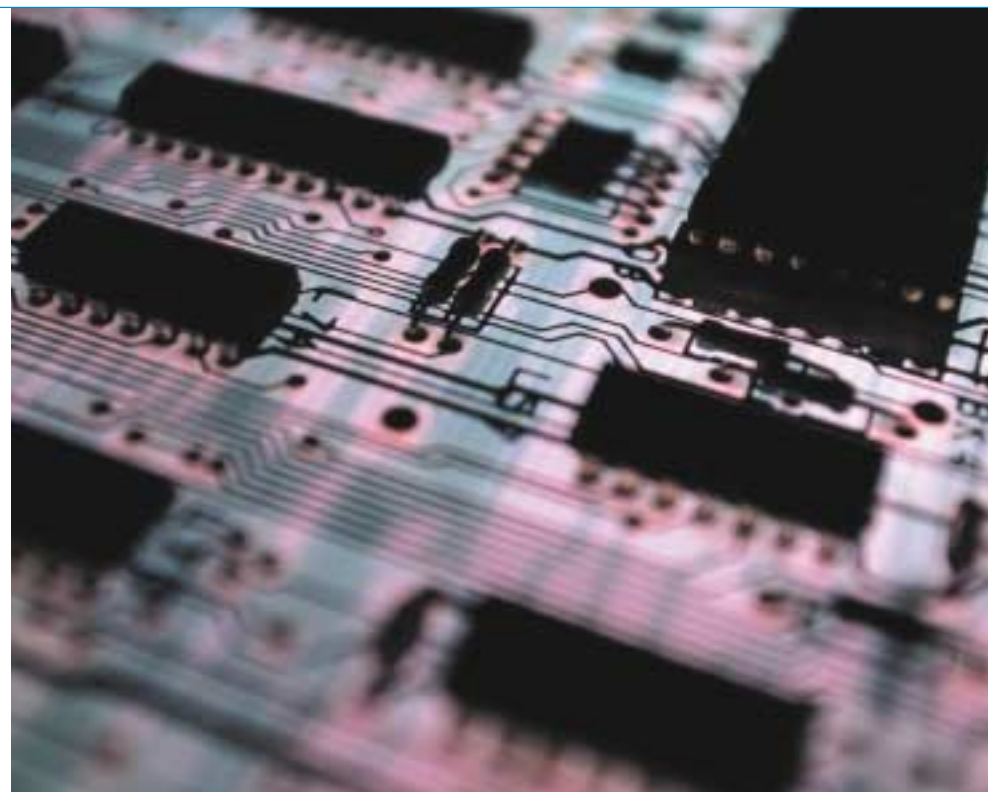
Bridging the semiconductor design productivity gap

In the microelectronics industry, design tasks are becoming increasingly demanding. Information appliances are gaining in complexity and design cycles are shortening as product lives decrease. More features are being defined in software rather than in hardware. As the system integrator also becomes involved in the chip design process, semiconductor design is increasingly demanding and necessitates a wider range of disciplines and partnerships.

In parallel with these trends, productivity gains in IC design (typically 20% per year) are significantly lower than those in IC manufacturing (over 40% per year), meaning that the effort for designing the most complex circuits drastically increases each year. This "design productivity gap" represents a major challenge for the whole microelectronics industry.

The IST Programme addresses these challenges by supporting the development of advanced methodologies and tools for microelectronics design and test, in particular by increasing the level of design abstraction, re-use of IP, and setting up application-specific design platforms. It aims to improve the competitiveness of European semiconductor and telecom industries in a global market and to concentrate the research community on industrially relevant topics. The work focuses on systems-on-silicon for information and communication terminals, and for communication systems and networks. Priorities include low power design, hardware/software co-design and verification, and reuse of IP.

Increasing complexity presents a design challenge for the microelectronics industry



In the area of system integration on silicon for communication systems and networks, PRO3 targets the design of software and hardware for the efficient execution of telecoms protocols in embedded programmable architectures. LEMON aims to improve the design of analogue and RF circuits integrated with CMOS logic in the context of a third generation W-CDMA transceiver. And INSONET is developing advanced intellectual property (IP) blocks for communication on power lines in small office and home networks.

Several projects focus on improving the re-usability of IP. ODETTE aims to reduce the design time and cost of digital embedded HW-SW systems by enabling the application of object-oriented design methodologies for the entire design and test, including (co-) simulation and synthesis. SYDIC-TELECOM will

improve access to system design know-how in the telecoms industry, while still protecting commercial intellectual property. It focuses on reuse methodology at the system level, rather than at the implementation level.

A generic environment for design and fast prototyping of complex digital applications, based on field programmable gate arrays (FPGAs), is being developed by FLEXBENCH. The system will address a very wide range of applications and will allow the significant reuse of validated design steps.

Other projects address enabling technologies for specific applications. PALOMAR is developing components for radio frequency identification systems that will operate over distances of up to four metres in the 2.45 GHz band. The work involves developing low power, low voltage integrated circuits for 2.45 GHz with EEPROM and power generation. AUTOMACS is aiming to optimise reliability and cost of circuits for high-power, high voltage applications in automotive electronics, based on DMOS logic technology.

Next generation professional mobile radio systems

Within Europe, TETRA trunked radio systems, of the type used by the rescue services, are currently implemented in the 380-430 MHz frequency range. Future European requirements for TETRA capacity will not be met by the current frequency allocations, and will need to operate in the 800-900 MHz band. The TIGRA project is developing the first integrated TETRA transmitter using SiGe technology for the 800-900 MHz range.

Further info		
IST Action Lines:	IST-2000 IV.8.1 IST-2000 IV.8.2	Microelectronics design and test Application-specific microelectronics
Project References:	AUTOMACS FLEXBENCH INSONET LEMON ODETTE PALOMAR PRO3 SYDIC-Telecom TIGRA	IST-1999 12257 IST-1999 11136 IST-1999 10358 IST-1999 11081 IST-1999 11476 IST-1999 10339 IST-1999 11449 IST-1999 11376 IST-1999 10178
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Web:	www.cordis.lu/ist/ka4/mel/index.htm	

FET: The nursery of new ideas

Research is like exploration. The treasures sought could be close at hand, in an area one knows well, or they could lie in a completely different and unexpected direction. As researchers we have to probe our surroundings carefully but also keep an eye to the distant horizon. The Future and Emerging Technologies (FET) action aims to balance the targeted approach of the key actions with a more visionary and exploratory perspective that will ensure the emergence of new ideas and new research activities for tomorrow.

Specifically, FET promotes research that is of a longer-term nature or involves particularly high risks – compensated by the promise of major advances and the potential of industrial or societal impact. It does so by looking with an open mind towards the horizon of emerging research opportunities. It can be seen as the 'nursery' of novel and emergent ideas, some of which may become the mainstream topics of the future. As such, FET is not constrained by the priorities of the key actions but aims to open new possibilities and set new trends for future research programmes.

Two complementary approaches are employed: one pro-active, the other receptive and open.

The pro-active scheme has a strategic character, setting the agenda for a small number of specific areas that hold particular promise for the future. Proactive initiatives run as targeted, mini-research programmes consisting of a set of autonomous but complementary projects. Projects are expected to coordinate their research and to maintain adequate interaction and information exchange with others. This can be reinforced by a network of excellence to assist cross-project networking and coordination, and in some cases by shared research facilities. Topics addressed so far include nanotechnology information devices, the "disappearing computer", neuroinformatics and quantum information processing & communication.

FET Open Funding Scheme

FET Open offers funding for work that could lead to breakthroughs or major advances, in particular the realisation of bold ideas that would involve high risks, or high quality longer term research with sound objectives (see main text). A specific flexible funding scheme aims to remove some of the obstacles that can hinder the realisation of such work.

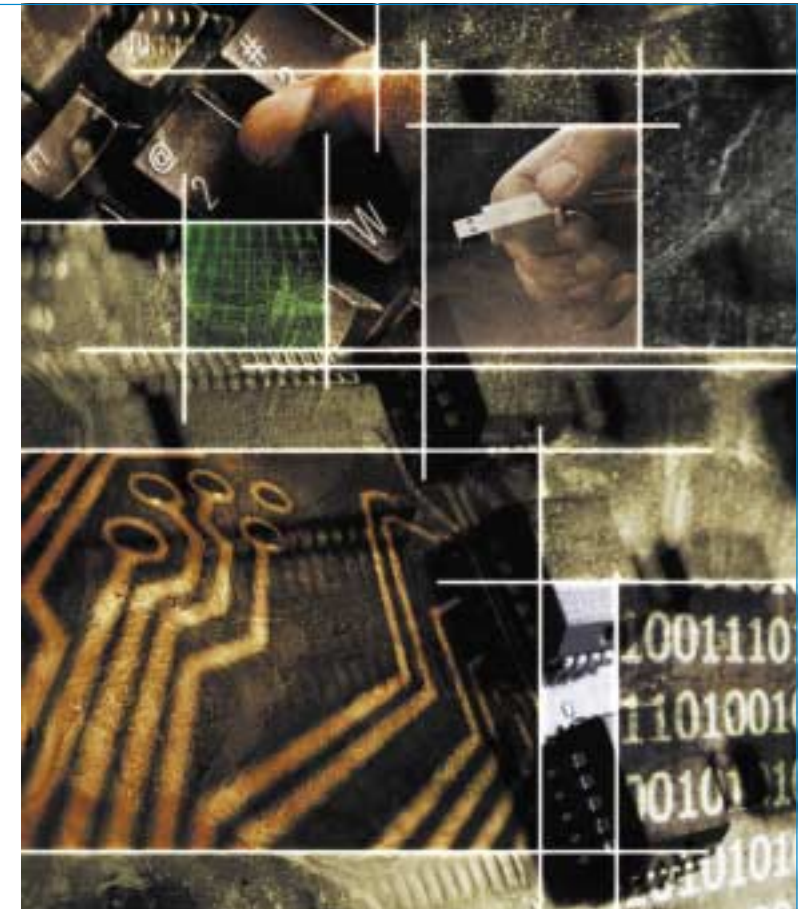
The single entry point into FET Open is a short proposal which describes, in a maximum of five pages, the "what" and "why" of the idea. Those short proposals that pass the evaluation successfully can proceed to writing a full proposal either directly or via an assessment project.

An assessment project is typically up to one year duration and gives the opportunity of validating an idea or demonstrating an underlying part of it. In particular it offers the opportunity of testing a concept in a way that should prove its feasibility.

The full proposal in FET Open follows the standard format for RTD proposals. It describes the "what", "why" and "how". Full-scale projects are supported under a standard research contract, typically of up to 3 years duration.

The other scheme, FET Open, employs the inverse approach : it has no 'top-down' prescription and aims to enable a range of ideas for future and emerging technologies to be explored and realised. The scheme is open at any time to the widest possible spectrum of research opportunities. Its scope includes not only the development of new technologies but also encompasses new ways of doing things as well as creating new roles for technology. Proposals are receivable at any time, for practically the whole duration of the IST Programme.

FET nurtures tomorrow's technologies



In reality, many breakthroughs have depended on sparks of the imagination that resulted in leaps and bounds that were inherently unpredictable. Sometimes new and highly unconventional ideas can seem impractical; yet trying out what seems to be risky can often materialise into a new line of research or new ways of doing things that can ultimately become trend-setting. For this reason, it is important to have an environment within which invention and creativity can thrive. Therefore, FET Open welcomes bold ideas whose realisation would involve high risks.

At the same time it would be wrong to think that it is only 'wild' ideas that lead to major advances. Research can often take a long time to come to fruition. Ideas that have matured past the 'wild phase' and been tested and proved valid to some degree may still need persistent and long term work to take them to levels acceptable for industrial or commercial take-up. These too are supported under FET Open.

Further info
IST Action Lines:
Commission Contacts:
Web:

IST-2000 VI
IST-2000 VI.1.1
Kostas Glinos
www.cordis.lu/ist/fethome.htm

Future and emerging technologies
Open domain
konstantinos.glinos@cec.eu.int

Simulation and visualisation for complex systems

Simulation and visualisation technologies have progressed tremendously over the last ten years. Once confined to supercomputers and high performance networks, today the barriers of high power, speed and costs are falling and high quality computer graphics are widely used everywhere, from drug development to children's games.

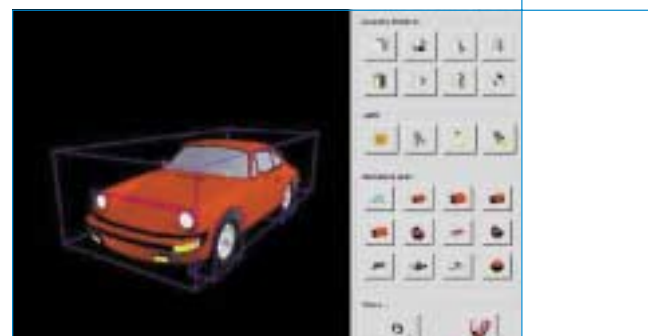
Simulation, involving virtual models of real-world processes, can bring many benefits for users. One benefit is the ability to reduce costs of complex activities, such as product assembly, through a virtual run-through before implementation. Another major application area is in risk-free environments for practising complex tasks, such as medical surgery or nuclear operations. Simulation is also widely used to model complex systems, such as industrial processes, weather forecasting and traffic flows.

Visualisation is closely related to simulation: it allows researchers to study scientific, technical and medical phenomena in ways which provide new understanding and insight. Using graphical representations, users are able to compress a lot of data into one picture to reveal new correlations between different quantities, and to view data selectively and interactively in real time. Visualisation techniques are now widely applied on PC platforms, with important application areas in physical sciences, engineering, biomedicine and virtual laboratories.

As well as advances in processing speed, simulation and visualisation have benefited from developments in software algorithms, which permit much smoother manipulation and representation of data. Programming models have evolved from specialised applications to object-oriented models which allow components to be reused. Open source solutions are increasingly in evidence. Access platforms have changed too. No longer confined to single networks, simulation and visualisation applications are increasingly deployed across distributed environments which provide users with access to common applications and datasets.

Projects supported under the IST Programme's 1999 Work Programme were mainly concerned with specific applications. These include virtual product prototyping (DIVIPRO), flood prevention (ANFAS), remote hazardous operations (TELEDIMOS), and modelling of the human respiratory system (COPHIT). REALSIM focuses on real-time simulation for the design of large-scale, complex systems based on the Modelica modelling language. A generic architecture for multi-user simulation environments is being designed by MADISON, based on MPEG-4 and internet standards. And a collaborative virtual environment for concept design is being developed under AIT-VEPOP. Other projects are concerned with trials and take-up measures in a variety of application areas.

Under IST's WP 2000, the emphasis is on RTD for new generic simulation tools. The application of open tools to support large-scale, real-time simulation within distributed environments is one priority. Another theme is middleware solutions to interface computer graphics, design technologies and model specification tools. This takes particular account of interoperability and the interfacing of simulation models and real-time control systems. Advances in the use and 3D visualisation of large datasets, and in collaborative pre- and post-processing of simulation data are also addressed.



Manufacturers can cut costs with collaborative prototyping tools, such as this one developed under Esprit project Cavalcade

An efficient man-machine interface is fundamental to any simulation exercise, especially in the real-time control of complex systems. Hence, drawing on work under Key Action III, the semantic representation, interactivity and usability of simulation and visualisation data is also an important focus. This includes the distributed visualisation of, and data mining from, very large data sets, and the incorporation of real-time multi-sensory techniques, such as feel and sound, into virtual environments.

A simulation environment for healthcare

Healthcare is an important market for simulation and visualisation applications. SIMBIO is developing a generic simulation environment for advanced clinical practice and healthcare. This environment will combine sophisticated medical imaging, high-level image processing, finite element techniques, and parallel and distributed computing technologies. The system will be validated in three medical applications: electromagnetic analysis of the brain; bio-mechanical simulations of the human head; and the design of knee joint replacements.

For the future, IST will address the potential to apply simulation technologies to the design and development of real-time and very large systems, such as the IT infrastructure itself. IT networks are increasingly complex, requiring the inter-working of many different technologies and subsystems. Real-time simulation (RTS) and large-scale simulation (LSS) are means to validate, test and optimise the design and operation of such complex systems. In particular, they offer a way to test the dependability and robustness of large-scale networks not available through any other means. Potential applications include service engineering and management, traffic engineering in mobile networks and in the internet, and interoperability between loosely-coupled network domains.

Further info	IST Action Lines:	IST-2000 III.3 IST-2000 III.4	Human language technologies Information access, filtering, analysis and handling Real-time simulation and visualisation technologies and services
		IST-2000 IV.4.1	
Project References:	AIT-VEPOP	IST-1999 13346	
	ANFAS	IST-1999 11676	
	COPHIT	IST-1999 14004	
	DIVIPRO	IST-1999 11421	
	MADISON	IST-1999 12100	
	REALSIM	IST-1999 11979	
	SIMBIO	IST-1999 10378	
	TELEDIMOS	IST-1999 10116	
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	www.hltcentral.org		
	www.diffuse.org/iaf		
	www.cordis.lu/ist/ka4/vision		

Innovation in advanced displays

Display technologies are essential to information systems and devices. Users will access the next generation of networked applications and services through intelligent, accessible interfaces, of which displays will remain a major part. Flat panel displays are already key components of many systems and are becoming a very large part of the ICT equipment market. The EU is one of the largest user of flat panel displays, with production higher than in the US last quarter of 1999, but still imports a large share of its needs. EU RTD programmes have supported a wide variety of research, both into advanced display technologies and into basic components and materials. Esprit, for example, funded 18 projects relating to advanced display technologies under FP4, providing total funding of Euro 38 million. Many of these have already led to or are proceeding towards commercialisable results.

MINDIS, for example, is developing an advanced display based on silicon backplane anti-ferro-electric liquid crystal (AFLC) technology that should have cost and performance advantages over cathode ray tubes and monochrome electroluminescent technologies. The display, which will be available at an SXGA resolution (1280x1024), should have applications in high resolution miniature displays for devices such as virtual reality headsets, and projection engines for large area (e.g. 1-3 metre diagonal) high resolution information displays. MOSAREL is also developing silicon backplane displays for very high resolution (GXGA) applications in rear projection and head up displays using the twisted nematic liquid crystal effect.

Work under the IST Programme addresses the need to find intuitive ways to capture, deliver and interact with advanced information systems. The main focus is on improving the usability of

Next generation X-Ray detectors

Building on technologies for active matrix displays, the MEDID project has developed a large area 40 x 40 cm² high resolution solid state X-Ray detector. The device can replace traditional X-Ray films for medical applications, offering added functionality for the Doctor and a lower exposure dose for the patient. It has already been tested successfully in several hospitals. The image is displayed within seconds and can be processed for diagnostic assistance, added to the patient's personal archive, or transmitted digitally if necessary. The Trixell company has been created by Thomson-CSF, Philips and Siemens to manufacture the detector and make it commercially available in September 2000.

portable devices often limited by their display performance, size and endurance; adding value to existing display technologies through the development of new materials, processes and components including their system integration with sensors/actuators; and innovative concepts for high performance applications like large-scale projection and immersive virtual reality and augmented reality applications. Thin flexible displays for smart cards, electronic paper, visualisation and wearable computers are another key interest. As in previous programmes, there are close links to basic research on new materials, which in FP5 is being undertaken under the Growth Programme.

IST's ADCIS project is developing an information display system for cars based on medium voltage field emission display (MVFED) as an alternative to AMLCD solutions. This flat and slim display technology is the closest to the well-known cathode ray tube (CRT) and offers very wide viewing angle, operation even under cold conditions and low power consumption. The new CANADIS project is extending the FED approach to large size displays using a carbon nanotube material as electron emitter. If successful it will make large displays CRT-like economically feasible.



Display technologies offer much scope for innovation

Other novel technologies being pursued under current IST projects include low cost passive black and white and colour displays based on polymer light emitting materials invented in Europe, (HIGHLIGHT); low-cost, high-performance PDP technologies (PLADIS); optical compensation films for liquid crystal displays (OCDIS), a car driver assistance system based on a new flat and slim see-through head up display (OEDIBUS); and low power large colour message boards based on 2D tiling of LCD pixels for highways and city public information (CROMATEAM).

Increasingly, advanced displays are being integrated with sensors and actuator technologies and with multi-sensory interfaces as part of seamless end-to-end services. The aim is to

achieve a mode of integration that is relaxed, natural, enjoyable and intelligent: "lean back" rather than "lean forward".

For instance, the head-up display of OEDIBUS is integrated with a variable transmittance device and light sensor adjusting background scenery brightness for a comfortable and safe viewing. An innovative GSM camera that will allow live image transmission over GSM communications networks is being designed by AMOVITE. The work involves the development of a dedicated sensor technology including on-chip pre-processing, redesign of the camera electronics, and the design of hardware and software required to connect and drive the GSM transmitter and the LCD display.

Further info

IST Action Lines:

Project References:

IST-2000 IV.6.1

MOSAREL
MEDID
MINDIS
ADCIS
AMOVITE
HIGHLIGHT
OCDIS
PLADIS
OEDIBUS
CANADIS
CROMATEAM

Advanced displays and sensors

ESPRIT 25340
ESPRIT 21807
ESPRIT 26300
IST-1999 10194
IST-1999 11156
IST-1999 12339
IST-1999 12085
IST-1999 10692
IST-1999 20394
IST-1999 20590
IST-1999 20614

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Building critical mass in semiconductors

The long-term competitiveness of the European microelectronics industry depends on world class research facilities and skills. In many cases, however, researchers and SME's are lacking access to the appropriate advanced and well-equipped facilities for the practical implementation of new ideas. In this highly knowledge-intensive field, skills shortage is also a major concern. These factors are hindering the take-up and nurturing of new semiconductor technologies in Europe. The IST Programme supports a variety of measures and projects that provide smaller research groups with access to advanced infrastructure for research and to prototype fabrication of microelectronics designs.

EURACCESS is a network of European research infrastructures that enables academic and industrial institutions to validate new research ideas and concepts, and to study their industrial feasibility. It takes particular account of the longer term research needs set out in the International Technology Roadmap for Semiconductors (ITRS)

EUROPRACTICE provides low cost possibilities to academics, research laboratories and SME's to use vendor CAD tools and to access technologies of foundries for IC prototyping and small volume manufacturing. The project has already been serving as a broker for such services to an impressive number of customers for several years. Best practice actions promote the first use of existing micro- and opto-electronics technologies for specific products. They may choose the support of the above projects to access facilities or services.

The 300SiSC project supports the on-going migration to 300 mm silicon wafers. Working in close collaboration with the Semiconductor Equipment Assessment (SEA) initiative (see box), it offers equipment suppliers low cost services for 300 mm wafers processing. As no single site is able to offer this facility, 300SiSC co-ordinates such services from wherever they can be provided at the required quality and cost.

IST also supports training fellowships in advanced microelectronics both to address the skills shortage and to strengthen critical disciplines needed for future development. Students at pre- and post-doctoral levels are assisted in carrying out innovative research, jointly supported by industry. Short courses are also arranged. Areas already addressed include: silicon-germanium in industrial fabrication lines (SIMIF) and next generation lithography using vacuum ultraviolet 157 nm laser sources (DELPHI).

Promoting European semiconductor equipment

Semiconductor Equipment Assessment (SEA) establishes strategic links between European equipment manufacturers and semiconductor manufacturers worldwide. It ensures that state-of-the-art equipment and innovative process techniques meet all the production manufacturing requirements of the mainstream users. In so doing, it bridges the productivity gap which can arise between process innovation and equipment as technology rapidly evolves. The SEA office (SEAD) standardises the assessment specifications and disseminates the results through effective channels to the global market place.

Further info	IST Action Lines:	IST-2000 IV.8.7	Application-specific microelectronics and optoelectronics – take-up measures Industrial microelectronic technologies: processes, equipment and materials – take-up measures Research training in microelectronics Improving human capital in IST
		IST-2000 IV.8.8	
Project References:		IST-2000 IV.8.9	IST-1999 10373
		IST-2000 VIII.1.4 research	
Commission Contacts:		300SiSC	IST-1999 10407
		EURACCESS	IST-1999 11025
Web:		SEAD	IST-1999 12057
		EUROPRACTICE	
	Rainer Zimmermann		rainer.zimmermann@cec.eu.int
	www.cordis.lu/ist/ka4/mel/index.htm		
	www.europractice.com		
	www.sea.rl.ac.uk		

Adaptable software architectures

The ever-increasing size, complexity and cost of software systems means that in many cases they can no longer be built entirely from scratch. The widely accepted component-based paradigm has been more and more adopted as a means of improving the productivity of software development. Developers try to reuse software to contain costs, reduce development time and increase quality. In doing so, the focus is on design, classification, certification and brokerage of individual software components.

Although component-based approaches greatly contribute to the development of software-intensive systems, their efficiency depends on the system architecture. In fact, the role and interface of components is determined by the architectural design of the system where they can be used and reused. This dependence is drawing more attention to the importance of architectural design. Issues to be dealt with include the need for more reusable software architectures and more flexible and evolvable

architectures. This is a growing concern in the area of new services, for instance for mobile networks, where the software architecture must be reconfigurable to deal with changes in available resources and services, and in users' requirements.

A basic concern in software development, which is compounded by the fact that systems are being built from components, is the ability to predict and control the emergent properties of such systems, especially performance, reliability and scalability. For example, existing approaches generally describe functionality at the architectural level, using modelling languages such as UML, which do not allow direct assessment of such quality aspects. There is a need to ensure, at the architecture level, that the required properties for the final software system will be met. This means describing not only the interfaces between components at the syntactical level, but also how the properties of the components will combine to determine, for example, the quality of specific services offered by the system.

An online market for software components

CLARIFI is creating a broker infrastructure to support online trading of component-based software engineering. Developers will be able to implement solutions using third-party components drawn from a wide range of sources. The broker supports the integrator by identifying the components that can be reused to build the target application. The broker also characterises the components and analyses the trade-offs between different possible solutions. For suppliers, the broker offers a characterisation and certification model and a support framework for the e-trading of components.

The IST Programme emphasises progressively software development at the architectural level. The research focus is shifting to models, tools and notations to describe system architectures and to compare alternative scenarios from the standpoint of their future evolution or reusability. These models and notations would relate components through semantic descriptions which tell the system architecture what functionality the component has and how it interacts with other modules. Many of the developments would be in addition to standards aiming at platform independence, such as CORBA/Java, with an emphasis on application frameworks for particular types of applications.

Further info	IST Action Lines:	IST-1999 IV.3.1	Component-based software engineering Technologies and engineering for software, systems and services
		IST-2000 IV.3	
Project References:		CLARIFI	IST-1999 11631
		Jacques Bus	
Commission Contacts:		Michel Lacroix	jacques.bus@cec.eu.int
			michel.lacroix@cec.eu.int

Probing the nano-world

Since the early 1970s, the microelectronics industry has followed Moore's law, doubling the processing power of its chips every 18 months. This performance increase has been achieved mainly by reducing the size of circuit features and the optimisation of CMOS technology. Minimum feature size reduced from 10 microns in 1970 to 0.25 microns in 1998. By 2012, feature sizes of 0.05 microns are envisaged, where less than 1000 electrons would be used in switching currents.

Although single MOSFET transistors with critical feature sizes down to 25 nm have already been demonstrated, the technological constraints in terms of interconnect technology, dielectric materials, lithography, and design complexity may slow down further progress. With each generation of semiconductor technology ever more costly to develop, there is an increasing need to find new approaches that break away from conventional miniaturisation.

The Microelectronics Advanced Research Initiative (MELARI) was launched by Esprit in 1996 to respond to this challenge. Fourteen projects were supported under the "nano-scale ICs" part of this initiative, which focused on developing novel nano-scale devices and circuits as well as associated nano-fabrication technology. The projects SPINUP and NANOTECH, for example, successfully developed novel technologies for imprinting (analogous to stamping) circuit features in the sub-100 nm range. These are expected to become an alternative to conventional lithography in some areas of semiconductor production.

Since MELARI was launched it has become apparent that nano-scale systems cannot and should not be seen as the successors to CMOS technology from either the technical or the application perspective. The exploitation of atomic and molecular scale behaviour may ultimately require completely different materials, processes, and device architectures than the current technology, originally designed to work on the basis of macroscopic effects.

General purpose computing may also remain an application area dominated by CMOS technology, with novel devices building their own markets. For example, there is currently a great need for large non-volatile storage devices. New hope in this respect has been gained since the SPIDER project demonstrated for the first time that spin injection into a semiconductor was possible, opening a new avenue to novel magnetic devices.

It is also now recognised that significant breakthroughs are more likely to arise at the interfaces between traditionally separate science and technology areas. For example, principles and techniques for self-organisation, nano-assembly and self-repair may be borrowed from biology. Neural networks and evolutionary programming may also provide inspiration for the development of novel architectures for nano-scale systems. In this context, the ANSWERS project is investigating a number of architectural concepts applicable to nanoscale devices.

The Nanotechnology Information Devices (NID) initiative supports innovative research aimed at the development of new concepts for information processing systems operating at the nano-scale. Launched under IST's Future and Emerging Technologies (FET) action, NID draws on the successful work under MELARI but is broader in scope. NID covers any research field that could contribute in shaping future visions for information processing nano-systems, from quantum electronics to nano-mechanics and biology.

NID work focuses on three main areas. Firstly, the development of novel architectures and designs for information processing systems that can be implemented at the nano-scale. A second area of interest is novel devices, such as logic gates, memory cells or other elementary components. Key issues here are scalability, projected power consumption and interfacing to the macroscopic world. Thirdly, NID is developing tools and techniques for fabricating structures with critical dimensions below 10 nm. Again scalability and cost are important issues, and there is an emphasis on self-organisation and self-assembly.

The BUN project, for example, is investigating the use of self-assembled designer molecules as a building block for future nano-scale information processing devices. In a first step, the project aims to gain an understanding of the electronic and mechanical behaviour of single molecules on surfaces, as well as develop the fabrication processes needed to build molecular circuits.

At the interface of electronics and chemistry, SATURN is studying single-wall carbon nanotubes, which are seen as one of the important elements of molecular electronics. The work focuses on nanotube growth and manipulation, with a particular emphasis on producing junctions. On the other hand, CORTEX is concerned with very high density, three-dimensional molecular wires, which could become important elements of future nano-scale computer chips.

Learning from Nature

Computers based on molecular DNA are a potential alternative to silicon for some applications in the longer term. FET's DNA-Based Electronics project is undertaking pioneering work into the use of DNA in information processing. The project is exploring the electronic properties of DNA, the use of DNA as a template for other molecular components, the assembly of DNA-based devices, and the characterisation of electrical performances. The aim is to establish the first prototype devices based on single DNA molecules. Spanning a wide range of interests, from academic groups to commercial companies, the project brings together European expertise in the field in an interdisciplinary research effort.

Further info IST Action Lines:

IST-1999 FET.P.3

Nanotechnology Information Devices

Project References:

Esprit 29097
Esprit 28785
Esprit 28667
Esprit 23307
IST-1999 11565
IST-1999 10236
IST-1999 13099
IST-1999 10593
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Promoting trust and confidence

Successful business has always relied on trust and confidence. This is especially true in the Information Society with its reliance on open and global information and communication infrastructures that are increasingly vulnerable to abuse. As access to the internet diversifies, from PCs to digital TVs, mobile phones, personal assistants and very soon cars and even home appliances, people will feel increasingly concerned about their security in this electronic world.

The European Union is committed to ensuring that businesses and individual citizens enjoy the high level of trust needed to ensure the take-up and safe use of these new services and applications. This approach relies on extensive RTD to support and inform legislative and regulatory activities and industry's self-regulation. The EU's research strategy is based on the mid- to long-term horizon together with shorter-term deployment of current innovative technologies. It focuses primarily on key architectures, technologies and tools for next generation security systems, in particular those which support scalability, dependability and customisation.

One emphasis is on identification and authentication systems that allow for a diversity of approaches to trust management, including the use of third-party services. These will allow identification and authentication of individuals and services in commercial, retail and personal transactions, so as to prevent the unauthorised collection, recording and disclosure of data. The NESSI project, for example, brings together Europe's top cryptographic players to address the medium to longer-term improvement of cryptographic primitives. The BANCA and UFACE projects are investigating advances in biometrics identification, authentication and access control.

Trust technologies are essential to the take-up of e-services

Secure architectures for e-commerce

EU RTD programmes have already made substantial contributions to the definition, development and validation of open architectures for secure electronic commerce. The ACTS project SEMPER, for instance, focused on the provision of multi-party security for a full spectrum of e-commerce services over insecure networks. The results covered public key security, such as digital signatures, certification and credentials, electronic payments and contracts, and fair exchange. SEMPER's open, Java-based architecture was made available for public review and evaluated extensively in real life trials. IBM, one of the project partners, is now exploiting several of SEMPER's results in its Trusted Third Party and payment solutions.

Interoperable systems for secure electronic financial transactions is another theme, especially as they relate to the euro and to use in the global marketplace. RTD here covers billing, payment, accounting and record keeping, as well as anonymous, small and micro payments. Again the focus is on system scalability and interoperability and also on risk management.



Technologies of interest include high-reliability and tamper-proof components including innovative smart cards and personal token systems.

Secure financial transactions increasingly deploy smart card technology. G3CARD proposes a new generation of smart cards that will remedy current vulnerabilities. PACE is building an open, international scheme for electronic purses with a focus on the euro. And ISOP1 aims to establish an open platform for smart card development.

Research into intellectual property rights is also supported. This focuses on tools and services to support the transfer and management of digital content as commercial assets. ASPIS offers an innovative approach to protect DVD ROMs and, more generally, secure internet connection and authentication. CREA Net addresses the devel-

opment of a secure environment for authors and producers to manage multimedia assets.

Other projects aim to benchmark best business practices, build consensus on future developments, and promote interoperability and standardisation. IPL-E is studying the application of private international law to internet-based transactions, including case studies and market analyses. The Financial Internet Working Group (FIWG) provides a structured forum for discussion of financial aspects of e-commerce within the financial services sector. SMART-IS is a working group on use of smart cards for internet access.

Future RTD priorities are likely to encompass items such as the development and validation of scalable and usable authentication infrastructures. This includes infrastructures with embedded electronic signature and/or biometric solutions, as well as tools for lifecycle management of keys and the interoperability of public and private key schemes. The development and validation of global security architectures and systems to combat cybercrime will also feature, as will the wide-scale deployment of generic solutions for e-transactions.

Biometric access control for e-commerce

BANCA is developing a secure system for controlling access to internet applications, such as tele-working and web-banking services, based on biometrics. The system will combine classical security protocols with robust multimodal verification schemes based on speech and images. The project incorporates state-of-the-art network security protocols developed under the ACTS projects M2VTS and OKAPI. Three demonstrators will be built and tested for applications in teleworking, home banking and biometric automatic teller machines (ATMs).

Further info		
IST Action Lines:	IST-2000 II.4	Information and network security and other confidence-building technologies
Project References:	ASPIS BANCA CREANet FIWG G3CARD IPL-E ISOP1 NESSI PACE SEMPER UFACE	IST-1999 12554 IST-1999 11159 IST-1999 10871 IST-1999 12274 IST-1999 13515 IST-1999 11854 IST-1999 12619 IST-1999 12324 IST-1999 11531 AC026 IST-1999 11587
Commission Contacts:	Thierry van der Pyl	thierry.vanderpyl@cec.eu.int
Web:	www.ispo.cec.be/istka2/c4 www.ispo.cec.be/ecommerce/clusters/trust.html	

Multimedia via satellite

Originally conceived with limited coverage and to serve a limited number of professional users, satellite communication systems are evolving towards global or large regional coverage. In the future it is anticipated that they will provide access to millions of users worldwide, using inexpensive interactive broadband terminals, for a range of applications, either mobile or fixed or broadcasting. This evolution is already visible in the broadcasting domain. It is being made possible by technological advances both in ground and space segments and by changes of the regulatory context.

Satellite communications under the IST Programme are driven by three main considerations. Firstly, from a technological perspective, satellite communication systems have to be fully compatible and integrated with terrestrial systems, and be capable of seamlessly supporting an equivalent portfolio of services.

Secondly, from a spectrum perspective, the trend is to move towards higher frequency bands, both because lower frequencies are heavily congested, and because higher frequencies offer the wider spectrum required to serve large user populations. This, in turn, raises specific technological issues.

Thirdly, from an institutional perspective, the work is planned to complement activities sponsored by space agencies and in particular the European Space Agency. This takes place in the context of tighter relations between the Commission and the ESA programmes, as called for by Council Resolution of 2 December 1999.

IST work also builds on previous activities sponsored under ACTS. Key themes here included software radio for both satellite and terrestrial environments, interoperability of terrestrial and satellite networks in an ATM context, global network management, interactive broadcasting, and application trials for various user communities.

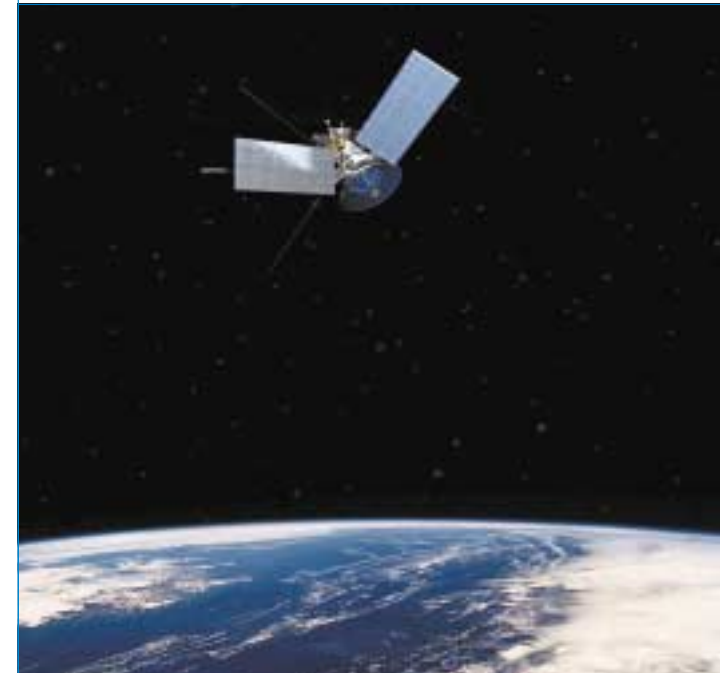
Towards broadband satellite multimedia

A universal user access interface for broadband satellite multimedia services is being defined by BRAHMS. Dubbed the Broadband Multimedia Satellite System (BMSS), the concept aims to address a range of multimedia user groups with data requirements up to 150 Mb/s, such as homes and small offices. BMSS is a potential vehicle for convergence between fixed and mobile multimedia networks towards the Global Multimedia Mobility (GMM) architecture, by merging service functions derived from the UMTS/IMT 2000 and from fixed broadband access.

Activities under WP 2000 focus on technologies and architectures for the satellite delivery of multimedia services. The enhancement of legacy systems is addressed, through provision of interactivity (in Ku or Ka bands), optimised caching architectures and competitive delivery of services based on internet protocol (IP). Optimised technical and economic architectures for interworking with terrestrial IP-based networks are also sought, together with integrated network management and radio source optimisation for both S-UMTS and broadband multimedia systems.

A variety of work on mobile systems is already underway. One of the main technical challenges is to provide users with the possibility to roam seamlessly across a range of mobile or wireless access networks, such as GSM, DECT, GPRS, UMTS and future fourth generation mobile systems.

VIRTUOUS is investigating migration paths towards combined terrestrial and satellite UMTS. The aim is to implement inter-working procedures that will enable the user to roam across various access networks as if within his own home network. Migrations steps and RTD requirements towards T-S-UMTS are being identified, taking account of progress in standardisation and related UMTS projects. The project builds on ESA-sponsored activities through upgrade of an ESA-sponsored demonstrator, which will be capable of demonstrating T-S-UMTS interworking at higher frequency bands (Ka band).



Satellites offer an important channel for broadband services

Smart antennae for broadband satellites

The success of satellite multimedia systems depends in part on on-board receiving antennae with very high, enabling multi-beam coverage of the most populated regions. MULTIKARA is designing an innovative, cost-effective multi-beam satellite antenna in the Ka-band (18-31 GHz), the only non-saturated band available. As well as design and testing of the antenna, the work includes associated microwave circuits and evaluation of the feasibility of the system for future in-flight use.

SUITED is developing a demonstrator that aims at proving capabilities of interworking of different mobile segments (satellite, W-LAN, GPRS) in an IP context, with interworking functions and complexity located at the edge of the core network.

In the area of fixed-broadcasting systems, GEOCAST is investigating the use of geostationary satellites used for TV broadcasts as a platform for two-way IP-based data services (multicasting). The project is defining the building blocks (terminals, gateways, satellite) and protocols (network, medium and physical layers) to match the needs of multicast systems, and is expected to make significant contributions to standardisation bodies.

Further info IST Action Lines:

IST-2000 IV.5.3

Integrated satellite systems and services

Project References:

BRAHMS
GEOCAST
MULTIKARA
VIRTUOUS
SUITED

IST-1999 10440
IST-1999 11754
IST-1999 12319
IST-1999 10167
IST-1999 10469

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Optical building blocks

The rapid deployment of optical networks goes hand in hand with the development of new technologies for optical components. Recent developments, such as optical amplification, passive optical devices and increases in laser output power have already enabled optical fibre networks to reach cost parity with traditional copper cable for new residential broadband installations. However, new cost-effective components are required to further exploit fibre capacity and push fibre further into the access network. Key challenges include cost-effective optical technologies for multiplexing, switching and routing, and in optical transmission technologies such as WDM and DWDM.

Wavelength division multiplexing (WDM) is an approach for enhancing the capacity of an optical fibre by using more than one wavelength. Each one of these wavelengths can carry an electrically modulated data stream, without interference, multiplying the total amount of data transmitted. Recent technological advances in WDM have moved key building blocks such as optical amplifiers and WDM transmitters from development to products. Next generation systems, known as dense wavelength division multiplexing (DWDM), will utilise many wavelengths within the network.

The IST Programme's work on optoelectronics builds on the substantial experience developed under both ACTS (Photonic Technologies) and Esprit (MELARI OPTO). From an industrial perspective, it focuses on advanced optoelectronic materials, devices and modules for high-speed routing, processing and interconnection, including devices for low-cost broadband applications direct to the home. Advanced processes, materials and devices are also investigated, with an emphasis on integration with basic CMOS processes, thereby adding light emitting, photodetection and interconnection functions to logic circuits.

Tunable laser for WDM systems

Tunable vertical cavity surface emitting lasers (VCSEL) are key components allowing high speed optical telecommunications networks to be flexibly reconfigured. TUNVIC is applying know-how in InP-based micro-optical electromechanical systems (MOEMS) and state-of-the-art VCSEL devices to the development of a new tunable laser source. The innovative feature is in combining MOEMS functions with the active part of a VCSEL in the long wavelength range. The project builds on technology developed under FP4 and involves leading European manufacturers of optoelectronics and telecom components.

WILD, for example, is developing high-power, wide-aperture semiconductor lasers for use in optical amplifiers. The project focuses on novel device geometries that allow active control of certain laser properties. LOBSTER is designing an ultra-broadband optical amplifier based on new advanced materials for use in DWDM systems. And GIFT is investigating a new class of GaAs 1.3 and 1.55 μm emitters and vertical cavity laser arrays with improved characteristics compared to InP

Reliable high-brightness laser diodes and optical modules that will improve transmission efficiency in small diameter fibres are being developed under ULTRABRIGHT. As well as increasing the power and brightness of laser sources used in WDM networks, the results will also be applied to photodynamic therapy, an advanced cancer treatment.

PCIC and PICCO are concerned with wavelength-scale photonic components for optical communications such as low-loss waveguides, bends, couplers, combiners, filters or monolithic wavelength converters. These projects also address fabrication processes using InP, GaAs or SOI.

Tomorrow's networks will run on optical technologies



AGETHA focuses on the amber and green resonant cavity emitting diodes and detectors needed for the next generation of plastic optical fibres (POF). These components will support data rates of 500 Mb/s and function at temperatures of up to 120°C. Test beds will simulate avionic and automotive applications and their environments.

GSQ proposes in-plane and vertical cavity diode lasers operating at 1300 nm using quantum dot emitters. In addition to process compatibility

with well established GaAs technologies, these devices on GaAs substrates are expected to outperform classical InP based devices in term of cost and reliability. Optoelectronic devices also support applications other than telecommunications. An all-digital offset printer is supported by a new 2-dimensional laser printing head and a spatial light modulator in the NIMED project, while 1-10 THz lasers that promise advanced techniques for medical imaging are being investigated in TERAVISION.

Further info		
IST Action Lines:	IST-2000 IV.8.4 IST-2000 IV.8.5	Optoelectronic technologies Advanced micro- and opto-electronics
Project References:	GIFT LOBSTER TUNVIC ULTRABRIGHT WILD GSQ AGETHA PCIC PICCO TERAVISION NIMED	IST-1999 12700 IST-1999 13322 IST-1999 11051 IST-1999 10356 IST-1999 10787 IST-1999 10450 IST-1999 10292 IST-1999 11239 IST-1999 10361 IST-1999 10154 IST-1999 11054
Commission Contacts:	Ronan Burgess Henri Rajbenbach	ronan.burgess@cec.eu.int henri.rajbenbach@cec.eu.int
Web:	www.cordis.lu/ist/ka4/mel/index.htm	

Next generation networks

High speed networking is of strategic importance for Europe. New approaches to networking are needed to cope with the explosive growth of the internet and the demands of future mobile and multimedia services. The challenge, for technology developers and network operators, is to provide the end-user with broadband services in a cost-efficient manner and with a well-defined quality of service.

To achieve this, new cost-effective network integration technologies and services are required that allow fibre, copper and wireless technologies to converge. Interoperability with legacy networks and systems and a migration path from legacy networks to the new network technologies are also key concerns. Increasingly, these will be all-IP networks, reflecting the convergence of fixed, mobile and wireless technologies and architectures around the IP standard, and in particular the new IPv6 internet protocol.

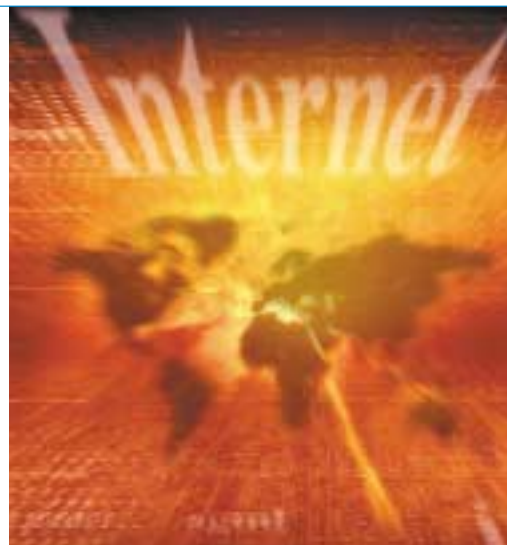
The IPv6 initiative was launched by the Internet Engineering Task Force (IETF) in 1995 to address the known shortcomings of the present internet protocol, IPv4. The new IP has increased addressing and security features and improved performance. This important new protocol should make it much more realistic to run real-time applications and services, such as e-commerce and multimedia services, over the internet.

Upgrading the Net

6INIT is leading the setting up of a first European operational platform providing customers with native IPv6 access points and services. 6INIT will define operational procedures for IPv6 networks and for migrating networks and applications from IPv4 to IPv6. It will also establish demonstration applications, such as telephony, video-telephony and video-on-demand, and implement IPv6-based services for financial information and remote newspaper printing. The project is a co-ordinated initiative of the major European telecom companies, equipment manufacturers and research labs.

The implications of IPv6 are a key interest in the IST Programme's work on network integration and next generation networks. The 6INIT project, for example, aims to prove the business case for IPv6 in Europe (see box). GCAP is defining new end-to-end transport protocols and a new global architecture to meet the quality of service requirements of specialised multimedia applications. The software is being deployed over an industrial IPv6 layer by means of an active network-based technology.

Networks are converging around internet technologies



The cost-effective integration of different network technologies is another key theme. NET-GATE aims to develop a flexible, scalable protocol gateway that will bridge the compatibility gap between different telecoms networks. The solution should provide interoperability between wireless platforms (GSM, GPRS) and wired platforms (ISDN, ATM, IP), as well as an open architecture for future technologies.

Several projects focus on quality of service (QoS) issues. TEQUILA is studying traffic management techniques to improve end-to-end QoS on the internet, and a differential charging system that will allow a market-based approach to service levels over the internet is being designed by M31.

BASS is developing a scalable dial-up-to-broadband network for home offices and residential users using ADSL technology. And CADENUS is proposing a solution for provisioning end-to-end user services over premium IP networks with QoS guarantees.

The technologies needed to build a true wireless internet system without the underlying wireless ATM layer are being studied by WINE. Starting from theoretical issues for wireless IP networks, the project will conduct simulations and large-scale case studies over research networks, and will implement the results in three test beds covering the Bluetooth, IEEE 802.11 and Hiperlan standards.

Bridging broadband networks

Tomorrow's broadband networks will transport high quality video content that cannot be streamed over today's internet. So the internet will be composed of heterogeneous networks with different bandwidth and protocol capabilities. The VideoGateway project aims to provide a gateway between the video streaming standards currently in use on the narrowband internet and those to be used for the next generation internet. It will also serve as a gateway between different video sources (DVB, stored MPEG video etc) and the narrowband internet.

Further info		
IST Action Lines:	IST-2000 IV.2.3	Network integration, interoperability and interworking
Project References:	IST-2000 V.1.6 CPA6	Next generation networks
	6INIT	IST-1999 12383
	BASS	IST-1999 11956
	CADENUS	IST-1999 11017
	NETGATE	IST-1999 10905
	TEQUILA	IST-1999 11253
	VideoGateway	IST-1999 10160
	WINE	IST-1999 10028
Commission Contacts:	Pertti Jauhiainen	pertti.jauhiainen@cec.eu.int
Web:	www.cordis.lu/ist/ka4/ipcn	
	www.cordis.lu/ist/cpt/2000cpa6.htm	

Follow the free

Open source software has emerged as one of the most intriguing phenomena of the Information Society. Although not entirely new, over recent years the open source movement has reached a critical mass that has readily identified it within the mainstream software market.

Open source is the distribution of software free from many of the restrictions of traditional software products. Users are able to use the software as they wish, for whatever they wish, on as many computers as they wish and in any appropriate situation. Furthermore, they can amend the software to fit their needs. This includes, for example, improving it, fixing its bugs, adding to its functionality, and studying its internal operations. They are also allowed to redistribute it to other users, usually for free, who could themselves use it according to their own needs.

A key feature is that the user has access to the software's source code. This allows a programmer to understand the programme's functionality and to work with it in much the same way as the original author. The user's freedom to modify, improve and distribute the code are set out under a software licence.

The impacts of open source technology are yet to be understood but are expected to be significant. Using novel development models, developers around the world are already collaborating on software projects employing open source approaches. With the source code open to widespread scrutiny, the software's strengths and weaknesses can be rapidly identified and improvements made. Users benefit through being less dependent on monopoly software suppliers.

Networks and companies are also emerging utilising new business models based on open source software development. For developers, the business case is a reflection of the shift from products to services in the new economy. Developers benefit not from the transaction but from contributing to a common pool of software solutions. In some cases they may also sell other products and services on the back of the open source solution. In general, the open source movement appears to have very positive impacts as an enabler of new markets and business opportunities.

One specific impact of open source technology is in promoting the take-up of technology standards. Two factors seem to be important here. Firstly, the availability of an open source reference implementation helps in the rapid adoption of a protocol by commercial and non-commercial organisations. Secondly, testing compliance against a standard code can help remove incompatibilities between different implementations as a protocol develops.

With a huge amount of code and development tools now available, it is possible to create robust software systems using only open source software and without any commercial components. This can have significant advantages for the rapid diffusion of software technology, for example in adapting software for specific local markets, or according to specialised needs, such as the disabled. The flexible distribution is especially important in developing countries, allowing them access to advanced technologies without having to pay expensive royalties.



Open source is changing the way people develop and use software

To date, virtually no support has been provided by governments for open source development. This is now changing, and in the EU open source approaches are stressed as an important element of the IST's Programme's work in software engineering, especially distributed development environments.

In addition, take-up actions to encourage the adoption and the development of free/open source software are also included under IST's WP 2000. These actions have been prepared in association with the Working Group on Libre Software, which brings together free software players from various European countries. The Working Group has produced an issues paper accessible on the Group's website.

Further info

IST Action Lines:

IST-2000 IV.3.1
IST-2000 IV.3.4(i)

IST 2000 IV.3.5(i)

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Philippe Aigrain
Working Group on Libre Software

Web:

Distributed software development
Best practice actions to encourage the adoption of open source software
Foster the initiation of open source/free software development projects
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<http://eu.conecta.it>

Riding Moore's law

The processing power of integrated circuits has doubled every 18 months, verifying the so-called Moore's law. These performance increases are achieved mainly by optimising and improving semiconductor process technology so as to reduce the size of circuit features. The continuous decrease in size, power consumption, weight and costs has led to products with much richer functionality, which are now diffusing into new communication and internet appliances at an explosive rate. In the so-called system-on-a-chip (SoC) approach, different circuit functions (such as memory, mixed signal and RF) and passive components (such as capacitors and inductors) are being integrated on the same chip, or at least on the same substrate.

The development path to maintain this trend is fairly well defined. From the 130 nm technology now being prepared for production, the industry expects to proceed to feature sizes of 100 nm by 2002, and to 20-35 nm by 2012. This miniaturisation has its down sides, however. As feature sizes decrease, newer, more sophisticated process technology and design tools and methods are required, the costs of which are escalating dramatically. Whereas a few years ago a typical semiconductor fabrication facility cost around Euro 1 billion, a new facility today costs 2-3 times as much – and costs are still rising. Physical limits, such as quantum effects, and technological limits, such as material reliability and power dissipation, may also hinder further progress.

Hundred nanometer CMOS technology

HUNT addresses the development and evaluation of the main process modules for the 100 nm CMOS transistor architecture. Utilising results from other European projects, such as ULTRA II, the outcome will be a high performance 100 nm CMOS front-end technology for logic applications. This technology will also be the basis for future system-on-a-chip generations.

To ensure a synchronised development, the global semiconductor industry has developed the International Technology Roadmap for Semiconductors (ITRS), setting out the perspective through to 2012. The roadmap identifies many difficult problems which need to be addressed by companies and research laboratories through substantial R&D efforts. The ITRS roadmap is strongly influenced by US manufacturers of components for PC's. For European manufacturers, which are more focused on portable and embedded systems, the focus is on system-on-a-chip development. The challenges in process technology for SoC are not just in terms of density of transistors, but also in how to integrate different modules on one chip, and the degree of integration of passive components.

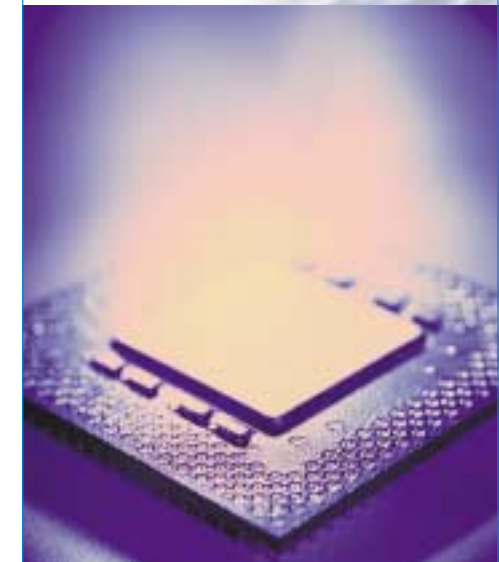
The IST Programme supports research and development of compatible basic CMOS process modules, based on silicon and silicon-germanium, and related equipment and materials for system-on-a-chip. The work is directed to increasing data transfer rates of communication systems, and the processing and storage capacities of terminals.

Pushing optical lithography to its limits, LICOTRENAS is part of a program to develop a 193 nm exposure wavelength high-throughput lithography tool, including stable optical mate-

rials, metrology, process, reticle know-how and demonstration. The aim is to develop an exposure tool suitable for the manufacture of ICs with feature sizes of 100 nm or even beyond. A close link exists to the ALASCA2 project in which the performance of the preceding generation of step-and-scan systems is being assessed by a large international consortium. Special attention is being given to the performance of the illumination system and the projection lens, and to the lifetime of optical components. The phased approach from R&D to take-up allows early feed-back to next generation work on both equipment and process issues (such as performance of new resists). PIRANHA is developing a high speed mask inspection system for very small defect sizes (80 nm) for 193 nm lithography.

In materials, DIRDA is applying wafer annealing under deuterium atmosphere to improve the reliability of highly integrated ICs, and TOPS is looking at a novel chemical vapour deposition (CVD) process for tantalum pentoxide dielectrics.

In the semiconductor industry, in-situ metrology has become an important topic, especially for 300mm wafer processing. Under SEA project APC300, critical plasma processes used in high-volume IC production at 300mm wafer size are being monitored in-situ by means of a novel technique known as self-excited electron resonance spectroscopy (SEERS). The results are expected to improve the overall stability of the plasma process and equipment productivity, and to reduce costs.



Miniaturisation presents massive challenges for semiconductor manufacturers

Another area of interest is in assessing and improving performance of equipment for 300 mm wafers. OXEPICLE is concerned with optimisation of pre-clean stages of advanced front-end CMOS processes. SUMMIT targets the area of metal contamination monitoring in the manufacturing of 300mm wafers through the development and testing of a new module.

Further info		
IST Action Lines:	IST-2000 IV.8.3	Industrial microelectronics technologies: processes, equipment and materials
Project References:	ALASCA2 APC300 DIRDA HUNT LICOTRENAS OXEPICLE PIRANHA SUMMIT TOPS	IST-1999 10367 IST-1999 11826 IST-1999 10372 IST-1999 11599 IST-1999 11751 IST-1999 10396 IST-1999 10334 IST-1999 12676 IST-1999 10541
Commission Contacts:	Rainer Zimmermann	rainer.zimmermann@cec.eu.int
Web:	www.cordis.lu/ist/ka4/mel/index.htm	

Engineering for real-time systems

Computer systems in an increasing variety of applications are required to operate in real-time. They cover safety-critical, mission-critical and security-critical applications in areas such as finance, transportation, telecommunications and industrial control. Increasingly, real-time approaches are required in embedded mobile applications too, such as automotive control systems. Whether as part of a networked infrastructure or embedded in products, real-time systems are essential building blocks in enabling our surroundings to become more intelligent and responsive.

The IST Programme supports innovative methods and tools for embedded systems and their inter-working, especially for data- or computation-intensive real-time applications. This includes the development and integration of software and hardware modules solving time-critical aspects and enabling embedded systems to be networked and/or to communicate via the internet.

The development process for embedded systems is a key interest. INTERVAL aims to take into account real-time requirements, such as timing constraints, during the development process. The project focuses on defining timed extensions to existing standardised languages, and will validate the new technology in two applications within the telecoms sector. AIT-WOOD-

Reliability for safety-critical real-time systems

Time-triggered architecture is an innovative European-funded technology for safety-critical, distributed and real-time applications, such as fly-by-wire or drive-by-wire. SETTA focuses on the systems engineering of time-triggered architectures.

The key characteristic of time-triggered, real-time systems is that all significant events, including tasks and messages, do not occur at random points in time but rather have to adhere to a predetermined schedule. This approach initially requires a larger design effort than classical, event-triggered systems. Once built, however, time-triggered systems have several advantages, such as predictability concerning their real-time behaviour, which make them uniquely suited for complex, safety-critical real-time systems. SETTA is promoting the industrial application of this technology into future vehicles, aircraft and train systems.

DESS aims to improve the design process for real-time systems, so as to significantly reduce both development costs and time-to-market. Focusing on process continuity between the industrial participants, object-oriented methods are being used as the basis for interoperable software tools. GEODAS is developing reusable generic components for data acquisition and analysis systems requiring the management of high data volumes in real time.

Real-time control systems are also an important area for RTD. AJACS is demonstrating an open technology allowing the use of Java in deeply embedded automotive electronic control units such as engine control systems. The technology will incorporate existing work on small footprint Java platforms and real-time Java. Two prototype automotive control units will be developed and the results will be promoted within the Java and automotive software communities as the basis for future standards. Also in the automotive sector, BRAKE is applying a cluster of networked embedded control units within an advanced braking system.

Innovative approaches to image recognition and signal representation are also considered. HIS-CORE, for example, focuses on 3D image acquisition (see box). VISORBASE applies a CORBA-based open architecture to an artificial vision system. Potential applications include motion detection, number plate recognition and face recognition.

Vision systems remain a priority for the future, in particular the development of robust cognitive vision systems capable of acquiring and using knowledge for decision-making. The challenge is to recognise and integrate a large number of objects and visual cues, and then to reason and learn from this information in a way that is meaningful for real-world decisions. Novel architectures and computational frameworks are likely to be required that permit adaptive, real-time responses.



Applications such as financial markets rely on real-time information

Real-time 3D video processing

HISCORE is investigating a new approach to high-speed 3D image acquisition for the very important mid-distance range and building an affordable real-time 3D colour camera. This system will integrate off-the-shelf closed circuit TV camera and project technology and combine it with new 3D- and colour coding schemes and a real-time video processing system to achieve a new 3D camera subsystem. An acquisition time of 40ms or less for both the 3D- and colour images is targeted. The system will be validated in two application areas: face recognition for access control and security, and recognition of hand gestures for new human-computer interfaces.

Further info IST Action Lines: Project References:

IST-2000 IV.2.2
AIT-WOODDESS
AJACS
BRAKE
GEODAS
HISCORE
INTERVAL
SETTA
VISORBASE
Pertti Jauhiainen
www.cordis.lu/ist/ka4/ipcn

Real-time systems
IST-1999 10069
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IST-1999 12128
IST-1999 10984
IST-1999 10087
IST-1999 11557
IST-1999 10043
IST-1999 10808
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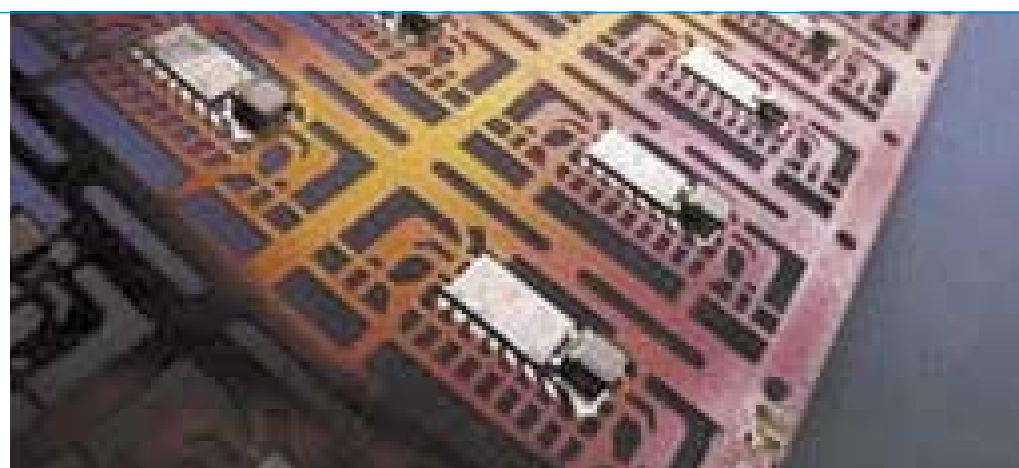
Supporting microsystems

Innovation in the design and manufacture of products is essential to the commercial well-being of European industry. In many areas of the marketplace, microsystems play an increasingly important part in this innovation process. From consumer goods to industrial equipment and medical devices, microsystems are key to making products more intelligent and more marketable. Clearly, therefore, learning how to exploit the benefits of these technologies, through embedding them in successful products, is vital to maintaining Europe's competitiveness.

A microsystem is a miniaturised system comprising several functions such as a sensor, signal processor and actuator. Alongside systems-on-a-chip, microsystems will be key to the development of user-friendly products and systems with embedded intelligence. They can make existing products smaller, cheaper, better and more reliable but also open up many possibilities for new products. Examples include accelerometers for automotive airbags, blood sugar monitors, and inkjet printer heads.

Europractice aims to stimulate and assist the wider take-up of advanced microsystem technologies by European industry. Originally launched under Esprit, the initiative offers a complete service, from idea to product, including: feasibility and proof-of-concept studies;

Accelerometers enter high volume production



prototyping and low volume production; access to large-scale industrial manufacturing facilities; custom design; software; and training. Having focused initially on application-specific integrated circuits (ASICs) and multi-chip modules (MCMs), under IST the emphasis is primarily on microsystems technologies (MSTs).

The Europractice MST Service gives customers access to a wide range of technologies for design and manufacture. Europractice operates through a network of service providers, each of which carries out its own marketing and promotion, and deals with customers directly. The network is supported by a co-ordination office which provides centralised support to the service providers, including general promotion. Potential MST users are offered comprehensive support to take their ideas from concepts to practical, tested and packaged products.

A network of Competence Centres provides application know-how and assistance with specific emerging technologies, particularly for new users. The Centres can assess the state-of-the-art, conduct feasibility studies and evaluate new product concepts, and fabricate initial trial devices. Eight centres are supported covering: physical measurement systems, micro-opto-electromechanical systems (MOEMS), medical and biomedical devices, microactuators, microfluidics, micro-chemical, medical microinstruments, and micromagnetic devices.

Networking the MST community

NEXUS is a network, launched under Esprit, representing key European industrial interests in microsystems R&D and manufacturing. It provides an infrastructure for users and suppliers aimed at stimulating co-operation and raising awareness. It monitors developments worldwide to identify emerging technologies and applications, provides guidance to members, and promotes a common voice to funding and standards organisations. NEXUS is also involved in integrating the Central European MST community within the pan-European activity.

A network of design houses (Design Clusters) provides access to multidisciplinary expertise necessary to develop and design MST components and introduce them into products. Using proven design processes, they can facilitate designs as part of a multi-project wafer. They provide a route to industrial production via either Europractice or non-Europractice foundries. The former, known as Manufacturing Clusters, are five groups of industrial manufacturers who offer services in a variety of technologies at low, medium and high volume production, including hybridisation, packaging and testing.

Lack of relevant experience and know-how is a common hurdle for companies wishing to exploit microelectronics- and microsystem-based technologies. Eurotraining can overcome this by providing users with flexible, low-cost access to a wide range of courses on microsystems and microelectronics.

Europractice's MST Service is having a significant impact on the take-up of MSTs in Europe. Every six months the Service contacts 500 organisations, 50% of which are SMEs. Around half are also new to microsystems. From this, around 150 quotations for research, design or prototype production are generated, leading to around 100 contracts being signed and executed.

Microsystems supply is complex with different types of customers expressing different needs. If microsystems is to become an industry next to, and in parallel with, the system-on-a-chip integration in microelectronics, users will need access to a sophisticated infrastructure and services. Europractice MST is providing a broad, user-oriented and customised approach needed to stimulate the take-up of MST in Europe.

Further info		
IST Action Lines:	IST-2000 IV.7.2 IST-2000 IV.7.3 IST-2000 IV.7.5 IST-2000 IV.7.6 IST-2000 IV.8	Subsystems Microsystems Subsystems – take-up measures Microsystems – take-up measures Microelectronics –take-up
Project References:	EUROTRAINING AWARDIS CCMICRO FOND MST NORMIC MEMSOI CCMESYS MICROFLUMAD MC4 INTECS MOEMS MIDEMAS LICOM MAGFAB COMBIOENV AMEF	IST-1999 11262 IST-1999 11137 IST-1999 11430 IST-1999 11823 IST-1999 11832 IST-1999 11840 IST-1999 12073 IST-1999 12246 IST-1999 12393 IST-1999 13368 IST-1999 13450 IST-1999 14000 IST-1999 20595 IST-1999 20825 IST-1999 20846 IST-1999 29020
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Adding to reality

Virtual reality (VR) is now widely used in a number of industries. In manufacturing, for example, VR is used to produce digital mock-ups, so reducing the number of prototypes needed in product development with corresponding savings in time and costs. Other common applications include spatial planning and visualisation in architecture, interior design and town planning, and training simulators in fields such as aerospace and medicine. Augmented reality (AR), which integrates virtual information into the user's real environment, offers many additional possibilities.

Virtual reality relies on immersion. Users are immersed within an imaginary, computer-generated virtual environment and are completely cut off from any view of the real world outside. The user is able to participate in this artificial 3D world through actions and gestures, and the VR environment in turn makes demands on us. In short, VR systems involve completely new ways for us to interact with our computers and our data.

In augmented reality, the user can see the real world around him with computer graphics superimposed or composited with the real images. Instead of replacing the real world, AR supplements it. Ideally, the user should perceive that the real and virtual objects co-exist. Current applications of AR include aerospace, automo-

The emotional computer

Although emotions have, for a long time, been considered undesirable for rational behaviour, there is now increasing evidence in psychology and the neurosciences that emotions play an important part in problem solving and intelligence. A new field of computer science, affective computing, is studying how human-computer interactions are influenced by our emotions. The aim is to enrich the user's experience of computing and provide "machine intelligence" with emotional capabilities.

SAFIRA aims to provide a framework to enrich interactions and applications with an affective dimension. A set of demonstrators is being developed in which users share a virtual environment with personality-rich characters, or avatars. The participants' cyberselves and the autonomous avatars inhabiting the environment will be able to interact in a variety of different ways as a means of testing whether emotional phenomena lead to more believable interactions between humans and computers.

tive, telemedicine, and devices for the disabled. Development is still at an early stage, however, and although some commercial systems are available, the full potential of augmented reality has yet to be realised.

The IST Programme supports research into innovative technologies and applications that aim to bridge the gap between the real and virtual worlds. VR and AR are considered as part of a continuum of "mixed realities". For VR, the emphasis is on augmenting virtuality and bringing real worlds to life. This is to be achieved by enhancing realism and level of detail, introducing intelligence, making them persistent and reactive environments. For AR, the emphasis is on fusing real and virtual universes by enhancing real environments for a range of applications, from wearable computers for navigation and industrial processes to film-making and interactive entertainment. New sensory experiences are also being investigated.

Augmented reality environments combine real and virtual worlds
(Picture from Esprit project COVISE)



Time for a meeting

You are at a meeting table with people spaced around in front of you. You are able to communicate with them effectively as if they are sitting next to you in the same room. In fact you are led to believe they are present in the same room – but they are actually located at several remote locations. For many types of meeting this high-realism telepresence conferencing system could replace the need to travel. Technologies in computer vision and graphics have developed to a position where this vision is achievable. The VIRTUE project is developing such a system based on practical and efficient solutions to technology issues. The final demonstrator will feature a semi-immersive display with life-size images of the head and torso, camera views for multiple participants, and an integrated visual representation of the meeting room.

The ENREVI project, for example, focuses on the enhanced real-time rendering of 3D objects that will have uses in applications such as film-making, CAD/CAM and training. ALIVE is developing authoring tools for augmented reality environments and INTERFACE is defining new models and tools for authoring and managing large-scale virtual and augmented environments. CPHIT is developing an immersive reality environment for medical applications.

Further info

IST Action Lines:

IST-2000 IV.4.2

Mixed realities and new imaging frontiers for innovative applications and services

Project References:

Art.Live
COPHIT
CROSSES
ENREVI
INTERFACE
PISTE
SAFIRA
VIRTUE
VISIRE

IST-1999 10942
IST-1999 10510
IST-1999 14004
IST-1999 11185
IST-1999 10036
IST-1999 11172
IST-1999 11683
IST-1999 10044
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Re-configurable mobile services

Over recent years, software radio (also known as software defined radio - SDR) has become one of the most important topics in mobile and personal communications. There are still a number of views on what SDR really is. From a mobile communications perspective, the initial idea behind SDR was to offer users access to multiple systems from a single terminal, initially in a military context, to resolve a specific situation (namely in the US) where a common system was missing to provide nation-wide roaming. It soon evolved, particularly in Europe, to be the capability to adjust the air-interface characteristics to cater for different transmission rates and service quality levels.

In this scenario, the role of the mobile and base station transceivers is that of a generic processing platform capable of implementing the instructions downloaded to it. Obviously, this transition from standard-specific to "general purpose" processing architecture brings significant gains in terms of flexibility to the network operator and also to the user. Currently, there is a one-to-one relation between the terminal and access network. This in contrast to the PC market, where the user has a choice from a number of different operating systems and applications software, and where the technological progress is "filtered down" to the user as software and hardware upgrades. For many, the latter should be the ultimate goal of SDR.

In some sense we are already experiencing the benefits derived by such an approach, as a number of mobile communications equipment manufacturers make use of common digital and analogue architectures in their design and production stages. By re-using a "similar" base catering for different mobile communications standards,

a manufacturer achieves considerable economies of scale. As a result, today the market prices of dual-mode terminals in Europe, implementing both GSM 900 and GSM 1800, are comparable to those of single-mode GSM terminals, and the addition of a third mode, usually PCS-1900, is economically feasible.

This perspective already represents a significant step forward for mobile communications networks. However, SDR concepts now extend well beyond the simple re-configuration of air interface parameters to cover the whole system, extending through the network into service creation and application development. There is no doubt that such a "radical" concept will require a phased introduction into mobile communications networks, with the first phase being dynamic applications downloadable into mobile terminals. Already, dynamic application download into Java-phones is being trialled in Europe.

In the future, we could see mobile networks completely controlled and dynamically re-configured by software. They would be capable of dynamically assigning resources to specific users, varying the coding and modulation according to load and QoS demands, and using different access techniques and frequency bands according to the environment and experienced load.

The next step would be to extend such concepts to the network, so allowing for truly intelligent adaptive operation. However, besides technological hurdles (e.g., re-configurable wide-band RF and IF components), issues such as downloading and associated security, and software accreditation have to be dealt with in advance.

Within the IST Programme, work on re-configurable radio concepts forms a significant element in RTD on mobile and personal communications. The emphasis is on systems, architectures and network concepts applied to emerging third generation cellular systems and mobile broadband systems. Advanced wireless local area networks including broadband wireless fixed access are also studied. A key goal is the study of mechanisms for secure downloading of applications code. Open architectures enabling the development and co-existence of multifunctional applications operating over heterogeneous networks are also a priority.

IST's SODERA project is defining and validating a radio architecture for SDR on third generation mobile terminals. The architecture will facilitate multi-modal operation covering GSM (900 & 1800, GPRS, EDGE), UMTS and CDMA. The work also involves design of radio front-end components using technologies such as biCMOS and micro-machining. MOBIVAS is defining and validating an application architecture for value-added services via downloadable SDR. The architecture will enable service providers to offer a variety of services directly to mobile users via the telecoms infrastructure.

PASTORAL aims to provide a re-configurable, real-time platform for the development of third generation mobile terminals. The platform will include re-configurable FPGA devices and will



Software radio will enable users to roam seamlessly between networks

be adaptable to GSM, WB-CDMA and TD-CDMA standards. IPR from the project will be input to on-going standards activities. TRUST is also developing re-configurable terminals that will enable the integration of many systems within the same platform. And CAST addresses the configuration of the physical layer in wireless communication equipment for terminals and base stations.

Further info		
IST Action Lines:	IST-2000 IV.5.1	
Project References:	CAST	IST-1999 10287
	DRIVE	IST-1999 12515
	MOBIVAS	IST-1999 10206
	PASTORAL	IST-1999 11251
	SATURN	IST-1999 10322
	SODERA	IST-1999 11243
	TRUST	IST-1999 12070
	WIND-FLEX	IST-1999 10025
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	Re-configurable radio systems and networks www.cast5.freemove.co.uk www.comnets.rwth-aachen.de/~drive www.mobivas.ccrle.nec.de www.ist-pastoral.org www.ist-saturn.org www.ist-sodera.org www.ist-trust.org www.vtt.fi/ele/research/els/projects/windflex.htm	

Stranger than fiction

Few areas of science are as impenetrable to the layman as quantum mechanics. This is partly because the quantum view of the world is so totally at odds with our everyday experiences. Phenomena such as teleportation – the transfer of quantum objects from one place to another without sending the objects themselves – seem to owe more to science fiction than to real world science.

Over recent years, however, scientists have recognised that quantum mechanics opens wholly new prospects for processing and transmitting information. Quantum approaches could revolutionise the way we handle, transfer and even define information leading, perhaps, to one of the most important breakthroughs in computing and communications since the emergence of the digital computer 60 years ago. The science involved is so close to fundamentals that completely new, as yet unthought of, ideas and applications will almost certainly emerge.

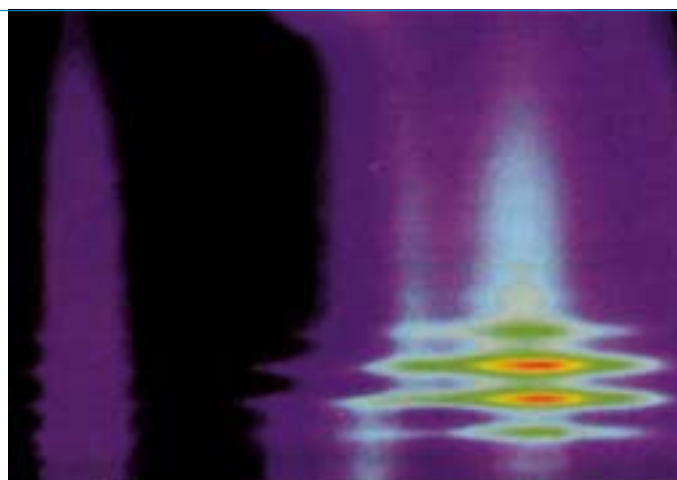
Spooky action at a distance

The QuComm project addresses issues in quantum communication and cryptography. The project aims to scale experimental quantum communication protocols for quantum cryptography and quantum teleportation and demonstrate them in real-world situations.

In quantum communication, the information to be transmitted is encoded on individual photons that are sent either in free space or through low loss optical fibres. Using non-linear optical effects, QuComm generates twin photons that are entangled in such a way that, irrespective of distance, any measurement of one affects the possible outcomes of measurements on the other. This is like having two dice that always show the same number, even if one is in Monte Carlo and the other is in Las Vegas. Albert Einstein famously described such quantum correlation as "Spooky action at a distance".

QuComm will undertake field trials of its technology, either in optical fibre networks with distances beyond 50km, or in free space at distances greater than one kilometre. Single-photon detection lies at the heart of many optical sensing applications and so interesting spin-offs are expected. Key areas for optical sensing innovations include wavelength division multiplexing for optical networks, range-finding and laser detection, and analytical techniques in the life sciences.

Wavelength and time-resolved image of a resonant tunnelling LED, from work by Esprit's PHANTOMS network



Since the early 1990s, scientific progress in quantum information has been rapid. It is now beyond doubt that a primitive quantum "computer" can be built and that fully secure cryptographic systems can be implemented. But while the scientific foundations of quantum information processing are increasingly secure, technological solutions are largely lacking. Can quantum computers be made that scale up and are cost-effective? What problems would they be able to solve? What other applications can be envisaged for quantum systems?

IST's Quantum Information Processing and Communications (QIPC) initiative aims to address these questions. Launched by the Future and Emerging Technologies (FET) action under IST's 1999 work programme, QIPC pulls together European expertise in the field to provide focus and build critical mass. It focuses on the development of novel systems and techniques for information processing, transmission and security that exploit the properties of quantum mechanical operations.

A key objective is the development of an elementary scalable quantum processor, which is likely to be an important step towards larger-scale quantum computing. Since it is impossible to select one specific technology for quantum computation at this stage, a variety of appropriate candidate systems are being investigated. Scaling properties and the ability to control decoherence (the destruction of the fragile quantum states because of interactions with the environment) are key considerations.

Another area of interest is quantum algorithms. So far there are few quantum algorithms that tackle problems of practical significance. Further "killer applications" for quantum computers are needed to demonstrate their potential and justify future investment.

Long distance and secure quantum communications is also a key theme. The ability to use quantum systems to transmit information at the laboratory scale is well demonstrated. But scaling these quantum communications protocols in distance and demonstrating their compatibility with the telecoms infrastructure, such as optical fibres, will be a highly demanding task.

One of the main technical challenges is in finding suitable methodologies to handle the inherent instability of quantum systems (decoherence). Another is the ability to store and retrieve information from quantum systems and to read-back results. And from a systems perspective, it will be necessary to design and develop components and processes that perform specific quantum tasks and can be used as building blocks of a QIPC system.

QIPC is supporting 13 projects, of which 3 deal with quantum algorithms and 4 with quantum cryptography. QUIPROCONE is a Network of Excellence connecting the other 12.

Further info		
IST Action Lines:	IST-1999 FET.P.1	Quantum Information Processing & Communications
Project References:	QUCOMM QUIPROCONE	IST-1999 10033 IST-1999 29064 www.ele.kth.se/QEO/qucomm/ ralph.dum@cec.eu.int ierpaolo.malinverni@cec.eu.int
Commission Contacts:	Ralph Dum Pierpaolo Malinverni	
Web:	www.cordis.lu/ist/fetqipc.htm	

Enabling Technologies

Tools for distributed computing

The trend towards distributed systems and services is heralding a revolution in our approach to computing. On the one hand, distributed approaches enable users to integrate and share legacy systems and applications within heterogeneous environments and in geographically-dispersed locations. In addition, distributed high performance computing (HPC) enables users to mobilise vast computer processing power to solve real-world problems in business and in scientific research. These very high-speed intelligent networks, known as grids, are opening the way to solutions and business practices that could not have been addressed before.

The IST Programme's RTD on distributed computing aims to help bring the power of HPCN and grid technologies to the business and research communities, enabling them to exploit the emerging developments in computing power, bandwidth and storage. One key focus is on the management of distributed networks and services. The work aims to develop and assess models, technologies and tools for the sharing and interactive use of applications and resources in distributed environments. Methods and tools to support network inter-working and management at the service level are also addressed, with an emphasis on increasing capacity, flexibility and functionality.

A data infrastructure for high-performance computing

A European standard for the storage and retrieval of multi-dimensional data for high-performance computing is being established under ESTEDI. The project addresses a main technical obstacle in HPC: the bottleneck in delivering large HPC datasets to users. This is achieved by augmenting existing application programmes with a flexible data management and extraction tool for spatial and temporal data. The multi-dimensional database system RasDaMan, developed under FP4, is being enhanced with intelligent mass storage handling, and optimised towards HPC. The applications targeted include fluid dynamics, climate modelling, cosmology, satellite imaging, and gene processing. The participating HPC centres will disseminate best practice to further centres and to European industry, and the data architecture itself will be commercialised by two SME partners.

The DOTS project aims to establish an open software model, built upon real-time distributed object technologies and emergent standards, to optimise the control of devices and systems within an electric power grid. DSE is building a multiplayer architecture to support the collaborative design, testing and verification of large programmes involving many contractors. The project is using common services supporting distribution and application-sharing based on international standards and tools.

CORVAL2 builds on the substantial work undertaken under Esprit regarding CORBA technology, an important platform for distributed computing. The work relates principally to new mechanisms and tools for testing conformance to the CORBA 2.3 and 3.0 specifications. IB is creating a software platform for business processes that require the integration of a variety of legacy systems and applications within heterogeneous software and hardware environments. The result will be a development environment that will help the user to define the logic of the business process, the data model to be used and the software modules with the different tools and legacy systems.



Rendering of 3D images by distributed processing using CINEMA-4D suite (Picture from Esprit project TTNATGMD)

High-speed film manipulation

The rapid growth in processor power over recent years, together with the associated development of computer algorithms, has created new commercial domains for distributed computing. One example is the digital manipulation of 35mm film. DIAMANT is developing a very large-scale distributed repository for media resources using off-the-shelf computation and state-of-the-art interconnect hardware. The system will permit the high-speed manipulation of uncompressed film, video and HDTV but could also be generalised to other application areas with similar demands, such as remote sensing and 3D medical imaging.

For the future, the challenge will be to meet the stringent requirements of real-time conditions within distributed environments. As distributed applications become mission-critical and more sophisticated, they are having to perform to much tighter real-time constraints. This calls for new approaches, architectures and tools, and hence a key focus in future RTD will be on development environments to support real-time distributed applications.

Further info IST Action Lines:

IST-2000 IV.2.1

Distributed systems and services provision

Project References:

CORVAL2
DIAMANT
DOTS
DSE
ESTEDI
IB

IST-1999 11131
IST-1999 12078
IST-1999 10258
IST-1999 10302
IST-1999 11009
IST-1999 10118

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Competing through microsystems

Sensors such as accelerometers are important components in the automotive industry. To compete in the world market, a new class of sensors is required with better performance, reliability, system compatibility, interchangeability, and lower unit costs. A series of projects supported under Esprit demonstrate the way in which European RTD programmes are helping European industry stay competitive through adopting microsystem technologies (MSTs).

For accelerometers, silicon-based sensors, using micromachining technologies to create the sensor function, were recognised as a promising candidate to fulfil automotive requirements. Microsystem technology, involving monolithic integration with microelectronic circuits, presented the opportunity to improve the quality of sensor systems. Potential applications were identified in: air-bag and safety restraint systems; adaptive and active suspension systems; braking and tracking control; and navigation and guidance.

The Esprit project MAXIMA, launched in 1992, was concerned with proof of concept for a multi-axial monolithic integrated accelerometer. The project established the compatibility of micromachining techniques with existing industrial IC fabrication lines. A complete process flow for monolithic integrated smart sensors (MISS) was also developed, together with associated methods for characterising materials, design rules and software tools.

Having established the basic smart sensor technologies, the follow-on project Si-Gyro was concerned with performance improvements and industrialisation of the technology. Launched in 1996, the aim was to develop a surface micro-machined one-axis gyroscope based on a technique known as thick polysilicon surface micro-machining (TPSM).



Detail of the silicon-based accelerometer developed under Si-Gyro

The work focused on improvements to meet the stringent requirements of the gyroscope application in terms of critical material and process parameters. These included control of stress and stress gradients in the active polysilicon layer, surface roughness, and inclusion of a buried polysilicon contact layer. The high density plasma etching process was also improved: this is the key process for silicon surface micromachining which determines the quality of the sensor structures. Other manufacturing aspects were also optimised, such as the housing and vacuum encapsulation of the sensor elements. Initial circuitry was realised on a separate chip and combined with the sensing device by hybrid mounting. The project also established a club of automotive end-users to agree a broadly based specification.

Under Europractice, the EU's microsystems take-up initiative, the innovation has been taken one stage further into full design and production. Working with one of Europractice's design houses, a consortium led by the German manufacturer Bosch has written design rules for the micro-gyroscope which have enabled it to enter a full production phase. Bosch has incorporated the device into a new automotive application, the design and manufacture of which provides employment for 200 people. From September 2000, Volvo has used the sensor in its smart airbags and other product applications will follow.

Further info IST Action Lines:

IST-2000 IV.7

Peripherals, subsystems
and microsystems

Project References:

MAXIMA
Si-Gyro

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