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R&D in Advanced Communications Technologies for Europe (RACE) - Mid-term Report on Phase II of RACE (1990-1994) -

(presented by the Commission pursuant to Article 4 of the Council Decision of 7th June 1991:
91/352/EEC on the Specific Programme of Research and Technology Development in the area
of Communications Technologies: RACE Phase II)

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Executive Summary

Telecommunication now underpins most industrial activities and is central to the performance of the service sector in Europe. Good telecommunications are crucial to business competitiveness and to the creation of new employment in the service and media sectors of the economy. The completion of the European Economic Space with no internal barriers to trade will open new opportunities and present new competitive pressures, and the increasing importance of telecommunications in international trade is already changing the way businesses operate. The prosperity of Europe in the 1990s will be critically dependent on good communications.

The central importance of trans-European communications infrastructures and services has been recognised in the Commission's White Paper on growth, competitiveness and employment. Of the eight key areas for investment stimulation identified in this report, three are directly concerned with the new opportunities opened up by the research and technology developments addressed by the RACE Programme: The development of a high-speed information infrastructure for Europe; the emergence of interactive digital video services as the driving force for integration of the TV and telecommunications sectors; and the development of telework as a way of realising new competitive advantages for business, new flexibilities in employment, energy saving and environmental protection.

The telecommunications, computing and broadcasting sectors already account for an annual turnover of over 500 billion ECU in the world. By 2000, the telecommunications sector will be the third largest in Europe, after food & drink and chemicals. Telecommunications infrastructures will be economically more important than the physical transport infrastructures.

Mastering the technology options has therefore become a key to economic growth and the creation of new employment. Over 50% of employment already depends on use of information and telematic systems, and the major growth in employment is in the information management and media sectors.

Demand for services is changing rapidly. Businesses need more flexible services, higher transmission capacities for fast data and image transmission and more competitive tariffs. Most major European companies now require fast data communications between their design, manufacturing, management and retailing activities. Demand for such services is already strong in the US: all major research institutes have access to very high-speed data communications, and 60% of the top 500 companies make use of high-speed digital transmission links.

The Decision on the first phase of a 10-year RACE Programme (Research and development in Advanced Communications technologies in Europe) was adopted by the European Council of Ministers in December 1987. This decision established the policy direction and a budget provision for an initial period of five years, to 1992, within the EC's 2nd Framework for Research and technology development. The second Phase of the RACE programme has been implemented as the Specific Programme on Communication technologies in the 3rd EC Framework Programme. This report on its implementation through Calls for Proposals in 1991 and 1993 is in relation with Article 4 of the Council Decision of June 1991 which requires that in the second year of implementation of the programme the Commission should examine it and report to the Council and Parliament.

The achievements of the first Phase of work (1988-1992)

The objective of the RACE programme, defined in 1987¹⁾ is to "promote the competitiveness of the Community's telecommunications industry, operators and service providers in order to make available to final users, at minimum cost and with minimum delay, the services which will sustain the competitiveness of the European economy and contribute to maintaining and creating employment in the Community".

As a result of the work carried out in the first five years of the RACE programme, Europe has a clear lead in the conceptual development of advanced communications networks and services. For the first time, telecommunications operators, the telematics industry and leading-edge users in most major application sectors have joined forces in development of the advanced communications technologies required for low-cost and innovative services. A unique environment was created in the RACE programme for concertation of their efforts.

The first Phase of the RACE programme strengthened the harmonisation of the European Telecommunications infrastructure; the development of Common Functional Specifications provided a "blue-print" for Integrated Broadband Communications. It fostered the close co-operation of central and peripheral regions, and contributed to the economic and social cohesion of the Community. In terms of technology development, development of the Asynchronous transfer mode for high-speed switching of digital communications gave European industry a lead in international competition;

The research on network management gave European network management systems international recognition; The work on digital

video and TV prepared the way for international standards for coding, multi-gigabit signal distribution systems and specifications for digital video-recording. Projects in the first Phase of RACE contributed 596 draft specifications to European and international bodies and published over 1700 scientific and technical papers in the open literature (Ref to RACE I Final report). In 1992, the Commission reported on the programme in the context of its Evaluation of the 2nd Framework Programme²⁾, and the RACE Management Committee carried its own evaluation at the request of CREST³⁾. A Final report on Phase I of RACE was communicated to the Council and Parliament in March 1992⁴⁾.

Phase II (1991-1994)

The work started under the first phase of RACE has now been followed-up and broadened by R&D projects under the new Specific RTD programme on communications technologies, the second Phase of RACE. This is part of the EC's 3rd Framework Programme, and provides for EC part-funding of R&D until December 1994⁵⁾. Following a first Call for Proposals in June 1991, most projects started work in January 1992, and the overlap RACE Phase I projects in 1992 has ensured continuity in the work. With the financial re-inforcement of the 3rd Framework Programme in 1993, as second Call for proposals was published in May 1993. Some key projects have been re-inforced and extended, and a second set of complementary projects started work in January 1994.

²⁾Communication from the Commission on "Evaluation of the second Framework Programme for research and technological development (SEC(92)675 Final), July 1992.

³⁾Reproduced in Section 3.2.1 of the final report in RACE

⁴⁾Communication of the Commission to the Council and European Parliament, COM(93)118, March 1993.

⁵⁾ Council Decision 91/352/CEE of 7th June 1991 adopting a Specific Programme of research and technology development in the field of Communications Technologies: OJ N° L192/8, 16.7.91

¹⁾Council Decision 88/28/EC of 14 december 1987 on a Community Programme of research and technology development in the field of Telecommunications Technologies: O.J. No L 16/35 21.1.88

The Programme will continue to make a significant contribution to Europe's economic development and socio-economic integration. It is accompanied by national activities⁶) and international actions, such as those of EURESCOM⁷), which reinforce the EC activity, and which are reinforced by it. The RACE programme is a unique framework within which Telecommunications network operators, industry and users all co-operate.

Management and evaluation of the RACE programme

The RACE programme is managed as a fully integrated set of tasks; each project has addressed one or more of a coherent set of R&D tasks, each of which has contributed to a single objective of the *"Introduction of Integrated Broadband Communications, taking into account the evolving ISDN and national introduction strategies, progressing to Community-wide services by 1995"*.

The Workplan for the programme sets the framework for the work of each project and for their interaction. This interaction has further been reinforced by regular "Concertation" between projects, technical discussions at 6 - 8 week intervals in which all projects participate. The technical results of the projects have further been consolidated by a core project responsible for development of IBC implementation strategies and interaction with European standardisation bodies.

The evaluation and auditing of the work in the programme has reflected the strongly integrated nature of the programme.

At the programme level, in 1991 and early 1992, the first Phase of work was evaluated, in the context of the other major IT and Telematics application programmes of the 2nd Framework Programme (ESPRIT and DRIVE) by an independent Panel⁸).

A Strategic Audit was carried out in 1993 to review the development of advanced communications in Europe and the strategic and policy objectives of the Community. The results of this review were presented to Members of the European Parliament in June 1993.

The research and technology development within the programme has been accompanied by regular assessments of the economic and social impact of developments in advanced communications⁹) The most recent of these assessments was carried out in 1993 and disseminated in March 1994

At the Project level, each project has been subject to a "Technical Audit" by independent experts in the relevant field of research every year. Technical Audits for Phase II projects took place in October 1992 and in October 1993. The results of these annual audits have been used to re-direct or terminate the work of Projects when necessary.

These evaluations and audits have all shown that the RACE Programme has been successful in relation to its original objectives.

⁶) Broadband communications trials are underway in, most EU + EFTA countries.

⁷) European Institute for research and strategic studies in telecommunications GmbH.

⁸) The report of the information and communications technologies reviewd Board, Chaired by Mr.W.DEKKER, June 1992.

⁹) The reports of these assessments have been published and widely disseminated as the series of reports on "Perspectives for Advanced Communications in Europe: PACE".

R&D in Advanced Communications technologies for Europe (RACE)

- Mid-term Report on Phase II of RACE (1991-1994) -

1. Introduction

Today, the telecommunications industries account for an annual global market in terms of services of ECU 285 billion; ECU 84 billion of which is in the European Union. The equipment market is worth ECU 82 billion at world level, and ECU 26 billion in Europe. The annual growth in value of telecommunications services is now about 8%, and 4% for equipment. The telecommunication sector will represent about 6% of European GDP by the end of this century. Investment in telecommunications networks and services is running at close to 30 billion ECU per year. The revenue is still largely associated with voice telephony, but most current capital investment is in the new generations of digital equipment, which can support the integration of voice, data and image communications. By 2000, as much as 30% of telecommunications revenues could be associated with value-added services using advanced data communications.

World-wide, all spheres of life are affected by the convergence of information technology, broadcasting and telecommunications. The combination of data processing techniques with innovative ideas in telecommunications has already led to the implementation of Integrated Services Digital Networks, but these are only a first step in a rapid evolution to a much wider range of multi-media services which will require new technologies, network and service management systems and new regulatory systems. The combination of service integration together with optical fibres offering cheap high-speed transmission (a million times greater capacity than over copper wires)

provide the techno-economic basis for a fundamental restructuring of all of the sectors through Integrated Broadband Communications (IBC). The development of this concept is the goal of the RACE Programme.

The present report documents the implementation of the second Phase of the 10-year RACE Programme, from 1991 to 1993.

The context and organisation of the Programme are described in Section 2 and 3, participation is described in Section 4; and programme evaluations and audits are summarised in Section 5. Links with other EC and European actions are described in section 6. The results of the R&D in the first phase of RACE have already been widely exploited, both in development of standards, in new network and service developments, and as a basis for further work in Phase II of the programme. The exploitation of the results of work underway in Phase II of RACE is described in section 7, and future requirements and options for work at European level are described in Section 8.

R&D projects in Phase II are described in Annex I. The participating organisations are listed in Annex II, and statistics on the participation are given in Annex III. The recommendations of the 1993 Strategic Audit of advanced communication developments are reproduced in Annex IV; a glossary of technical terms is given in Annex V, and a list of references to the formal Decisions of the Council of Ministers and Communications of the Commission is given in Annex VI.

2. The context and organisation of the Programme.

2.1. R&D as part of the Union's Telecommunications policy

The RACE Programme forms an integral part of the telecommunications policy of the European Union. Linked to the liberalisation and re-regulation of the telecommunications sector, standardisation policy and the information market policy, it builds on information technology developments in the framework of ESPRIT, and for the first time involves the European telecommunications network operators, as major actors, in collaborative technology and service development. By addressing the future cost-performance of the communication infrastructures in Europe, the RACE programme has contributed to development of the single market, the international competitiveness of European industry and to the social and economic cohesion of the Union.

The major goals of the telecommunications policy of the Union, first set out in the Council Resolution of June 1988¹⁾, are to:

- Create or ensure Community-wide network integrity, based on the principle of full interconnectivity between all public networks concerned,
- Progressively create an open common market for telecommunications services,
- Promote the creation of Europe-wide services according to market requirements and social needs,

- Further develop an open, Community-wide market for terminal equipment,
- develop a common market in which telecommunications administrations and other suppliers can compete on an equal footing.
- continue Community measures regarding common standards;
- stimulate European co-operation at all levels, particularly in the field of research and development of telecommunications,
- create a social environment for the future development of telecommunications, and,
- integrate the less-favoured areas of the Community fully into the emerging Community-wide market.

In 1992 and early 1993, a major review of the telecommunications service sector resulted in a Commission communication²⁾ on the findings. The recommendations were adopted by the Council³⁾. These policies have provided a clear framework within which the development of communication technologies has been able to complement changes in regulations and standardisation.

¹⁾Council resolution of 30th June 1988 on the development of the common market for telecommunications services and equipment up to 1992; 88/C 257/01; O.J. No C 257/1, 4.10.88.

²⁾Communication to the Council and European Parliament on the consultation on the review of the situation in the telecommunications services sector, COM(93)159 final, 28.4.93.

³⁾Council resolution of 22.7.93 on the review of the situation in the telecommunications sector and the need for further development in that market (93/C213/01; O.J. C213/1, 6.8.93)

2.2 The objectives of the RACE Programme

The main objective of the RACE programme is to contribute to the *"Introduction of IBC⁴⁾ taking into account the evolving ISDN and national introduction strategies, progressing to Community-wide services by 1995⁵⁾"*

The specific objectives of Phase I were:

- to promote the Community's telecommunications industry;
- to enable European network operators to compete under the best possible conditions;
- to enable a critical number of Member States to introduce commercially viable IBC services in 1995;
- to allow service providers to improve cost-performance and introduce new services; to make new services available at a cost and on a timetable at least as favourable as elsewhere;
- to support the formation of a single European market for telecommunications equipment and services, and to contribute to regional development by allowing less developed regions to benefit fully from telecommunications developments.

For Phase II, the objective⁶⁾ is to enable the integrated Broad band network to take on the emerging new services, constructed on "open" standards, and to make the use of integrated services both flexible and cheaper. In addition, a number of technical objectives were set out in Annex II to the Framework programme Decision, and in the Annex I to the Decision on the Specific Programme. The contribution of RACE R&D projects to these objectives is described in Table I.

During the development and implementation of the programme, the interpretation of the concept of Integrated Broadband Communications has evolved in response to changing market and regulatory conditions. The definition below reflects the consensus developed within the RACE Management Committee during 1990.

⁴⁾"I" "Integrated" not only means "integrated services" (at the user level and at the appropriate network levels, it also points to "integrity" of the whole network, and therefore to the proper interworking of all its essential constituent, including the existing and emerging ones: telephony, packet-switched data, ISDN, satellite, mobile, etc.

"B" "broadband" not only means the high-end" (in terms of bit-rate) portion of the services, it also designates the total mix of services to be considered, starting from the "upper end" of ISDN (e.g. certainly including 2 Mbit/s accesses, and possibly even 64 Kbit/s in specific application areas), up to what will be required by a realistic introduction of video (interactive and distributive) services (e.g. 140 Mbit/s).

"C" "Communication" not only means the "conventional" switching/transmission/CPN functions, it also includes the most advanced features to make services provision user-friendly, performant and economically sound.

⁵⁾Council Decision of 14 December 1987 on a Community programme in the field of telecommunications technologies - R&D in advanced Communications technologies in Europe (RACE programme); 88/28/EEC: O.J. No L 16/35, 21.1.88.

⁶⁾Set out in Annex II to the Council Decision of 23rd April 1990 concerning the framework programme of Community activities in the field of research and technological development (1990 to 1994) (90/221/Euratom, EEC)

3. Implementation of the programme

3.1 Phases of implementation

In view of the rapid evolution of the telecommunications sector in Europe, it was decided from the beginning that a phased implementation of the RACE programme would be most appropriate, so as to ensure the necessary flexibility and responsiveness to changing circumstances. Therefore, the programme began with a Definition Phase⁷⁾ during 1986, involving major participation from industry experts so as to provide a solid foundation for the future programme.

This was followed by Phase I of the RACE, which formally began in June 1987, and which ended in December 1992. Key themes in Phase I of the programme were supporting the development of standards for the newly emerging Broadband communications technologies, the development of necessary new equipment and components, and a series of application pilots to trial the new communications means which were beginning to emerge.

The RACE programme had been envisaged as a ten-year programme of work, to be implemented in two phases, and indeed by 1991 an important shift in perception had occurred. What had seemed to be an ambitious, almost futuristic, vision at the beginning of the programme had matured to a realistic opportunity - commercial introduction of Integrated Broadband Communications was now confidently expected within four years. Moreover, it had become increasingly evident that telecommunications and advanced information services would play a key role in world socio-economic development as we approach the 21st century.

⁷⁾Council Decision of 25th July 1985 on a definition phase for a Community action in the field of telecommunications technologies - R&D programme in advanced communications technologies for Europe (RACE): 85/372/EEC; O.J. No L 210/24; 7.8.1985

These circumstances led the European Parliament and the Council of Ministers to give priority to adoption of the new Specific Programme⁸⁾, thus the second phase of RACE was adopted as a Specific Programme within the Third EC Framework Programme for research and technology development in June 1991. It was the first of those in the Third Framework Programme to be adopted, and the Workplan was immediately the subject of a favourable opinion of the RACE Management Committee.

A first Call for Proposals was published in June 1991; the proposals were evaluated in September and October 1991. Over 200 proposals were evaluated and 95 projects started work in early 1992. These projects are scheduled to complete their work, within the current budget provisions, by the end of 1994. Following the financial re-enforcement of the Third Framework Programme by the Council in December 1992, a second Call for Proposals was published in May 1993. The additional projects resulting from the evaluation of these proposals started work in January 1994. All the RACE Phase II projects are detailed in an annex to this document.

Whereas the projects in Phase I of RACE concentrated on the evaluation of options, those in Phase II prepare for the introduction of IBC. Telecommunications, and switching and transmission in particular, is one of the rare high-tech sectors in which Europe is one of the world leaders, and the work in RACE was designed to maintain and increase this lead.

A further important aspect is harmonisation, both for the Single Market and to achieve the necessary economies of scale. For example, a significant consequence of the consensus on ATM which has emerged is the elimination of

⁸⁾ Council Decision 91/352/CEE of 7th June 1991: O.J. No L 192/8, 16.7.91

functional disparities between the various operators' future networks. This facilitates international interconnection and interoperability, and greater compatibility among services, and it eliminates delays and additional costs caused by adaptations. The reduction in cost also enables manufacturers to focus their energies on new developments, thus making them more competitive. Also, R&D work involving the integration of a range of sub-systems into specific components is demonstrating that the technologies and skills are available to produce system components economically and on a large scale.

The RACE II projects reinforce the collaboration and commitments already made by industrial users, the telematics industry and telecommunications operators in RACE I. The focus of the new R&D is on applications, services, operation and management, but maintains a high level of technology development to consolidate and extend the key areas needed for realisation of cost-effective provision of IBC services.

3.2 Structure of activities

A full description of the individual projects in Phase II, and of their inter-relationship with the Phase I projects, is available in the programme Annual reports for 1992 (RACE '92), 1993 (RACE '93) and 1994 (RACE '94).

The projects cover the eight priority areas for research which were identified in the Annex to the Council Decision:

AREA 1	IBC (Integrated Broadband Communications) R&D
AREA 2	Intelligence in networks/flexible communications resource management
AREA 3	Mobile and personal communications
AREA 4	Image and data communications
AREA 5	Integrated services technologies
AREA 6	Information security technologies
AREA 7	Advanced communications experiments
AREA 8	Test infrastructures and interworking.

The distribution of the financial resources of the programme over these areas, including the 13.3% reinforcement in 1993, is summarised in Table 1. Brief description of work in each area are given in the following section.

The ways in which Phase II projects address the technical objectives specified in the Decision on the 3rd Framework Programme and Annex I to the Specific Programme are described in Table 2.

The contribution of each project to the Phase II objectives are described in Annex I. The projects in the 2000 series started in January 1992. The projects in the 2100 series started in January 1994 and end in December 1995.

TABLE 1
SUMMARY OF USE OF FINANCIAL RESOURCES IN PHASE II OF THE RACE .
PROGRAMME

PROGRAMME AREA	DECISION (MECU)	REINFORCED (MECU)	TOTAL (MECU)
Area 1	111	9	120
Area 2	43	5.4	48.4
Area 3	53	9	62
Area 4	68.11	14	82.11
Area 5	39	4	43
Area 6	29	2	31
Area 7	121	13	134
Area 8	20	8	28

3.3 Project activities in each Area

3.3.1 Area 1: Integrated Broadband Communications R&D

This area of the programme is concerned with Integrated Broadband Communications R&D. Broadband services and applications are only possible if a broadband physical infrastructure exists to support them. Only optical fibres can currently provide the bandwidth required by all the services envisaged by IBC. The technology research and development for IBC in this area of the RACE programme is therefore strongly focused on fibre optics, and the Trans-European Networks for telecommunications will be largely based on optical fibre technology. The future optical infrastructure must and will meet the challenges imposed by the convergence of the telephony, data and cable TV networks. The work in this area is therefore concentrated on research and development which is highly relevant to the future needs of telecommunications users in Europe.

A primary objective is to ensure that all users who wish to have access to Broadband services will be able to do so at economic cost, anywhere in Europe. Users will therefore require direct Broadband connections to the optical fibre network.

Another important area of activity is to develop the fixed fibre infrastructure necessary to support the growing demand for mobile services.

Thus the main priorities for Area 1 are:

- to develop the concepts, architecture and definition of networks and transport systems based on optical technology
- the development of the network and system technology, transmission techniques and network management, closely related to the development of optical components and equipment
- the development of the technology basis for high performance low cost optical devices and modules
- the advanced development of new materials, technologies and transmission techniques to support all requirements of future IBC networks.

3.3.2 Area 2: Intelligence in networks/flexible communications resource management

This area of the programme is concerned with intelligence in networks and flexible communications resource management.

The provision of increasingly sophisticated services supported by universal integrated Broadband communications requires increasing intelligence to be built into the operations and management of networks and services. The effective management of their resources has long been a concern of telecommunication operators and the advent of multi-service/network providers has increased the need for a more structured approach to be taken to management. Considerable progress has been made in the last few years on the standardisation of a Telecommunication Management Network (TMN) framework architecture and activities within RACE have made a major contribution to these standards. There is now a need to concentrate more on the management of services and the relationship between various domains of service/network management in a multi-service/heterogeneous network environment. Another area requiring further investigation is customer access to management applications.

The planned integration of fixed and mobile communications offers the opportunity to provide a new concept in telecommunication services in which use of an identical personalised set of services is available to a person irrespective of his current location (home, office, car, visiting office, remote site etc.) and irrespective of the particular terminal device which is used to access the service. This concept, which is aimed at extending the UPT (Universal Personal Telecommunications) concept, is called the "Personal Service Communications Space".

Thus, the main goals of work in this area are:

- to continue to make major contributions towards the evolution of a standardised TMN reference configuration,
- to define coherent and agreed concepts and architecture of Service Management,
- to validate the recommended management approaches by undertaking case studies and trials,
- to make major contributions towards defining the concept of Personal Service Communication Space as an extension to the concept of UPT
- to define and validate the architecture and components required to realise this PSCS service

3.3.3 Area 3: Mobile and personal communications

This area of the programme is concerned with mobile and personal communications. Recent market developments and initiatives taking place in Japan and North America, indicate that in order to meet the challenges of globalisation and international competition, very significant efforts should be devoted in particular to the development of mobile/personal communications networks, systems, products and services, as a means to capture a significant percentage of the world market. Within the European Union, it is hence of strategic importance that the efforts pursued at a national level be complemented by Commission-sponsored projects aiming at the development not only of a pan-European market but also of world markets.

Current market studies indicate that Europe is mobile-aware and close to entering a mass-consumer market for mobile

telecommunications. The most successful national market currently supports a mobile penetration of about 10%. To achieve the predicted higher penetration levels will require broadening the user community to the general public and at the same time offering more advanced and diverse services to the business community.

Work in this area of the RACE programme contributes to the development of Third Generation Mobile Telecommunication Systems, conceptualised by the Universal Mobile Telecommunications System (UMTS) and Mobile Broadband System (MBS), intended to realise true personal mobile radio communications from anywhere within Europe, and to allow people to communicate freely with each other from homes or offices, cities or rural areas, fixed locations or moving vehicles.

The primary objective of the work in this area, particularly in the case of projects dealing with UMTS, is the contribution to standardisation activities. Activities in support of standards development encompass:

- the study of network issues including network management, mobility management, resource management, security aspects, etc.,
- the comparative evaluation of the two rival radio access techniques, namely CDMA and advanced TDMA, through the development of common assumptions and the establishment of performance assessment scenarios,
- the study of all aspects related to the integration of the UMTS satellite component into the fixed network infrastructure,
- the research and development of technologies,
- the marketing aspects, service creation, quality of service, service

requirements, evolution and implementation strategies, operational and functional requirements.

In the case of MBS, which is the second aspect of the work in this area, the standardisation stage is likely to be reached later. Hence the work focuses mainly on the development of the enabling technologies, expected technological evolution and economic feasibility of mobile Broadband services.

3.3.4 Area 4: Image and data communications

This area of the programme is concerned with image and data communications.

The concept of Integrated Broadband Communications is inherently multi-media. The integration of existing telecommunication, broadcast, and personal computer services will create the evolution space for a vast array of new multimedia services which are more tuned to the totality of human senses. Images should ultimately be treated with the same ease as voice and data are today, both specifically and as part of an integrated multimedia communication process. Image communication will impose new challenges on the network operator (e.g. fast response, high bit rates), the service provider (e.g. developing attractive multimedia services), and the end user (new ways of user-service interaction).

Among IBC services, the most demanding information transmission requirements come from image communication services in general, and from high definition television (HDTV) in particular. It is expected that services involving digital video will form a major part of IBC traffic by the time that an integrated Broadband digital network is implemented in Europe. Digital video will not only be used for mass home entertainment, but will also be an important component of many image

communication services in many environments. A significant amount of work in this area is therefore devoted to optimising the arrangements for conveying conventional TV/HDTV signals through Broadband network, thereby creating an attractive environment and opportunities for further exploitation of these new technologies.

The two main objectives of the work in this area are:

- to exploit the potential of IBC for the emancipation of image communication
- to develop systems for IBC for image communication and distribution services.

The calls for proposals in 1993 have resulted in a considerable increase in the number of projects and extension in this area of work. The new projects are in the areas of image transmission, multimedia services and in image encoding and decoding chips, and they much improve the coverage of the area.

3.3.5 Integrated services technologies

This area of the programme is concerned with integrated services technologies.

Service engineering is the process of defining, creating, deploying and maintaining user and management services. In the increasingly competitive environment anticipated for the provision of services, new services will need to be conceived and created rapidly and cost-effectively in response to user requirements. Nor are these services expected to remain static. As users gain familiarity with, and confidence in, the initial advanced service offerings, new requirements will arise and service providers will need to be continuously enhancing their services to maintain and extend their customer base.

The Service Engineering process needs to address the requirements of the market

place for interoperable services in a multi-service/network provider, multi-vendor environment with the high level of performance, integrity and availability expected of telecommunication services; services which address the needs of a wide diversity of potential users with different skill levels and perceptions of requirements.

Projects in this area address issues arising from the particular needs of service engineering. In particular, they address:

- the need for a better understanding of user requirements, including those users with special needs,
- the need to provide a framework for the definition of re-usable service components and their interaction with other service and network components,
- the need for means to ensure cost effective creation of new services within the above framework.

Thus activities within this area make an important contribution to defining and investigating an Open Services Architecture for telecommunications.

3.3 6 Information security technologies

This area of the programme is concerned with information security technologies.

The basic objective of these R&D actions in the field of Information Security can be stated as that of providing validated specifications, guidelines and technology for practical and effective information security for the development, implementation, and operation of advanced communications-based applications and services, in particular at a pan-European level, for general users, the business community and public administrations, without compromising the interests of the public at large.

The economic provision of trustworthy electronic information implies the application and incorporation of a variety of security techniques and procedures into the various components involved. Advantage can be taken of the fact that the same common technology may be used to meet the different needs of the telecommunications infrastructure, the service environment, the enterprise network and the user space.

While technology may be common and local aims the same, there can quickly arise contradictions between the efforts of the different players. A communication service may need to be supplied and managed in ways that avoid fraud and the actual content of a particular communication may also need to be protected. But different players will view the relative importance of these two requirements differently, and the costs involved and the desire to assume responsibility may also vary between actors. There is therefore a need to have clear definitions of what is supplied and what guarantees are given so that individuals and companies can cost effectively assume their proper responsibilities. Security technology and protocols have to be developed and implemented to match the social, commercial and contractual interfaces involved.

Information security systems must protect privacy and intellectual property, allow fair competition, and still meet the needs of law enforcement and national security. The future challenge is to meet the complex, sometimes contradictory needs of the general public, business and administrations. While the security elements necessary for the European information space must be made available if society is to profit from its investments in telecommunications and broadcasting systems, widespread acceptance and approval by all parties of these elements is also important to safeguard legitimate interests and to prevent misuse of information and of security techniques.

Actions in this field require concerted efforts on technological development, standards, verification and certification procedures and regulation.

3.3.7. Advanced Communications experiments

This area of the programme is concerned with advanced communications experiments (ACEs).

Advanced Communications Experiments provide the opportunity for those concerned with the provision of advanced services or equipment to interact with real users who eventually will be the customers for the new services or equipment. In this way, service and equipment providers are able to assess the true requirements of users in real working situations; and the future users of advanced services are able to assess the feasibility of their requirements in an experimental situation, and the capability of the service or equipment providers to answer their needs.

Associated with the full spectrum of needs exhibited by users from a wide variety of industrial sectors, it is possible to extract commonalities of requirements and to bring these together into a smaller number of "generic applications". This approach provides a common way of supporting the applications required by many different sorts of users.

Each project needs to maintain a good balance between application definition, application validation, and technology development. There is a high priority requirement to match experiments to networks, to ensure maximum community coverage, and to avoid duplication.

The key objectives for ACE projects are:

- to advance understanding of users' needs and wants for advanced communications,

- to identify by a process of trial implementation the range of advanced communications applications and services required by many different business functions and sectors, and to determine the benefits and opportunities provided by advanced communications in a realistic experimental environment,
- to promote awareness of realistic exploitation opportunities offered by advanced communications,
- to provide feedback, particularly in relation to those service attributes and system specifications considered crucial to the viability of the application,
- to assist in the specification and verification of the generic applications,
- to verify the economic, commercial and technical feasibility of applications of advanced communications facilities.

3.3.8 Test infrastructures and interworking

This area of the programme is concerned with test infrastructures and interworking. Thus projects in this area are horizontal R&D activities supporting the work in the other areas.

The last phase before the introduction of IBC technology by 1995 is to ensure that all elements will interwork at all levels and satisfy all user needs and constraints. This implies a timely testing phase of trials and experiments to verify technology, user acceptance, Quality of Service, and compliance with standards and regulations.

Over the last several years, in parallel to RACE's efforts in developing Broadband technology, the European network operators have installed a considerable optical fibre infrastructure. In addition, supported by national or European Commission-sponsored programmes, several national testbeds for Broadband communications have been or are being set up in various locations; the so-called IBC islands. These testbeds are based on different technologies, have different objectives and require transborder connections. Therefore RACE projects belonging to this area identify common elements that form the basis for introducing IBC interoperability at all levels, and at the same time use current available networks (including the IBC islands) to provide a first step for the introduction of IBC. An important objective is to stimulate the demonstration of Broadband communications in Europe by interconnecting IBC islands and high performance computing centres in different member states, ultimately helping to provide Europe with a ubiquitous Broadband network - the European initiatives on information Highways

TABLE 2
CONTRIBUTIONS TO TECHNICAL OBJECTIVES

Objectives of Area 1: Integrated Broadband Communications R&D

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
Common understanding of the IBC evolution and its implications	Identification of harmonised implementation strategies, taking into account the diversity of existing infrastructure and user needs	Clear definition of the important issues and concepts of IBC
Common definition of IBC systems and sub-systems	Studies of optical fibre and ATM network design and topology, extendible to pan-European networks	Proposals and models for pan-European all-optical networks. Harmonisation of transit and local network architectures
Identification of technology and R&D requirements	Systems and related components and performance /cost comparisons, including WDM, TDM, SDH, ATM	Enables higher quality and improved performance of systems. Cost reductions of local access connections
An understanding of the cost-effectiveness of alternative implementation routes	Development of common tools for techno-economic and operational assessments.	Common tools have been developed for techno-economic analysis, for advanced network planning and management.
Analysis of standardisation requirements	Inputs to CMP and to ETSI. Generation of consistent set of reference models for novel network architectures.	Consensus on harmonised European approach to IBC infrastructure specification

Objectives of Area 2: Intelligence in networks/Flexible communications resource management.

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To enable second-generation systems to exploit foreseeable progress in data processing	Prototype implementations of emerging standards-conformant service and management components	Acceleration of availability of standards-conformant products from multi-vendors, interworking to provide advanced, managed telecom services Validation of emerging standards
To contribute to standardisation and definition of interconnection protocols	Development of an architectural framework for the definition of inter-operable network and service management systems Exploration of the implications involved in realising new concepts in personal communications	Common functional specifications and inputs to standardisation bodies: ETSI, ITU-T on Telecom Management Networks. Common functional specifications and inputs to standardisation bodies: ETSI, ITU-T on the evolution of UPT and IN.

Objectives of Area 3: Mobile and personal communications

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To contribute to the definition of standards necessary for the 3rd generation systems (UMTS - The Universal Mobile Telecommunications System)	Work on planning tools, traffic analysis, fixed network integration, network modelling and management, mobility management, adaptive air interface, service creation & deployment, cell design, access schemes, coding and modulation. Identify evolution and implementation scenarios. Carry out field trials	Contributions to the development of Common Functional Specifications and significant input to standardisation bodies: ETSI-SMG5, CCIR, CCITT and ISO.
To permit the exploitation of new hyperfrequencies in mobile communications: (MBS - Mobile Broadband System)	Specification of a system concept, design of demonstrators and millimetre wave transceivers permitting data rates necessary for video transmission. Expected evolution and economic feasibility also investigated.	Contribute to the development of the basic enabling technologies (MMIC technology, in particular using pHEMT processes) and the system concepts for mobile broadband at 60 GHz

Objectives of Area 4: Image and data communications

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To integrate image into multi-media communications	Development of interworking technology for transmission by ATM, cable, fibre, satellite and radio Development of multimedia storage system, video-on-demand services, access control and copyright protection, user friendly interfaces	Promote digital TV distribution by various means Rapid uptake of audio-visual services with European technology
To ensure the development of allied protocols and coder-decoders	Development of low bit rate coding, cost effective VLSI codecs, transcoding VLSI Development of 3D TV image synthesis and studio CPN	Impact on world audio-visual standards i.e. MPEG 2 Improved support for industry, education, research, medicine and TV production

Objectives of Area 5: Integrated services technologies

Technical objectives	Ways in which Phase II projects addresses these objectives	Impact of the RACE work
To ensure the ease of use of new service by small and medium-sized undertakings	Development of design guidelines in the implementation of user-service interfaces, to ensure widespread acceptability to users User trials of prototype implementations of user-service interfaces, in particular those exploiting new technology and mechanisms	Common Practice Recommendations Validation of design guidelines. Acceleration of the commercial availability of adaptations to user interfaces for people with special needs
To prepare the scientific and technological basis for development of standards	Development of a harmonised architecture for the definition of reusable service and management service components, in a multi-service provider, multi-vendor environment Prototype implementations of service creation environments (guidelines, methods, tools) supporting the deployment of telecom services	Common functional specifications representing consensus on future architectures providing enhancements to IN and IN/TMN harmonisation Acceleration of commercial availability of service creation environments

Objectives of Area 6: Information security technologies

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To contribute to the development of technologies for information security	Definition and prototyping of a security architecture. Development of security management framework. Investigation of automatic processes for detection and neutralisation of malicious software.	Demonstrates possibilities for more efficient and effective security in complex environments Provides a framework for development of a wide range of security services. Demonstrates initial technical feasibility of enhanced behavioural surveillance techniques
To contribute to the definition of international standards and verification technologies	Work on a conceptual framework and methodology for integration of needs, liabilities and obligations. Development and validation of standards for security in open, distributed and heterogeneous environments. Development of components to defined ITSEC (IT Security Evaluation Criteria) levels	Take-up of key concepts enabling convergence on standards and products. Feedback from application of European evaluation criteria to state of the art components and environments into work on Common Criteria (EU/NA).

Objectives of Area 7: Advanced Communications experiments

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To verify the feasibility of integrated communications systems	Advanced communications experiments build working pan-European pilots of their applications in different industry sectors Use and adapt currently available equipment and services to trial advanced applications Execute techno-economic and market analyses of advanced communications applications Identify generic applications	Prototypes of integrated communications systems in many industry sectors, e.g. manuf., design, banking, publishing, retail, construction, culture, transport etc. now established and running Advances state-of-art in leading edge-communications Many advanced applications now approaching market/real user launch Small number of underlying generic services and platforms developed to support multiple applications
To contribute to developing interconnection standards	Projects experiment with trial interconnections and disseminate results to the industry Real world tests reduce uncertainty for service suppliers and manufacturers	Interconnection standards pioneered in RACE form starting point for to-be-established standards

Objectives of Area 8: Test infrastructures and interworking

Technical objectives	Ways in which Phase II projects address these objectives	Impact of the RACE work
To validate standards and functional specifications	Implementation of functional specifications in prototype equipment. Performance of experimentation on prototypes. Implementation of standards on larger scale equipment.	Harmonisation of standards, based on practical trial experience. Particular contribution to the UNI (user-network interface)
To establish interconnection and interworking systems and protocols	Interconnection of broadband components within testbeds, then interconnection of testbeds with ad hoc solutions, then via public networks. Applications trialed on interconnected testbeds	Catalyst for the development of the European broadband infrastructure. Raises awareness of broadband capabilities and remaining technical issues.

4. Participation in the Programme

The 117 R&D projects involve the participation of 574 different organisations and companies, including all the major European telecommunications actors. In addition, 49 different organisations from EFTA countries (Austria, Finland, Norway, Sweden and Switzerland) has 105 separate participations in the work.

4.1 Involvement of the European telecommunications industry and network operators

All the major European telecommunications equipment suppliers are heavily involved in the work (for example, the Alcatel group has 60 participations from eleven organisations in the group from Germany, Portugal, France, Italy and Norway). 37% of participations are from the telecommunications equipment supply industry and 17% from telecommunications network operators. In terms of the effort devoted to the work the involvement of these organisations is even stronger: 47% from the supply industry and 18% from the network operators.

4.2 Involvement of SMEs

Despite the high cost of R&D in advanced telecommunications, the second phase of RACE has attracted a strong participation from small and medium-sized enterprises (SMEs). They represent 41% of the participations in Phase II projects, compared with 28% for Phase I, and 16.5% for the 2nd Framework Programme as a whole⁹⁾. Small organisations, whether enterprises or research organisations, participate in over 70% of Phase II projects, compared with 60% in Phase I, and provide 34% of the total effort.

4.3 Contribution to economic and social cohesion

By investigating and developing strategies for IBC introduction all areas of the EU, including in less favoured regions, the programme has paved the way for the realisation of Trans-European Broadband Communications Networks as foreseen in Chapter XII of the Treaty on European Union. Particular attention has been given to the need to link island, landlocked and peripheral regions with central regions of the Union

A substantial number of accompanying measures, workshops and summer schools have ensured that the R&D carried out has been accessible to scientists and engineers from all areas of the European Union, and a particular effort has been made to organise workshops and seminars in less favoured areas.

82 projects (70%) involve organisations from less favoured regions of the Union, compared with 60% in Phase I. Through their participation, these companies are contributing to transfers of technology and expertise to these regions. About 20% of participations are by organisations in the four countries eligible for the "cohesion fund".

⁹⁾Evaluation of the second Framework Programme of RTD: Report from CREST to Council, September 1992. CREST/1212/1/92.

5. Evaluation and Auditing of the RACE Programme

5.1 Evaluation as an on-going process

In view of the rapid evolution of communication technologies and services, evaluation has been seen as an on-going process throughout the preparation of the programme, its implementation and its execution. It has also been a process that has affected every level: the strategic orientation of the programme, the operational management of the programme, and the technical direction of every project.

The evaluation process started with the extensive collaboration of telecommunications actors in planning the programme and in development of the Workplan. Continuing collaboration with industry and telecommunications operators allowed a yearly up-date of the both the Programme Workplan and the workplans of each project. In addition, regular meetings between the consortia making up the programme (Concertation Meetings) ensure that there is a continuous informal process of progress monitoring and adjustment by all projects. The consistency of work is assured by the Consensus Management Project, which has close relations with European standardisation bodies.

The progress in work in Phase I was reported to the Council of Ministers and the European Parliament in 1990 in the "30 month" review and in 1993 in the Final report¹⁰⁾. For Phase II, This mid-term review documents the implementation of the programme. The results of the work and the impact of the programme on European telecommunication, economic growth and employment creation will be summarised in the Final report to be prepared at the end of 1994.

¹⁰⁾ R+D in advanced communications technologies for Europe (RACE). Final report on Phase I: COM(93)118, March 1993

5.2 Programme Audits and evaluations

The work on Integrated Broadband Communication (IBC) in RACE has been periodically adjusted to respond to rapidly evolving techno-economic conditions and service opportunities. Therefore, within the programme, a periodic critical examination (Audit) has been carried out at two levels:

- A strategic review of advanced communications developments, including an evaluation of the performance of RACE as a whole with respect to mid-term and policy objectives of the Union in an international context
- The technical aspects, evaluating the performance of the RACE projects with respect to the programme objectives

5.2.1 Strategic Audits and programme evaluations

In 1991 and early 1992, the RACE programme was evaluated in the context of the other major IT and Telematics application programmes of the 2nd Framework Programme (ESPRIT and DRIVE) by an independent Panel chaired by Mr Dekker¹¹⁾. The Commission has separately responded to the recommendations of this Panel¹²⁾.

In 1992, the Commission reported on the first Phase of the RACE programme in the context of its Evaluation of the 2nd Framework Programme¹³⁾. The Committee on Research Science and Technology (CREST) was invited by the Council to comment on the Commission's report. CREST passed on the invitation to the

¹¹⁾ The report of the information and communications technologies review Board, Chaired by Mr. W. Dekker, June 1992.

¹²⁾ The Commission's response to the Dekker report, January 1993

¹³⁾ Communication from the Commission on "Evaluation of the second Framework Programme for research and technological development (SEC(92)675 Final), July 1992.

RACE Management Committee (RMC), which submitted its report in July 1992. The recommendations were reported in the Final report on Phase I. An independent Strategic Audit was carried out in 1993 to evaluate the work in respect of the strategic and policy objectives of the Community in an international context. The main conclusions are reproduced in Annex IV.

5.2.2 *Impact assessments and forecasts*

The research and technology development within the programme is accompanied by regular assessments of the economic and social impact of developments in advanced communications. The reports of these assessments are published and widely disseminated as the series of reports on "Perspectives for Advanced Communications in Europe: PACE". The most recent of these assessments was carried out in 1993. It focused on the potential impact of investment in advanced communications on macro-economic growth. The analyses showed that additional growth of up to 6% in GDP could be stimulated in Europe by a pro-active policy of investment in both the provision of advanced and high-speed infrastructures and by stimulation of new uses and applications of services¹⁴⁾. This activity provides the factual background for the yearly up-date of the work under the programme as well as minor adjustments during the course of the year. This activity has been fully integrated into the 2nd Phase of RACE following the provisions made in the Council Decision on the 'Specific Programme on Communications Technologies'.

5.2.3 *Technical Audits of RACE projects*

To be able to adapt the Programme to the development of technology and to changes in the perception of demand, the Council Decision provides for an annual revision of the workplan. All the on-going projects are annually reviewed with respect to the objectives of the programme and new needs. Each project has been subject to a "Technical Audit" by independent experts in the relevant field of research every year. For

Phase II, the first such Technical Audit took place in October 1992 and the second in October 1993. The results of these annual audits has been used to re-direct or terminate the work of Projects when necessary.

The Technical Audit has consisted of the following major elements:

- (a) Each year, the partners in each project carry out a "self-evaluation" by reviewing the project in all its essential aspects and document the results in an Annual Review Report.
- (b) These are evaluated by independent external experts (Auditors) identified with the help of RMC. Following the evaluation of the reports, the projects are given a "hearing" under the chairmanship of the Commission. The Projects have an opportunity to highlight achievements and to outline future work. The Auditors, grouped in Panels according to their respective expertise, are able to question the projects to complete the picture given by the Annual Report and the Presentation.
- (c) The Panels consolidate their conclusions and recommendations, and document them in the Audit Panel Reports to the RMC and to the Commission.
- (d) The Audit Reports are complemented by an assessment of the contractual deliverables by the Project Officers of the Commission (in general the deliverables are considered confidential and are not disclosed to the Auditors).

This procedure has proved both fair and effective. The Audit reports have served as an excellent basis for negotiation of contracts for the detailed workplans of each project, each year.

5.3. *Dissemination and exploitation of results*

The Role of Concertation and the Consensus Management Project

The Concertation mechanism has been developed to improve information collection and dissemination. The mechanisms for Concertation are the: Consensus Management Project, Project Lines, Common Interest Circles, Concertation Technical Groups and Concertation meetings

¹⁴⁾ The economic impact of advanced communications; Teknibank report for DG XIII, May 1993.

themselves. Both Consensus Management and the Concertation mechanisms are important elements in the collaboration concept for the development and introduction of IBC. The Consensus Management Project performs the function of RACE Systems Engineering and has the specific remit of editing Common Functional Specifications (CFS) and Common Practice Recommendations (CPR). The preparation of CFS and CPR has been an important output of RACE, and as the programme moves from "Exploring Options" to "Preparing for Implementation" these will become increasingly driven by the needs of their intended audiences, the developers and purchasers of products and services.

Dissemination, Workshops, Conferences and Deliverables

Participants in the RACE programme as a whole present aspects of the programme work at conferences and exhibitions throughout Europe. The RACE Directorate also organises and supports a number of workshops and conferences each year on important communications issues, including fibre to the home, broadband islands, intelligent cities, and business opportunities using advanced communications. Approximately 35 workshops and conferences were run in 1993 and 1994 should match or exceed this number. A major event of 1993 was the CEBIT exhibition at Hannover, where 11 live demonstrations were hosted on the Commission's stand, linked to similar exhibits within CEBIT, as well as to communications experiments in 11 different countries. The event was coupled with a

conference and public hearing on the 1993 Strategic Audit. The range of dissemination measures are also illustrated by the wide range of publications, contributions to standards and patents registered, as well as the database on deliverables. There will be a total of 3056 deliverables from RACE and accompanying measures. Of these 1096 will be in the public domain, 622 are restricted to the RACE community, 621 are limited to certain RACE projects only, and 618 are for internal use within the project.

Exploitation Plan

It is a requirement of RACE that project consortia specify their plans to exploit results. RACE also uses a number of mechanisms for internal exploitation in which components produced by technology demonstrators are built into sub-system demonstrators, and these subsystems in turn are used to build more complex system demonstrators. Further, technical information on system performance are fed to the application experiments, which in turn provide improved understanding of user needs and opportunities for product and service development. Exploitation reports have described the possibilities for economic exploitation, whether of scale, scope or integration; the impact of compatibility and interoperability, systems developments, individual technology developments, business sector applications and infrastructure impact as well as strategic leverage. A number of databases and an "Impact and Exploitation" questionnaire have been used to provide additional summarised overviews.

6. Links with other EU and European actions

6.1 Links with ETNO and EURESCOM.

Links with CEPT and its subsequent bodies have changed substantially during the development and implementation of RACE.

The re-regulation of telecommunications, in line with the new European Telecommunications Policy, led the CEPT to set up a number of separate bodies, two of which have established strong linkages with RACE activities: ETNO, the European Telecommunications Network Operators group, is now the forum for discussions between network operators on regulatory and network interoperation issues; and EURESCOM who provides a forum for joint applied research. Almost all major European fixed network operators participate in EURESCOM, and it serves as a valuable interface between the Commission, RACE projects and the most network operators.

6.2 Links with European and international standardisation bodies

As part of the implementation of European telecommunications policy, ETSI, the European Telecommunications Standardisation Institute, was set up in 1988. It is now established as the major European forum for the development of technical specifications. The pre-normative work in Phase I of RACE provided 596 separate contributions to the standardisation work of ETSI, CCITT and CCIR. In addition, regular meetings have been held with representatives of CEN/CENELEC, EBU and SPAG.

6.3 Links with other Commission programmes/European activities

RACE projects capitalise on the results of projects developing generic technologies, i.e. ESPRIT (microelectronics components, software tools, AIP for network management etc.); similarly projects in the specific programme of

RTD on telematic systems of general interest draw heavily on the results of RACE projects.

The collaboration with COST has been implemented by close links between related work and periodic meetings on the programme management level.

With the EUREKA Initiative, the strongest interaction has evolved in the field of audiovisual technologies. Part of the work related to the promotion of HDTV (EUREKA project 95) was complemented by work under a Phase I RACE contract; and EUREKA project 256 on video-coding was associated with the RACE integration activities.

To establish a broader synergy in Phase II, a joint EUREKA-RACE concertation meeting was held in September 1992. A total of 30 EUREKA projects are active in these areas of communications research; in generic telecommunications systems and components; local networks and services for industry, and in the area of audio-visual media technologies.

Continuing information exchange with RACE RTD projects is ensured through common participants, and though participation in topical workshops and conferences.

Strong Links have been established with research in the cost¹ framework. Joint workshops have been organised with COST projects in the areas of optical communications and mobile communications, and Cost project co-ordinators are invited to the RACE project concertation meetings.

6.4 Links with organisations in EFTA countries

Organisations from Austria, Finland, Norway, Sweden and Switzerland are involved in Phase II of the RACE programme. 50 organisations from those countries participated in 94 projects (126 participations in over 80% of the work)

¹ Co-operation in Science and Technology

7. Implementation strategies, accompanying measures and socio-economic impacts

The development of distance working - "telework" - in Europe is of crucial importance for Europe's economic development: it will be a major driver of technology development in the next few years; it will open new opportunities for small businesses; it will contribute to easing the problems of congestion in cities, and it will give peripheral and rural areas a unique opportunity to attract a much wider range of employment than in the past. It can help both to give industry new competitive advantages; it can contribute to easing some of the environmental pressures and can introduce a new flexibility into the employment market, without detracting. The opportunities presented by the new communications technologies will have a very important impact on future economic growth in the Community and the international division of labour world-wide. Three distinct but interlinked growth processes are at work:

- Improved access to better information raises productivity throughout the economy,
- Improvements in communications raise the utility, and consequently the marketability, of both old and new services leading to their expansion,
- Transition to the new service-driven and information-based economy requires very large public and private investment in new infrastructures, both physical - cable, switches, terminals - and human, for the development of value-added telecommunications services.

In the White paper on growth, competitiveness and employment, the Commission has proposed that the Member States of the European Union, and the European institutions, should together focus on five priorities: Promotion of the use of information technologies, particularly in the public sector, but also through promotion of teleworking; Promotion of investment in basic trans-European services, for ISDN and high-speed networking; creation of an appropriate regulatory framework to ensure competition, guarantee universal service and security of information and communication systems;

develop training on new technologies, and increase industrial and technological performance in European business, notably through increasing research and technology development. Specifically in the area of trans-European telecommunications networks, nine priorities for investment stimulation are identified:

- Establishment of high-speed communications networks;
- consolidation of integrated services digital networks across Europe;
- consolidation of systems for electronic access to information;
- development of European electronic mail services;
- implementation of interactive video services, based on CATV and telecommunications infrastructures and technologies;
- stimulation of teleworking;
- stimulation of telematic links between administrations;
- development of teletraining services; and
- development of telemedicine services and networks.

A total investment of over 500 billion ECU will be required in Europe by 2005 - from network operators in infrastructure development; from service providers in developing new service provision capabilities, and from businesses to allow them to obtain competitive advantage from new infrastructures and services. The economic and employment advantages of this investment will only be realised if the key European infrastructure and service developments are technically compatible, operationally interconnected, and synchronous in time.

In order to stimulate and assess the exploitation of RACE results by the participants, a "RACE Exploitation Plan" has been regularly updated throughout the period from 1988 to date. It provides an integral view of the exploitation of the results by participants.

7.1 An indicative IBC implementation timetable

Effective exploitation of R&D is only possible if all actors have a coherent view of the direction and pace of commercial developments. The R&D in the RACE programme has therefore always been scheduled and specified in relation to an indicative implementation plan for Integrated Broadband Communications, which has been regularly updated. It involves a step-wise introduction of advanced services, starting with the ones for which there is business and professional demand as early as 1992/1993. The current indicative implementation schedule, as described in the RACE annual report for 1992 (RACE'92) involved the following milestones:

1992/1993:

- Early introduction of business and professional applications;
- Advanced Communications Experiments to test new services and network management systems: ATM, MAN, and IBC in Customer Premise networks.
- Procurement/investment decisions for future pan-European IBCN and full IBC services,
- Major standards finalisation,

1994:

- Completion of inter-connection of all capitals of the Community and with neighbouring countries, based on the extension of existing optical trunk networks, but supporting voice, data and image traffic, either separately or as integrated services.

1995:

- Initial IBC network implementation and completion of customer access for business in centres of economic and manufacturing activity: At least 50,000 corporate users of advanced services.

- Application field trials to test a full range of IBC services (incl. residential customers with 2-way video and digital video services) using commercial IBC equipment,

1996:

- Offer of commercial basic Broadband services, based on 2, 34 and 155 MBit/s links, including fast inter-LAN data transmission, desk-top video-conferencing, video-processing, CAD/CAM and telework applications.
- Inter-operation of fixed Broadband networks with mobile, satellite and other networks.

1997:

- Availability of IBC services to business users in towns of more than 500,000 inhabitants, and beginning of wide-spread "fibre-to-the-home" implementation.

2005-2010:

- 50% penetration of IBC services.

This indicative timetable will again be reviewed in 1994, in the context of the preparation of guidelines for the development of trans-European Broadband Networks, as foreseen in Title XII, Article 129b and c of the Treaty on European Union.

7.2 High-speed information infrastructure development in Europe: accompanying measures on optical network interconnection.

In a specific action, the European Parliament took the initiative in 1992 to provide financial resources to stimulate the interconnection of optical fibre networks through demonstration projects. The objective was to interconnect IBC islands and high-performance computing centres in different Member States. In implementation of this initiative, four projects were supported, each of which has helped to improve conditions for testing and analysing the impact of new services, applications and end-use systems.

The ISABEL project interconnects two Broadband islands; The RIA network in Portugal and the RECIBA network in Spain. It is the first trans-border interconnection in the European Union to use two ATM cross-connects. The interconnection trial has supported co-operative working and distance learning. It involved collaboration between Telefonica I+D in Spain and CET in Portugal.

The TIRONET project involves the interconnection of a Metropolitan Area Network in Dublin and an SDH ring in Northern Ireland, using two 2 Mbit/s links. The project was demonstrated at the Communications '93 exhibition in Dublin in late 1993. The first application on this interconnection was of Media Communication Software, operating between the exhibition site and a Nynex office in Antrim (Northern Ireland). It involved a multi-way divided conference with simultaneous multi-media collaboration between the sites.

The second application consists of a pilot experiment in remote learning using multi-media databases. The project has been managed by BT Northern Ireland, in collaboration with the University of Ulster, University College Dublin, Nynex Media Communications Ltd, Queens University Belfast, Telecom Eireann and MARI Northern Ireland.

The BETEL project involves interconnection of three sites: CERN in Switzerland, Sophia Antipolis and Lyons in France. This is the first international network using ATM technology. The BETEL platform interconnects FDDI rings in a fully meshed network via routers and terminal adapters, 34 Mbps links and one ATM cross-connect. Applications include tele-teaching, a physics analysis workstation and distributed computing. The platform was demonstrated at the InterOP '93 conference in October 1993. The work was co-ordinated by France Telecom Expertel and involved co-operation with CERN, Alcatel CIT, the Ecole Polytechnique Fédérale in Lausanne, the Institut Eurecom and the Institut National de Physique Nucléaire et de Physique des Particules.

Finally, the HPC-VISION project interconnects two Broadband islands in France and Germany. The applications supported are vision-based on-line inspection of manufactured parts and robotics applications. The project is co-ordinated by the University Louis Pasteur in Strasbourg, working with the Fraunhofer Institut in Karlsruhe.

7.3 Interactive digital video -services: Demonstration and standardisation support

At its meeting on 16th June 1993, the European Council of Ministers adopted a resolution on advanced TV systems and invited the Commission to present a Communication on digital TV, addressing mechanisms to allow rapid agreement on common Community perspectives for market development and standardisation, and (if necessary) Community financial support in this area.

The European Parliament in the end of June 1993 approved a budget of 12 MECU for accompanying measures to RDT on digital image transmission. This permitted the Commission to launch a call for proposals with the following main objectives:

- acceleration of European consensus development on technical specifications for digital image transmission and system implementation strategies;
- demonstration of digital image transmission systems;
- social and economic implications of the transition to digital image transmission.

Retained proposals address all three objectives.

1. The first priority is the Euro-Image proposal presented by the European Digital Video Broadcasting (DVB) project which was created on Sept. 10, 1993 (by 117 organisations). The purpose of the proposal is to create in Europe a framework for a harmonious and market driven development of digital TV via cable, satellite and terrestrial broadcasting, ensuring an adequate amount of interests among broadcasters, operators, radio regulatory bodies and equipment manufacturers. The pre normative work will address satellite and cable modulation systems, common multiplex for all transport media, service-identification system based on MPEG-2 and consensus on DVB contributions to standardisation bodies.

2. Due to the favourable conditions of the transmission media the pre-normative work related to satellite and cable systems is more advanced than the work on terrestrial (over the air) TV. Proposal dTTb (Digital TV for Terrestrial Broadcasting) is the European project competing with the US initiative on terrestrial digital Advanced TV Broadcasting.
3. In Southern Europe terrestrial and satellite broadcasting is complemented by Single Mast Antenna TV (SMATV) systems that use a common antenna to receive the broadcast signals. This is distributed through cable in a building or group of buildings. The objective of project DIGISMATV is to develop the interface from the digital signal received from satellite or terrestrial and to adapt it for distribution in a community.
4. A cheap Video Tape Recorder (VTR) that can be used both at home and in camcorders is necessary for HDTV to become part of affordable consumer electronics. This can only be made available through digital technology as demonstrated by RACE project R1001. DART-4 aims at demonstrating recording of MPEG like video services, background storage in future Personal Digital Assistants (PDAs), coupling of recorders to MPEG decoders and to ATM services, and at contributing to standardisation of digital video/data in world standardisation bodies.
5. The progress of digital technologies applied to the transmission of audio-visual services introduces the capability of delivering several hundred channels to the end user through cable or satellite networks. Project AMMIS (Advanced man-machine interface for programme selection in a digital TV multiplex) aims at developing and demonstrating advanced man-machine interfaces suited to programme selection and interactive viewing in the context of a very wide offer of TV programmes, and at analysing the impact of advanced man-machine interfaces in the evolution of the digital TV terminal towards the "Telecomputer". It will also apply the MHEG standard for the programming of multimedia

and hypermedia objects in order to progress towards open multimedia systems.

6. Proposals **MEDIATE** and **DIWIC** (Digital Wireless Cable) merged to form project **DIMMP** (Digital Microwave Multi-Point / Multi-channel Propagation). Whilst **dTTb** aims at digital TV transmission in the VHF/UHF bands where there is spectrum congestion but better propagation conditions, project **DIMMP** aims at the broadcasting of in excess of 100 channels in 2 GHz of bandwidth (in the US the FCC allocated the band 27.5-29.5 GHz). These Microwave Multi-point Distribution Systems (**MMDS**) have less favourable propagation conditions so they will need more dense transmitting antenna coverage. They consist of cellular based networks offering terrestrial based propagation of video signals at microwave frequencies. Due to their very high channel (hundreds) capacity they are considered credible challengers to **dTTb**, **DBS** and **CATV** and are known in the US as wireless cable.
7. **ORACLE** studies the conditions for the successful commercial introduction of image-based services and applications, and the impact of digital image transmission on the media industry and other early investors in the first generation of Integrated Broadband Communications services and applications.
8. Digital distributive services such as Pay-per-view, Video-on-Demand, Pay-TV and new multimedia services will rely more and more on personalised access. It would be inconvenient for the user to have individual de-scrambling and conditional access adapters for each individual programme he would like to receive. Project **ACCOPI** (Access Control and Copyright Protection for Images) develops a common functional model and demonstrator for access control that will permit users to have access to different programmes with the following capabilities: reliability of key distribution, copyright protection efficiency, cost efficiency of the system including management.

Interconnection via Fiber Optics

Three projects (**IBER**, **BETEUS**, and **INTREPID**) are building on the experience drawn by **ISABEL**, **BETEL**, and **TIRONET** (see section 7.2). They will strengthen the existing interconnection activities by adding functionalities and connectivity to their existing interconnected testbeds. Once these are in place, the projects will implement the appropriate applications for multimedia demonstration purposes, leading to a better understanding on the issues related to image transmission in broadband networks.

7.4 New service introduction and telework development

A large number of office and information management work now involves the use of personal computers, electronic mail, file transfer and information access. A rapidly increasing proportion of these jobs can now be done outside a traditional centralised office environment, using telecommunications networks. New forms of working, including teleworking, are attractive to large businesses as they seek to reduce fixed costs by de-centralisation and moving their work closer to customers, and to small businesses as they form trans-border groupings to compete in European markets.

The business sectors most involved are those with a high information content:

- In high added-value up-stream activities such as research, software development, product design, etc.
- In business management activities: Accounting, financial services, insurance claims processing, business services and information management; etc.
- In media activities: journalism; publishing; TV, video services and games development; advertising and publicity services; etc.
- In retail and distribution: Transport fleet management; stock control; retail and customer services; commercial sales support; etc.

There are 50 million PCs in use in businesses in Europe, half of which have network access capabilities. There are already seven million business subscribers to mobile telephone systems: one million subscribers to GSM which can support electronic mail and data transfer as well as voice communications. Estimates of the number of people teleworking for part the time are largely a question of definition. The potential is however large. Over 60% of the US and European workforce is involved in information management activities in the service sector. Even if only 10% of these made use of new information infrastructures to give them and their employers more flexibility, there could be 10 million occasional, part-time and full-time teleworkers in Europe.

At the European Summit in Copenhagen, the President of the European Commission highlighted the importance of rapid development of new frameworks for co-operation between businesses in Europe, of the development of performant trans-European transport and telecommunications infrastructures, and the creation of a common "information space" within which de-centralised economic activity can develop through interactions between small businesses. He stressed the need to create a European network of training facilities for new skills and the need to encourage distance working, from the achievements of social policies in the Member States of the Union.

In the context of EU actions related to advanced communications developments, on 21st June 1993 the Commission of the European Communities decided on a new set of preparatory actions. It invited proposals for actions to stimulate experimentation and implementation of transnational telework systems in Europe and to assess their social, environmental and economic impacts. Over 120 proposals were received by the Commission services by the deadline of 3rd September 1993. The proposals involved 403 different organisations from all 12 Member States of the Union, plus 4 of the countries of EFTA (Austria, Finland, Sweden and Norway) and five other countries (Bulgaria, Canada, Morocco, Malaysia and the USA).

The strength of the response to the Call for proposals, and the high standing of the organisations involved, confirms that teleworking is now a major area of interest and commitment. Great strides have been made in the development of the core and supporting technologies, but there is now an urgent need to understand the organisational, social, legal and fiscal changes that may be needed to allow these new forms of working to develop in a coherent way in the Member States of the Union, and to develop across national borders in a second phase of consolidation of the European Economic Area.

Teleworking development has emerged as a major theme in the RACE programme. In addition, the Member States of the Union agreed to complement this R&D with a wider "concerted action" on telework, tourism and telematic support for small businesses. The European Community Telework/Telematics Forum (ECTF) has been set up as the framework for this action. It provides a framework for exchange of information and experience, and a forum for development of a common vision.

During 1992 and 1993, seminars have been organised in North Holland, Galicia and Mallorca (Spain), Wales and Cambridge (UK), Tuscany (Italy), Bonn (Germany), Sophia Antipolis (France), Chios (Greece) and in connection with major international conferences in the UK and Montpellier (France). Over 1000 companies have already participated in the information exchange activities: All the major equipment manufacturers are involved, the major European telecommunications network operators are active participants and sponsors of the initiative, and a growing number of companies undergoing restructuring are now looking to telework and flexible working arrangements.

The activities of the Forum will be supported in 1994 by an Action Plan for stimulation of telework in Europe. The Action Plan will consist of 2 pilot demonstrations of telework in decentralisation of large organisations; 6 demonstrations of trans-European networked telework centres; 5 demonstrations of trans-border small business networking, and one

analysis of telework as a mechanism of urban and inter-urban traffic decongestion.

Supporting actions will involve analysis of requirements for, and constraints to organisational restructuring; analysis of legal and regulatory constraints to transborder telework in the European Economic Area; identification of telework technologies and systems, and codes of practice for management of telework. In addition, the actions will involve the setting up of a regional "help desks" for organisations wishing to introduce telework, particularly across borders; reinforcement of the EC Telework Forum, and compilation of information on European trends in the development of telework.

These actions illustrate the range of situations and sectors in which managed telework can contribute to both economic development and a new flexibility in employment. The trials and demonstrations cover a wide range of new employment opportunities; from networks of telework centres for the disabled to the collaboration of highly trained engineers in nuclear power plants. They will demonstrate the opportunities and advantages of de-centralisation of employment to less favoured regions, particularly rural areas, and new opportunities for employment within the European Union in provision of specialised services to developing countries.

7.5. Research co-operation with less favoured regions and with central and eastern Europe.

At the initiative of the European Parliament, and following the re-inforcement of budget provisions for accompanying measures to the Union's research and development actions in July 1993, the Commission invited proposals for regional initiatives in the area of advanced communications and telematics, to enable organisations in less favoured regions of the Union to participate more easily and fully in future EU RTD actions, and to strengthen scientific and research collaboration in central and eastern Europe. The seven projects which will start in January 1994 cover these areas.

The objectives are:

- to stimulate the establishment of research and supporting facilities in less favoured regions in order to enable a greater participation of organisations, particularly small businesses, in future EU research and technology development in the areas of advanced communications and telematics, and
- to establish teleworking facilities and networks in central and eastern Europe in order to strengthen research links with the European Union.

These actions are complementary to those carried out under the Action Plan for stimulation of telework in Europe, and will complement the development of research infrastructures in the Union under the STRIDE and TELEMATIQUE programmes, and research information access and technology transfer actions in the VALUE and SPRINT programmes.

7.5.1 Establishment of advanced communications and telematics research and supporting facilities in less favoured regions of the European Union

The objective is to stimulate the establishment of research and supporting facilities in less favoured regions in order to enable a greater participation of organisations, particularly small businesses, in future EU research and technology development in the areas of advanced communications and telematics.

The projects cover contributions to:

- the establishment of research facilities in less favoured regions of general interest to organisations throughout the Union and supporting facilities in less favoured regions that can be of general value to EU R&D;
- the development of advanced communications services both to facilitate access to information and co-operative working with partners in the development

and execution of R&D projects, and as a research tool for experimentation with new uses of advanced communications and telematic systems;

the development of a network of organisations which can work together in the stimulation of interest in EU R&D, in stimulation of working contacts between scientists, researchers and industry (particularly SMEs) throughout Europe, and in research exploitation by SMEs.

The BINET project (G1001) will plan, develop, install, configure and operate an Advanced Broadband Interconnection Network, based on ATM technology, linking four telecommunications research and development centres in Spain and Portugal and a high-tech Industrial Park in Portugal. This will build on the BETEL project and extend the Trans-European ATM trial into Spain and Portugal, stimulate usage on this trial network, and allow the interconnection to other research networks and R&D laboratories in other European countries.

The SUNRISE project will plan, develop, install, configure and operate a VSAT-based system for research collaboration between small and medium-sized businesses and universities in the less favoured regions of Greece, Italy, Portugal and Ireland. It will be based on the systems developed for distance learning in the JANUS projects (DELTA) and will involve the identification of businesses and universities with complementary research interests in the less favoured regions using a geographical information system on the socio-economic characteristics of less favoured regions.

The EPRI-NET project will establish research and supporting facilities in the less favoured regions in Spain and east Germany in order to enable a greater participation of organisations, particularly small businesses, in future EU research and technology development in the areas of advanced communications and telematics. A VSAT network will be established in Spain and east Germany, connecting some 100 central contact points, open to all less favoured regions

of the European Union. It will also be extendible to Central and Eastern Europe.

The INTELLEC project will facilitate and stimulate the research co-operation between SMEs and universities in both the Irish Republic and the UK province of Northern Ireland, with organisations in other regions of the European Union. It will involve a significant improvement to the international inter-operation of systems for research information exchange to and from Ireland and the identifications of complementary

research interests of a wide range of organisations. The project will provide logistical and co-ordination support to four "common interest groups" in the areas of R&D in IT, telecommunications and telematics; in publishing applications; in related software development, and in education and training applications and initiatives.

The WISE project will build on the very extensive INTERNET systems of inter-operating research information networks, to which over 200,000 European research organisations are already connected, to facilitate access to information in a simple and consistent way by organisations throughout Europe, including SMEs in less favoured regions. The project will complement the actions of the SUNRISE, EPRI-NET and INTELLEC projects, as well as the new actions in central and eastern Europe. Special actions will be taken in Germany and Portugal to ensure that there are appropriate access facilities to world-wide information systems.

7.5.2 Science and technology teleworking and information relay networks in central and eastern Europe

At the initiative of the European Parliament, the European Union is implementing a number of actions to strengthen scientific and technical links between the European Union and researchers in central and eastern Europe. During 1992, a first series of actions involving support for a mobility scheme, for conferences,

workshops and seminars, and for joint research projects was launched.

Access to information and the ability to collaborate across national boundaries with colleagues with similar scientific and technical interests is the lifeblood of research. At the initiative of the European Parliament, additional resources have been made available in 1993 to re-inforce and further stimulate working contacts between scientists and researchers throughout Europe.

These additional actions are intended to be of practical and immediate benefit to as large a number of scientists and researchers as possible, within the framework of a coherent implementation of scientific teleworking networks and research information relay centres. The actions complement the development of research infrastructures in central and eastern Europe under the PHARE and TACIS programmes, and research information access and technology transfer actions in the IMPACT, VALUE and SPRINT programmes.

The objective is to establish teleworking facilities, research information networks and relay centres in central and eastern Europe in order to strengthen research links with the European Union, particularly through development and use of advanced communications, telematics and information services, allowing scientists and researchers to collaborate freely with their colleagues in the Union.

The TELESERVE project (C1002), in partnership with National Authorities, will identify scientists and researchers in a target list of 15 countries. It will procure and deliver PCs and modems and ensure that the identified scientists can connect to international services. Existing networks and local services will be used wherever possible.

The project will provide an easily used English language interface, initial training and on-going support. It is expected that of the order of 2000 end users in central and eastern Europe will be linked to European telematics networks supporting teleworking and research information exchange by 1995.

The ESATT project (C1001) will take a longer term approach. It will involve a review of currently available information sources, an assessment of the needs of scientists and researchers in eastern Europe, and draw up a functional and management profile for science and technology relay centres. The project will organise a major regional conference on telework and information services in late 1994.

8. Future requirements and options for R&D on communications technologies at European level.

In June 1992, the RACE Management Committee set up an ad-hoc group to identify priorities for future European R&D in the area of telecommunications. The report of the group is was reproduced in the Final report of Phase I of the RACE programme (Ref. Final report on Phase I of RACE (1988-1992) COM(93)118; March 1993).

Many of these ideas and themes for future EU R&D were reflected in the Commission's Working Document of the 4th Framework Programme, notably in the proposed themes of "Image technologies", "high-performance computing and networks", "functional integration in manufacturing" and "Advanced Communications".

In preparation for the follow-up of RACE, sector actors were invited to contribute views on the requirements and options in Advanced Communications Technologies and Services (ACTS) during the latter part of 1993. From these contributions, a first draft document - Requirements and Options in ACTS - was prepared and distributed for comment. In October and November, a series of workshops was held to refine and develop the ideas offered.

A total of 407 participations from 17 countries were made to the eight workshops which covered:

- Multimedia image communication and digital TV;
- Technologies for photonic networks;
- High speed networks;
- Mobility and personal communications;
- Intelligence in networks and service engineering;
- Quality of service, security and safety in communications networks and services;
- Service usage trials;
- Horizontal actions in support of the above.

The results from the workshops were consolidated into a second draft document, distributed to the workshop participants, which is currently under review following comments received. This material will form the basis for the development of a workplan for the proposed ACTS Programme.

Annex I

PROJECT CONTRIBUTIONS TO RACE OBJECTIVES

Area 1: IBC (Integrated Broadband Communications) R&D

Project	Main Deliverable(s)	Impact
R2001 WTDm	A pilot broadband customer premises network (CPN) using wavelength and time multiplexing techniques (WTDm) installed in a broadcasting production centre (NRK), and used to support TV productions operations.	Pilot implementation of IBC which confirms the advantages of optical technology. More widespread introduction of IBC eased by the development of optical components supporting high density WDM (2nm) and high bitrate TDM.
R2005 MODAL	Optically supported micro-wave and millimetre wave antennae systems for broadband/personal communication. Two demonstrators will be built operating at 30 GHz & 60 GHz respectively.	Exploits the synergy from interconnection of optical fibre network to mobile/wireless systems in a cost-effective manner
R2006 WELCOME	Highly advanced, fully packaged and system tested quantum well (QW)-based components, discrete and monolithically integrated. Includes 1550nm transmitters and 980nm pump lasers for high speed systems operating at and beyond 10Gbit/s.	Provides high performance components necessary for enhancing IBC, to be used in the next generation of (higher speed) trans-European fibre networks
R2010 POPCORN	Low cost, high performance polymeric passive components for single mode optical networks, including fully packaged power splitters, star couplers, wavelength multiplexers, and hybrid InP devices.	Substantial cost reduction of passive optical components, essential for cost-effective fibre customer access connections
R2011 TRAVEL	Technology to upgrade existing fibre networks to 10Gbit/s or 20Gbit/s	Enables the speed and capacity of existing fibre links to be increased, while ensuring compatibility with next-generation networks
R2012 HIPOS	40Gbit/s Optical Time Division Multiplex (OTDM) transmission system, using ultra-fast (2ps) polymer-based all-optical switches.	Ultra-high capacity networks can be realised by Optical Time Division Multiplexing
R2013 EDIOLL	A wholly new class of optically pumped, integrated lasers in LiNbO ₃ material, including tuneable and mode-locked lasers. Monolithic integration of lasers and modulators.	Such devices have a wide range of key applications in future optical networks, including high-speed and analogue systems.
R2014 FIRST	A FTTH trial in Aveiro using passive optical access network. Supply of optical amplifiers, optical transmitters and receivers, and utilisation of sub carrier multiplexing for telephony. Trial includes network management. Demonstration of analogue and digital TV distribution. A study and a tool for life cycle prediction.	Promotes understanding of how to introduce fibres into the local loop cost effectively, and a common European approach to standardisation of fibre local access.
R2015 ARTEMIS	Optical fibre sub-systems for use in the generation of ultra-short pulses, amplification, switching and transmission.	Provides essential technology for future generations of optical networks, operating at speeds of 40Gbit/s and beyond.
R2016 STRATOSPHERIC	Evaluation of string mode algorithm. implementation specifications for a high speed switch and string mode.	Will drastically improve the throughput of broadband networks while gaining from statistical multiplexing. These specifications support the implementation by R2023 (UNOM) of two ATM broadband demonstrators operating at up to 2.5 Gbit/s.

R2018 GAIN	Realisation of optical fluoride fibre amplifiers for all three optical transmission windows 800nm, 1300nm and 1500nm. An analysis of the impact of these components on network design.	Enhances the performance and capabilities of the optical networks. Improves the quality of service and reduces costs.
R2024 BAF	Techno-economic evaluation of four broadband FTTH access systems. Technical implications of choice of access system, including fibre management at the exchange, and ease of supporting various services.	Important contribution to reduction of infrastructure costs in the Access Network. Part of a major effort to refine cost-effective introduction scenarios.
R2028 MWTN	A demonstrator of an all-optical transport layer. Comprising a multi-wavelength transport network based on a combination of optical amplifiers, optical switches, tuneable optical filters and lasers.	This system changes the topology and increases the capacity of optical networks and enables advanced network management techniques. The advanced components will be exploited in new products to advance the introduction of IBC.
R2038 FLUOR	Pr-doped optical amplifiers at 1300nm wavelength, based on novel halide glasses.	The availability of optical amplifiers at 1300nm enables existing fibre networks to be upgraded, with increased capacity.
R2039 ATMOS	A demonstration of new concepts for achieving high speed (≥ 2.5 Gbit/s) and high capacity switching systems (Tbit/s) for ATM based optical networks.	Provides viable solutions for the introduction of optical switching. Impacts the cost and performance of ATM-based networks supporting IBC.
R2048 HIBITS	New electro-optical interconnection technology that solves intercom problems inside a broadband switch. A feasibility study of 2.4 Gbit/s self routing ATM switches.	Reduces the costs of interconnection and of broadband switching equipment.
R2062 COMFORT	Erbium-doped fibre amplifier (EDFA) technology and component packaging. A totally integrated broadband network to be built as a demonstrator.	A range of commercially sound components, for the implementation of cost effective fibre-to-the-home networks. Some of these components are already being exploited commercially.
R2065 COBRA	Three demonstrations of coherent multi-channel systems (CMC): Videoconferencing at 140Mbit/s; Flexible business connections at 155Mbit/s; Transmission and routing of digital HDTV.	Coherent wavelength multiplexing increases the capacity of optical networks, giving inherent advantages in transmission transparency and flexibility. Demonstrators increase awareness of performance capabilities.
R2068 LACE	The development and implementation of a broadband Customer Premises Network, (CPN) including ATM switching and Gigabit LAN elements. Demonstration of a practical application in co-operation with actual users.	Demonstrates that ATM technology being introduced within the public B-ISDN is able to support connectionless services between LANs in customer premises, as previously achieved e.g. via leased lines.
R2069 UFOS	Tuneable semiconductor lasers operating at a higher speed and at higher temperatures. A low cost single frequency laser. DFB Lasers with 3nm tuning range and DBR lasers with over 30 nm tuning range. CAD package for design of lasers. Development of low cost packaging techniques.	Reduction of cost of lasers through increased production yield. Reduced cost of systems through a higher environmental tolerance and higher output power. These lasers are designed particularly for exploitation in coherent and WDM systems.
R2070 MUNDI	Design and construction of two demonstrators: one based on a moderate density WDM for distributive systems (digital multi-channel TV) and another based on higher density WDM for interactive service provision.	Major impact on wavelength division multiplexing (WDM) technology, providing key components and demonstrating cost savings and performance benefits for both distributive and interactive service provision.

R2073 OMAN	A common 'core' Opto-Electronic Integrated Circuit (OEIC) chip manufacturing and packaging technology for future use in European foundries. Production of several prototype OEICs	Cost-reduction of telecoms equipment and systems by using OEICs in volume manufacture.
R2088 TOPIC	A verification technology for IBC, including a methodology and a tool set for Quality of Service (QoS), validated through a demonstrator using real IBC environment.	Validates standards related to QoS and network performance. Major contribution to standards on FDTs (e.g. SDL, LOTOS extensions with features for handling timing and performance properties). Enhances capabilities to test broadband components which have to operate and interwork to achieve a given QoS delivered to users.
R2096 BUNI	Implementable specification of the User Network Interface (UNI/T _B interface) taking into account emerging concepts. Experimental broadband switched network incorporating results from several RACE I projects on which the UNI interface can be validated	Enables service and terminal providers to test and demonstrate their experimental equipment in a representative network environment. Increased leadership of partners in related topics (SDH, SDH/ATM relationship) and strongly influences the development of products and standards activities. Impact on the development of components and products. Creates synergy between activities of several projects and provides a testbed for RACE activities.
R2097 ATD	Studies on ATM specific issues: traffic, signalling, network management, evolution and network introduction planning. Development of components and integration of a technology testbed incorporating a representative of all the main network elements, both from CPN and public networks (terminal adapters, residential and business NT2, NT1, local and transit exchanges, remote units).	Availability of a testbed for RACE II activities. Development of ATM technology and increased awareness of the implications of the adoption of pure ATM principles. Availability of ATM components and products paving the way towards commercialisation. Strong impact on standards bodies activities (ETSI, ITU-TS).
R2103 CAPS	Low cost components for fibre customer access systems, based on Active Silicon integrated Optical Circuit (ASOC) manufacturing technology.	Substantial cost reduction in optical network transceivers, leading to commercial implementation of fibre access for the residential sector.
R2109 LIASON	1 x N lossless optical splitter implemented as an active integrated planar waveguide device operating at 1550nm wavelength.	Cost effective implementation of the customer access connection by fibre networks.
R2121 BISIA	An ATM based access network for new interactive services to private homes, using existing infrastructures where appropriate.	Reduced cost and timescales for introduction of broadband interactive services in the residential sector.

Area 2: Intelligence in Networks / Flexible Communications Resource Management

Project	Main Deliverable(s)	Impact
R2002 GEMA	Evaluation and enhancement of Generic Maintenance tools and technology by implementation of demonstrators in two Broadband Islands.	Improvement of the technology and robustness of maintenance tools intended to maintain large heterogeneous communications networks.
R2003 MOBILISE	The concept, services and architecture for a Personal Services Communications Space (PSCS). Demonstration of the preliminary application of a PSCS Mail Service.	Personal communications will provide all users with transparent access to a personalised profile of services on an international scale.
R2004 PREPARE	A communications management demonstrator specifically tailored to validate end-to-end inter-domain management issues (e.g. interfaces, protocols, managed objects, relationship between service and network management). The testbed includes ATM nodes, DQDB ATM nodes, ATM switching capabilities and a number of token rings.	Expedites the introduction of inter-operable management products in the market. Explores new technologies to manage end-to-end connectivity in an heterogeneous environment. Impacts on standardisation (x interface and VPNs) and on the work of EURESCOM.
R2021 DESSERT	Application of Intelligent Decision Support Systems (DSS) for Service Management. Provision of an architecture, AIP technologies, recommendations and a tool kit environment.	Gives service providers the ability to take "informed decisions" regarding service provision. Advances the application of AIP to telecommunications.
R2041 PRISM	Definition of reference configurations for the management of IBC services, the associated resources and the external access to those management services. The generic results (e.g. on customer access to management facilities, security in service management) are applied to VPN and UPT. Development of ISM Stax database and a PRISM animation package.	Strong impact on the design of future service management systems. Major contributions to Common Functional Specifications and to standards bodies. Strong potential impact in international initiatives, e.g. Eurescom.
R2059 ICM	Definition of a TMN architecture and functions to be implemented in 4 different BB networks in order to demonstrate components integration, to verify performance and to evaluate results. Also development and use of a network simulator.	Further the design, production and validation of TMN and IBC network components. Provides management components to operational TMN systems being upgraded to IBC.
R2104 PERCOM	Specify, design and implement a Personal Communications Space (PCS) Service Node.	PERCOM bridges the gap between conceptual work carried out in R2003 and the practical realisation of PCS.

Area 3: Mobile and Personal Communications

Project	Main Deliverable(s)	Impact
R2007 PLATON	Algorithms for the planning of third generation mobile systems	Contribution to the software tools available for planning third generation mobile communication systems.
R2020 CODIT	Definition of radio protocol requirements and architecture. Functional specification of a test bed. Implementation of a radio channel simulator. Channel measurements to produce a preliminary propagation model.	Impact on the specifications for spread-spectrum based, multiple access schemes applicable to 3rd generation mobile communication systems, in particular through the development of a real time testbed.
R2066 MONET	Definition of UMTS requirements and constraints. UMTS network scenarios and key functions. UMTS services definition. Specifications of the simulation tools. Draft requirements for UPT and UMTS on IN concepts. Allocation of security services and service levels.	Contributes to the specification of third generation mobile communication systems, in particular through the development of simulation tools.
R2067 MBS	Demonstrator specifications, system architecture and functionality. Definition of the radio sub-system requirements.	Contributes to the specification of future broadband mobile communication systems in the 60 GHz frequency band, in particular through the development of a laboratory testbed.
R2084 ATDMA	Advanced Time Division Multiple Access (ATDMA) system definition and specification of a real time testbed. Construction of channel models from actual propagation measurements. Identification of key fixed network issues related to mobile access. Contributions towards the definition of common test scenarios.	Contributes to the standardisation of ATDMA schemes applicable to 3rd generation mobile communication systems, in particular through the development of a real time testbed.
R2108 TSUNAMI	Technological development and field trials in adaptive antennas for mobile applications. Optimum component architectures and designs, antenna array design and associated control algorithms. Examines the interaction between adaptive antenna technologies and the multiple access schemes (CDMA and TDMA).	Contributions to standards bodies based on the impact of adaptive antenna technologies to the UMTS.
R2117 SAINT	Operational and functional requirements for UMTS satellite integration. Development of UMTS-Satellite component integration scenario. Interworking of the satellite component with other networks.	Contributes to standardisation in ETSI SMG5, in a number of aspects concerning the integration of the satellite component into the UMTS.
R2123 GIRAFE	Low voltage, low power and high-integration components for use in mobile terminals	Reduced battery consumption, yielding savings in weight, volume and cost of mobile terminals

Area 4: Image and Data Communications

R2026 DART	Technology demonstrator and standards for digital video tape recorder for consumers, using MPEG2 + ATM formatted services.	Will enable all HDTV and IBC services in consumer markets.
R2045 DISTIMA	Demonstrator of complete digital stereoscopic TV system: camera, ATM transmission, and display.	Improved TV applications in industry (MPEG2).
R 2052 MONALISA	Electronic set demonstrator (ELSET) integrating technologies required for the construction, handling and fast synthesis of 3D models for creating image sequences.	Reduction of TV program production costs through the real-time mixing of real and synthetic images and advances in generic analysis-synthesis image systems.
R2053 MORPHECO	Software demonstrator of a second-generation object-based coding and decoding scheme for still and moving images.	Contribution to emerging standards for second-generation very-low bitrate coding such as MPEG4.
R2055 TRANSIT	Hardware demonstrators of high-quality image format conversion systems, oriented towards future consumer markets.	Provides solutions to bridge the gap between different image formats, facilitating the convergence of video and computer technologies
R2056 AMICS	Data structures for an open architecture for multimedia image communications - a demonstrator of an image interchange gateway.	The harmonisation of image formats enabling better image exchange.
R2064 FLASH-TV	Innovative modulation and coding schemes with improved availability of service and high picture quality, for satellite contribution links interworking with ATM.	Speeds-up the development of HDTV in Europe by demonstrating the feasibility of contribution links for high-quality television.
R2072 MAVT	New Coding Algorithms for UMTS and DECT, optimising low bitrate coding in terms of video and audio coding delay. Some based on current standards (H.261, MPEG, JPEG) and others based on developing standards. Definitions of audio and video services suitable for mobile use, and input video formats for those services.	Leading the fields of very low bitrate audio and video coding, and mobile transmission of audio-visual services. Supports the introduction of new applications into the existing DECT and GSM networks. Key player in the development of a joint European proposal for the MPEG 4 coding standard.
R2075 HD-SAT	Implementation of the final demonstrator for wide RF band high definition digital TV (W-HDTV) via satellite cable and ATM.	Demonstration of a cost effective system delivering studio quality images to the home. Proposals for W-HDTV standards.
R2082 DTTB	Standards proposals for a European digital terrestrial TV transmission system - A demonstrator of such a system, interworking with cable and ATM.	Speeds-up the transition to a more efficient terrestrial TV transmission system.
R2105 DIAMOND	Demonstration of Video on Demand service chains on ADSL and CaTV with a low cost delivery platform, video on demand server and application management system.	Speeds-up the introduction of multimedia retrieval services like Video on Demand.
R2110 HAMLET	Hardware demonstrator of an MPEG2 scaleable TV/HDTV encoder (high 1440, spatial and SNR scalability).	Enables other projects to demonstrate MPEG2-based real-time digital TV/HDTV broadcasting, paving the way to the introduction of digital TV services.
R2111 MOSAIC	Reliable methods for the subjective assessment of image quality and degradation.	Improves the assessment of audio visual communication systems.

R2122 COUGAR	Demonstrator of flexible codec hardware implementing the MPEG-2 video coding standard at SNR Profile and Main level. VHDL models of video codec architectural blocks, design and fabrication of specific VLSI devices and investigation of source pre-conditioning, especially for images derived from film.	Rapid pull-through into European chip-sets, equipment and systems - of the large body of knowledge and experience gained by European researchers in the development of the MPEG video coding standards.
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Area 5: Service Engineering

Project	Main Deliverable(s)	Impact
R2009 IPSNI II	Specification of a terminal emulator. A mechanism to support effective design of user-to-service interfaces.	Increases the range of people actively seeking to take up usage of IBC services.
R2017 SCORE	The development and evaluation of methods and tools for service creation.	Such methods and tools for creating a wide range of services that can be implemented seamlessly, over the heterogeneous networks of Europe.
R2049 CASSIOPEIA	Open Service Architectural framework (OSA) supporting a service engineering environment able to promote the quick introduction of new and enhanced services, and their management.	Paves the way to the adoption of international standards in the area of OSA. Provides a diversity of telecom actors with the means for cost effective provision and management of advanced broadband services.
R2076 BOOST	An object oriented service creation environment, based on adaptation of existing software engineering tools.	Such tools shorten the time required to bring proven services to the market and will significantly contribute to the uptake of "service engineering" by the service industry.
R2089 ASCOT	Defines a usage framework model and a usage reference model for service configuration.	Results of considerable significance to service providers having to cope with the requirements for configurability.
R2092 LUSI	Guidelines for broadband user-service interfaces. Creates design targets for user-service interfaces for use by the general public.	Better service penetration and take up of such services, within what will become a competitive market.
R2094 MITS	User service interface models and metaphors specification for those interfaces.	Practical support for designers of Computer Supported Co-operative Working (CSCW) and multimedia services during the design of user-service interfaces.
R2114 DRAGON	Practical demonstration of the feasibility of applying RACE concepts for the provision of Services on top of real broadband networks.	Practical validation of ISE concepts. Transfer of technology, and generation of interest for commercial exploitation.
R2124 EURSAF	Definition of an extended ISE architectural framework and of a migration path from current state-of-the-art practice towards advanced architectures. Liaison with standards and other world-wide initiatives.	Stimulate adoption of ISE principles by both TOs and SPs. Influence standards and other world-wide initiatives.

Area 6: Information Security

Project	Main Deliverable(s)	Impact
R2050 PALINDROME	Methodology framework.	Increased awareness of the complexity of supplying security in multi-domain, multi-service environments.
R2051 SESAME	Working set of components and protocols forming the architectural framework.	Extension of scope of secure distributed applications and operations, based on a set of protocols, services, and assured data-elements; backed up by establishment of international and industry standards.
R2057 SECURENET	Architectural design and functional specifications for active protection system.	Shows the feasibility of applying novel techniques for network protection.
R2058 SAMSON	Prototypes of management services integrated into a security management system.	Provides a framework for the management of security in networked environments.
R2113 SECURENET II	Prototype system for real-time, active network protection against malicious software.	Shows the commercial feasibility of protecting networks in an automated fashion.

Area 7: Advanced Communication Experiments

R2008 EUROBRIDGE	Implementation of several service prototypes, integrated on one service platform. These include: multimedia mail, video conference, distributed co-operative work, remote multimedia database access and security services. These services support in a flexible manner, several IBC application trials.	Availability of EuroBridge services in several IBC Islands in Europe, demonstrably able to support a range of applications and to inter-work trans-nationally on existing networks.
R2019 AGORA	Determines the future evaluation needs of rural applications, and brings together key actors in the rural broadband sector.	Provided rural applications projects in RACE with a direct links to related policy initiatives and work in other RTD programmes.
R2022 BARBARA	Feasibility studies and functional specifications for rural teleshopping and tele-twinning of schools. Assessment of usage requirements.	Raised awareness of the potential of advanced communications for rural communities.
R2025 MIMIS	A multimedia demonstrator providing conference and co-operative work facilities based on ATM networking.	Contributions to standards in the domain of conferencing. Promotion of market awareness for multimedia conferencing systems based on future ATM network technologies.
R2027 BANK	Definition and implementation of pilot systems providing multimedia services and common financial functions to the banking sector.	Validation of application concept: to use multimedia broadband services to support common financial functions within the banking environment.
R2029 ESSAI	A teleshopping system to be installed at public trial sites in Milan and Basle, selling real goods to real customers for real money.	Pioneers public-site teleshopping services.
R2030 APTITUDE	Implements a teleworking system for decentralised regions.	Increases awareness of the opportunities presented by new teleworking applications.
R2031 PAGEIN	Trials super-computing in a heterogeneous terminal and network environment, demonstrating remote collaborative design.	Stimulating the adoption of high performance networking in the aerospace sector.
R2033 TELECOMMUNITY	Definition of a set of requirements for end-user groups, addressing issues of older/disabled people.	Reduction of social service costs. Identification of the needs for video-telephony in this sector.
R2034 EDID	Demonstration of collaborative design in the aerospace industry, based on ATM technology and a high speed LAN.	Commercial products, enhancing the competitiveness of the European aerospace industry.
R2035 TIBAS	Definition of a series of services for the automotive and automotive supply industries.	Creates awareness of the possibilities to reduce production-cycle times through use of advanced communications.
R2036 TRAPPIST	Definition of standards and working procedures for distributed, non-destructive testing (NTD) methods. Definition and implementation of field trials for validation.	Stimulating demand for high capacity services: NDT methods will be one of the most 'bandwidth-hungry' industrial applications.
R2037 DIDOS	Trials a distributed service centre concept in publishing and communications, specifically in technical documentation for manufacturing industry.	Provides a sound understanding of common requirements and identifies integration synergies for applications in this sector.
R2040 MOEBIUS	A mobile (containerised) multimedia test and application platform, having access through the INMARSAT satellite network to the ISDN.	Demonstrates the benefits of advanced communications in marine and remote terrestrial applications.

R2042 EUROPUBLISHING	Trials of an open publishing architecture, including distributed document management, access to image archives, on-line delivery of multimedia publications, and the tracking of editorial and production processes.	Leads to a flexible, distributed but integrated publishing system available throughout Europe.
R2043 RAMA	A pioneering multimedia information service for major European museums. Allows remote access to museum archives for researchers, publishers, students etc. throughout Europe.	Enhances public accessibility of cultural 'treasures' protected by museums. Supports multimedia tele-working and tele-learning applications..
R2046 ARAMIS	Trials an aircraft maintenance information system through a real-time distributed application. Uses digitised aircraft maintenance information in a multimedia environment. Study on the organisational impact of such capabilities.	Seeks to improve the management of aircraft maintenance at remote sites. Demonstrates the efficiency of reducing decision time and out-service costs.
R2047 VERA	Four application experiments exploiting distributed multimedia systems in the agriculture sector.	Expands the electronic support available to rural enterprises, making them more effective in their own markets of e.g. cattle breeding, dairy production and animal/crop disease control.
R2054 VIRMAS	Develops and tests broadband monitoring and surveillance equipment.	Introduces new concepts in visual verification to the security industry.
R2063 DITTO	Definition and implementation of field trials for distributed multimedia case-handling systems in the insurance sector.	Contributes to the evolving structure and functioning of the future office environment.
R2071 CHARISMA	Implements a distributed generic case handling system based on an ATM network.	Validates and promotes applications requiring advanced communications technologies in the area of case handling.
R2077 TELEMARKETPLACE	Specification of a teleshopping application exploiting existing phone and CATV networks, using advanced speech recognition equipment.	Will be developed as a commercial system, addressing the tele-shopping mass-market.
R2078 TIM	Investigates the use of a Europe-wide network of multimedia information services to support the marketing of travel and tourism products.	Creates new commercial opportunities by enabling direct control of tourism product development and marketing amongst point-of-offer and point-of-sale organisations distributed across Europe.
R2079 NETMART	Implementation of a multimedia conference service for markets in the European pig-meat sector.	Widens availability of market information for this sector. Creates a virtual marketplace.
R2080 BRICC	Mobile multimedia workstations, remote video monitoring of site progress and shared interactive databases are tested in real working conditions.	Improves the economic efficiency of the construction industry by offering shared real-time access to information for all relevant professionals.
R2098 SOCRATES	Bring together the key actors concerned with identifying the major factors for successful implementation of advance communications experiments in rural areas.	Improved the quality, relevance and co-ordination of subsequent research projects undertaking application experiments in rural areas.
R2102 AREA	Provides an integrated multimedia service supporting Mediterranean rural communities in identifying plant pathologies.	Improves support services made available to farmers in this area.
R2106 LAMBDA	Offers inhabitants of remote rural areas a range of multimedia counter services supporting administration and professional advisory services.	Practical demonstration of the potential value of broadband based services to rural areas.

R2107 ACLARA	Trials a multimedia communications system for local authorities in rural areas.	Shows where advanced communications systems can offer efficiencies and other benefits in the administration of rural communities.
R2112 SMAC	Develops multi media tools for Computer Supported Co-operative Working (CSCW) between automotive component suppliers and manufactures.	Reduction of the "Time-to-Market" for new automotive products through a significant streamlining of the procurement process.
R2119 BRITEUR	Will trial the interworking of ATM and CATV services in a rural area.	Provides a means of bringing advanced telecommunications services to rural areas.

Area 8: Test Infrastructure and Interworking

R2023 UNOM	Three broadband applications will running on the UNOM testbed in a realistic environment. Testbed further used for the testing of interconnection performance	Much improved understanding of issues related to user perception of broadband communications. This broadband island will later participate within a Pan-European broadband infrastructure.
R2032 COMBINE	Performance analysis of heterogeneous networks and protocol optimisation for interworking.	Optimises interworking between different broadband networks, increasing integration of supported services.
R2044 MAGIC	Signalling network architecture and call control protocols.	Promotion of integrated concepts and solutions related to broadband ISDN signalling for multi-service applications. Major source of contributions to Common Functional Specifications and standards bodies.
R2060 CIO	Prototypes multimedia teleservices (multimedia mail and joint viewing and tele-operation), to be implemented in several broadband islands. Examination of interworking and common transport protocol issues.	Eases the interconnection of such broadband islands to offer pan-European services. Accelerates the deployment of IBC.
R2061 EXPLOIT	Develops and builds interworking units between ATM, PDH transmission systems (2MBit/s and 140MBit/s) and existing networks and services like N-ISDN and Frame Relay.	Interworking units will permit the integration of future broadband networks (based on ATM) with existing transmission systems and services, allowing rapid evolution to IBC.
R2074 CATALYST	Implementation and test of a first demonstrator, providing an ATM satellite link. Design and development of systems and equipment to be used in more advanced demonstrators.	Demonstrates the utility of satellite technology to support initial IBC applications, in particular in peripheral and rural areas lacking terrestrial broadband infrastructure.
R2081 TRIBUNE	A broadband User-Network Interface (UNI) testbed for third parties, centred around an ATM switch.	Facilitates the widespread introduction of broadband networks in Europe by giving external users access to the testbed, linking this to other broadband islands, providing feedback to standards bodies on B-UNI standards, and improving the testbed users ability to validate their own implementations.
R2101 IMMUNE	Distributed restoration systems for ATM. Design and planning of fault-tolerant networks. Will establish coherent survivability strategies for public and private IBC network	Will establish coherent survivability strategies for public and private IBC networks, and recommendations for optimised ATM switch control architectures.
R2115 HIPERNET	Integration, installation and verification of a high-performance gigabit ATM multimedia network, to support distributed language training in an application trial.	Will yield commercially viable sub-systems for high performance multimedia networks, suiting a wide range of applications and scales.
R2116 TOMQAT	Definition, implementation and testing of a total quality management system.	Provides Network Operators and Manufacturers with methodologies for performance monitoring, quality of service management and quality of service assessment.
R2118 BRAVE	Interconnection of two ATM platforms and exploitation of experiments with real traffic sources to validate network-to-network operability and private domain management functions. Recommends solutions for ATM traffic control and resource management.	Increases understanding of ATM traffic behaviour and ATM multiplexing issues.

Accompanying Measures

R2083 CMP	A priority plan for the preparation of Common Functional Specifications (CFSs). This plan reflects the view of all RACE projects, consolidated with the standardisation bodies priorities. Performs consensus management within RACE. Provides mechanisms for consensus widening. The compilation and publication of CFS developed by RACE projects Dissemination within RACE, of progress made in standardisation (outside of the Programme).	By widening the Consensus achieved, the project improves the acknowledgement and acceptance of RACE results. The CFS plan helps projects and standardisation bodies fine tuning their own work plans.
R2085 INTERACT	Provides the RACE community with an integrated on-line information service (including techno-economic and standards information).	Supports the various techno-economic evaluations performed by RACE projects, providing a consistent base from which broadband development scenarios may be assessed.
R2086 IAF	Macro-economic models estimating to what degree IBC investment will increase white collar productivity, and lead to cumulative incremental growth rates within the European Union.	A source of policy recommendations for IBC deployment, taking into account such needs of society that may be provided through advanced communication.
R2087 TITAN	A fully operational techno-economic tool for cost evaluation and comparison of different architectures of the access network.	The modelling tool makes possible the development of cost-effective optical components and has shown under which conditions FTTC becomes a cost effective solution.
R2090 PALACE	Provides a systems engineering office and rapporteur function to Project Line 7 of RACE- the advanced communications experiments (ACE).	Encourages active co-operation amongst ACE projects working in areas of common interest. Articulates PL results in the form of contributions to CFSs, CPRs and standards bodies.
R2091 URSA	IBC deployment scenarios and budget cross-flow analyses.	Contributes to Common Functional Specifications for generic applications derived from integrating the results of all ACEs and other sector case studies performed in Europe.
R2093 RIO	To provide to the RACE community, a general, text based, on-line information system, having in addition messaging and file transfer facilities .	Should aid the functioning of the RACE program by enabling users to locate and exchange information more effectively.
R2095 BRAIN	Organisation of Summer schools and various seminars. Some sessions within such schools to take place at multiple locations, interconnected via broadband links.	Raises the awareness of broadband issues and provides a thorough knowledge to young engineers. Helps address practical issues arising from real time broadband interconnection.

Annex II

Participating organisations

Participating Organisations

Project	Role*	Company	Country
R2042	P	FAW LINZ-AUSTRIA	
R2113	P	UNIVERSITY OF VIENNA	
R2095	A	AIB - VINÇOTTE NUCLEAIRE	B
R2044	P	ATEA	B
R2077	P	BABBAGE INSTIT FOR KNOWLEDGE & INFO TECH	B
R2016	A	BARCO NV KORTRIJK	B
R2033	S	BARCO NV KORTRIJK	B
R2082	P	BARCO NV KORTRIJK	B
R2061	P	BELGACOM	B
R2032	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2044	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2048	C	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2061	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2066	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2074	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2083	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2097	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2101	C	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2117	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2166	P	BELL TELEPHONE MFG CO (ALCATEL-BELL)	B
R2034	P	BIM SA / NV	B
R2054	S	DAEDALUS N.V.	B
R2064	A	EBU RES. CENTER	B
R2048	P	FRAMATOME CONNECTORS BELGIUM NV	B
R2033	A	GASELWEST	B
R2027	P	GENERALE DE BANQUE	B
R2039	P	IMEC VZW	B
R2048	P	IMEC VZW	B
R2065	P	IMEC VZW	B
R2069	P	IMEC VZW	B
R2095	A	IMEC VZW	B
R2097	P	IMEC VZW	B
R2101	P	IMEC VZW	B
R2077	P	INTEGAN	B
R2077	P	LERNOUT & HAUSPIE SPEECHPROD.	B
R2033	P	MUNICIPALITY KORTRIJK	B
R2083	C	RACE INDUSTRIAL CONSORTIUM	B
R2016	A	RAYNET NV	B
R2087	P	RAYNET NV	B
R2016	P	REFER NV	B
R2023	P	REFER NV	B
R2041	P	REFER NV	B
R2085	P	REFER NV	B
R2090	P	REFER NV	B
R2077	P	SHERPA NV	B
R2077	C	STENTOR SPEECH PRODUCTS	B
R2061	P	UNIVERSITY GHENT	B
R2009	P	UNIVERSITY LEUVEN (CATHOLIC)	B
R2110	P	UNIVERSITY LEUVEN (CATHOLIC)	B
R2060	P	UNIVERSITY LIEGE	B
R2061	A	ALCATEL STR AG	CH
R2029	P	ASCOM AUTELCA AG	CH
R2003	P	ASCOM TECH AG	CH
R2006	S	ASCOM TECH AG	CH
R2020	P	ASCOM TECH AG	CH
R2024	P	ASCOM TECH AG	CH
R2029	P	ASCOM TECH AG	CH
R2032	P	ASCOM TECH AG	CH
R2039	P	ASCOM TECH AG	CH
R2041	P	ASCOM TECH AG	CH
R2059	P	ASCOM TECH AG	CH
R2061	P	ASCOM TECH AG	CH
R2066	P	ASCOM TECH AG	CH
R2081	P	ASCOM TECH AG	CH
R2115	P	ASCOM TECH AG	CH
R2166	P	ASCOM TECH AG	CH
R2061	C	ASSOCIATION SWISS PTT/ASCOM TECH	CH
R2039	P	EIDGENÖSSISCHE TH ZÜRICH	CH
R2060	P	EIDGENÖSSISCHE TH ZÜRICH	CH
R2111	P	EUROPEAN BROADCASTING UNION	CH
R2110	P	LTS/EPFL	CH
R2013	P	PAUL-SCHERRER-INSTITUTE ZÜRICH	CH
R2095	A	SWISS FEDERAL INSTITUTE OF TECHNOLOGY	CH
R2061	P	SWISS TELECOM PTT	CH
R2111	P	SWISS TELECOM PTT	CH
R2006	P	UNIVERSITY LAUSANNE (POLYT. FED.)	CH
R2024	S	UNIVERSITY LAUSANNE (POLYT. FED.)	CH
R2053	P	UNIVERSITY LAUSANNE (POLYT. FED.)	CH
R2072	P	UNIVERSITY LAUSANNE (POLYT. FED.)	CH

Participating Organisations

Project	Role*	Company	Country
I.2076	I	ACIT	D
R2060	P	ACOTEC GMBH	D
R2002	P	ALCATEL SEL AG	D
R2005	C	ALCATEL SEL AG	D
R2006	C	ALCATEL SEL AG	D
R2011	C	ALCATEL SEL AG	D
R2011	S	ALCATEL SEL AG	D
R2015	P	ALCATEL SEL AG	D
R2033	C	ALCATEL SEL AG	D
R2039	P	ALCATEL SEL AG	D
R2042	P	ALCATEL SEL AG	D
R2048	P	ALCATEL SEL AG	D
R2061	P	ALCATEL SEL AG	D
R2062	P	ALCATEL SEL AG	D
R2066	P	ALCATEL SEL AG	D
R2076	P	ALCATEL SEL AG	D
R2078	P	ALCATEL SEL AG	D
R2081	A	ALCATEL SEL AG	D
R2083	P	ALCATEL SEL AG	D
R2089	P	ALCATEL SEL AG	D
R2096	P	ALCATEL SEL AG	D
R2097	P	ALCATEL SEL AG	D
R2104	C	ALCATEL SEL AG	D
R2108	P	ALCATEL SEL AG	D
R2114	P	ALCATEL SEL AG	D
R2166	P	ALCATEL SEL AG	D
R2062	P	ANT NACHRICHTENTECHNIK GMBH	D
R2072	P	ANT NACHRICHTENTECHNIK GMBH	D
R2106	A	ASCOOTA BURO CENTER	D
R2035	P	BAYERISCHE MOTORENWERKE AG (BMW)	D
R2113	P	BAYERISCHE MOTORENWERKE AG (BMW)	D
R2037	P	BERTELSMANN AG	D
R2085	P	BIBA	D
R2091	P	BIBA	D
R2113	P	BIBA	D
R2107	P	BREMEN INSTITUTE OF INDUSTRIAL TECHN.	D
R2040	A	BREMER INSTITUT FUR BETRIEBSTECHNIK	D
R2094	C	BREMER INSTITUT FUR BETRIEBSTECHNIK	D
R2040	P	BREMER VULKAN VERBUND AG	D
R2036	A	BUNDESANST. F. MAT.FORSCH. U. -PRUEF.	D
R2036	A	BUNDESANST. F. MAT.FORSCH. U. -PRUEF.	D
R2036	P	BUNDESANST. F. MAT.FORSCH. U. -PRUEF.	D
R2042	P	BURDA GMBH	D
R2061	P	CADIS GMBH	D
R2081	P	CELLWARE GMBH	D
R2096	P	CELLWARE GMBH	D
R2043	A	COMPART	D
R2052	P	DAIMLER-BENZ AG	D
R2067	A	DAIMLER-BENZ AG	D
R2072	P	DAIMLER-BENZ AG	D
R2011	P	DBP TELEKOM (FTZ)	D
R2023	P	DBP TELEKOM (FTZ)	D
R2024	P	DBP TELEKOM (FTZ)	D
R2044	P	DBP TELEKOM (FTZ)	D
R2045	P	DBP TELEKOM (FTZ)	D
R2060	P	DBP TELEKOM (FTZ)	D
R2061	P	DBP TELEKOM (FTZ)	D
R2070	P	DBP TELEKOM (FTZ)	D
R2082	P	DBP TELEKOM (FTZ)	D
R2087	P	DBP TELEKOM (FTZ)	D
R2109	P	DBP TELEKOM (FTZ)	D
R2084	P	DE TE MOBILE (DEUTSCHE TELEKOM)	D
R2008	P	DETEBERKOM GMBH	D
R2036	C	DETEBERKOM GMBH	D
R2037	C	DETEBERKOM GMBH	D
R2042	C	DETEBERKOM GMBH	D
R2060	C	DETEBERKOM GMBH	D
R2076	P	DETEBERKOM GMBH	D
R2078	C	DETEBERKOM GMBH	D
R2093	P	DETEBERKOM GMBH	D
R2067	P	DEUTSCHE AEROSPACE AG.	D
R2036	P	DEUTSCHE AEROSPACE AIRBUS GMBH	D
R2027	P	DEUTSCHE BANK AG	D
R2006	P	DEUTSCHE BUNDESPOST TELEKOM	D
R2083	P	DEUTSCHE BUNDESPOST TELEKOM	D
R2089	P	DEUTSCHE BUNDESPOST TELEKOM	D
R2097	P	DEUTSCHE BUNDESPOST TELEKOM	D
R2082	P	DEUTSCHE FORSCHUNGS. FUER LUFT & RAUMFART	D
R2026	P	DEUTSCHE THOMSON-BRANDT GMBH	D
R2082	P	DEUTSCHE THOMSON-BRANDT GMBH	D

Participating Organisations

Project	Role*	Company	Country
R2020	S	DT. FORSCHUNGSSTALT F. LUFT- U. RAUMFAHRT	D
R2052	P	DVS DIGITALE VIDEOSYSTEME GMBH	D
R2040	C	EMIT GMBH	D
R2033	P	EMPRICA GMBH	D
R2033	S	EMPRICA GMBH	D
R2003	P	EMPRICA, GES.F.KOMM.-U.TECHN.FORSCHUNG	D
R2003	S	EMPRICA, GES.F.KOMM.-U.TECHN.FORSCHUNG	D
R2003	C	ERICSSON EUROLAB DEUTSCHLAND GMBH	D
R2008	C	ERICSSON EUROLAB DEUTSCHLAND GMBH	D
R2084	P	ESG ELEKTRONIK-SYSTEM & LOGISTIK GMBH	D
R2041	P	ESG ELEKTRONIK-SYSTEM GMBH	D
R2057	P	FAW ULM	D
R2035	P	FHG - IGD	D
R2112	P	FHG - IGD	D
R2042	P	FHG/IAO	D
R2037	P	FOGRA	D
R2033	S	FRANKFURTER VERBAND FÜR A+B HILFE E.V.	D
R2030	P	FRAUNHOFER GESELLSCHAFT - ISI	D
R2056	P	FRAUNHOFER INST. F. GRAPH. DATENVERARB.	D
R2107	P	FRAUNHOFER INST. F. GRAPH. DATENVERARB.	D
R2005	P	FRAUNHOFER INST.F.ANG.FESTKÖRPERPHYSIK	D
R2088	P	GES. F. MATHEMATIK UND DATENVERARBEITUNG	D
R2058	P	GESELLSCHAFT MATHEMATIK UND DATENV.	D
R2060	P	GESELLSCHAFT MATHEMATIK UND DATENV.	D
R2004	P	GMD FOKUS	D
R2041	P	GMD FOKUS	D
R2049	P	GMD FOKUS	D
R2056	S	GMD FOKUS	D
R2068	P	GMD FOKUS	D
R2116	P	GMD FOKUS	D
R2042	P	GMD-IPSI	D
R2026	P	GRUNDIG E.M.V.	D
R2082	P	GRUNDIG E.M.V.	D
R2108	P	HAGENUK GMBH	D
R2045	P	HEINRICH HERTZ INSTITUT	D
R2055	P	HEINRICH HERTZ INSTITUT	D
R2064	P	HEINRICH HERTZ INSTITUT	D
R2069	P	HEINRICH HERTZ INSTITUT	D
R2110	P	HEINRICH HERTZ INSTITUT	D
R2065	P	HEINRICH-HERTZ-INSTITUT	D
R2071	P	IABG	D
R2023	P	IKOS SOFTWARE SERVICE GMBH	D
R2048	P	IMM INSTITUT FÜR MIKROTECHNIK GMBH	D
R2021	P	INFORM GMBH	D
R2045	P	INSTITUT FÜR RUNDFUNKTECHNIK GMBH	D
R2075	P	INSTITUT FÜR RUNDFUNKTECHNIK GMBH	D
R2082	P	INSTITUT FÜR RUNDFUNKTECHNIK GMBH	D
R2040	A	INSTITUT FÜR SEEVERKEHR UND LOGISTIK	D
R2014	P	KABELRHEYDT	D
R2083	P	KRONE AG	D
R2008	P	LEHRSTUHL INFORMATIK IV	D
R2042	P	LINOTYPE-HELL AG	D
R2036	P	LUFTHANSA AG	D
R2060	P	MEDIA PORT BERLIN GMBH	D
R2010	P	MICROPARTS GMBH	D
R2024	P	MIKROELEKTRONIK ANWENDUNGSZENTRUM HBURG	D
R2032	P	MIKROELEKTRONIK ANWENDUNGSZENTRUM HAMB.	D
R2061	P	MIKROELEKTRONIK ANWENDUNGSZENTRUM HAMB.	D
R2106	A	MUNICIPALITY DOMMITZSCH	D
R2106	A	MUNICIPALITY ELSNIG	D
R2107	P	MUNICIPALITY GANDERKESEE	D
R2081	P	OSITRON SCHMIDT OHG	D
R2042	P	OTTO VERSAND	D
R2043	A	PERGAMON MUSEUM	D
R2036	A	PHILIPS IND. ROENTGEN	D
R2020	C	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2055	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2061	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2066	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2081	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2082	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2097	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2101	P	PHILIPS KOMMUNIKATIONS INDUSTRIE AG	D
R2085	A	PRODUTEC GMBH	D
R2010	P	QUANTE	D
R2033	P	ROBERT BOSCH GMBH	D
R2064	P	ROBERT BOSCH GMBH	D
R2072	C	ROBERT BOSCH GMBH	D
R2010	C	ROBERT BOSCH GMBH, FORSCHUNGSINSTITUT	D
R2078	A	SCHENKER-RHENUS REISEN KÖLN	D
R2041	P	SIEMENS AG	D

Participating Organisations

Project	Role*	Company	Country
R2045	C	SIEMENS AG	D
R2046	P	SIEMENS AG	D
R2052	P	SIEMENS AG	D
R2055	C	SIEMENS AG	D
R2058	C	SIEMENS AG	D
R2060	P	SIEMENS AG	D
R2062	P	SIEMENS AG	D
R2065	P	SIEMENS AG	D
R2066	P	SIEMENS AG	D
R2069	C	SIEMENS AG	D
R2070	C	SIEMENS AG	D
R2072	P	SIEMENS AG	D
R2073	P	SIEMENS AG	D
R2083	P	SIEMENS AG	D
R2084	C	SIEMENS AG	D
R2088	P	SIEMENS AG	D
R2096	P	SIEMENS AG	D
R2118	P	SIEMENS AG	D
R2166	P	SIEMENS AG	D
R2027	P	SIEMENS AG, OEN ZL P	D
R2051	P	SIEMENS NIXDORF INFORMATIONSYSTEME AG	D
R2035	P	SIEMENS PCN/CORPORATE R&D	D
R2112	P	SIEMENS PCN/CORPORATE R&D	D
R2063	P	SIGOS SYSTEMINTEGRATION GMBH	D
R2051	S	SNI ASSOCIATED USERS	D
R2029	P	STZ - GESELLSCHAFT FUER SOFTWARE TECH.	D
R2037	P	TEKOM	D
R2092	P	TELEMATIC SERVICES GMBH	D
R2056	C	TELENORMA GMBH	D
R2068	P	TELENORMA GMBH	D
R2083	P	TELENORMA GMBH	D
R2004	P	TELENORMA GMBH BOSCH TELECOM	D
R2008	P	TELES GMBH	D
R2025	P	TELES GMBH	D
R2079	P	TELES GMBH	D
R2102	P	TELES GMBH	D
R2086	P	TELMARK GMBH	D
R2003	P	UNIVERSITY AACHEN (RWTH)	D
R2117	P	UNIVERSITY AACHEN (RWTH)	D
R2067	P	UNIVERSITY AACHEN (TECHNICAL)	D
R2035	A	UNIVERSITY BERLIN	D
R2112	A	UNIVERSITY BERLIN	D
R2060	P	UNIVERSITY BERLIN (TECHNICAL)	D
R2088	P	UNIVERSITY BERLIN (TECHNICAL)	D
R2116	P	UNIVERSITY BERLIN (TECHNICAL)	D
R2092	P	UNIVERSITY BONN	D
R2040	A	UNIVERSITY BREMEN INST.F.HF-TECHNIK	D
R2010	P	UNIVERSITY DORTMUND	D
R2024	P	UNIVERSITY HAMBURG-HARBURG (TECHNICAL)	D
R2045	P	UNIVERSITY HANNOVER	D
R2052	P	UNIVERSITY HANNOVER	D
R2072	S	UNIVERSITY HANNOVER	D
R2110	P	UNIVERSITY HANNOVER	D
R2044	A	UNIVERSITY ILMENAU (TECHNICAL)	D
R2025	P	UNIVERSITY KOLN (BIFOA)	D
R2030	P	UNIVERSITY KOLN (BIFOA)	D
R2106	P	UNIVERSITY LEIPZIG	D
R2006	P	UNIVERSITY MARBURG	D
R2013	P	UNIVERSITY PADERBORN	D
R2028	P	UNIVERSITY PADERBORN	D
R2006	P	UNIVERSITY STUTTGART	D
R2024	P	UNIVERSITY STUTTGART	D
R2031	P	UNIVERSITY STUTTGART	D
R2060	P	UNIVERSITY STUTTGART	D
R2061	P	UNIVERSITY STUTTGART	D
R2095	A	UNIVERSITY STUTTGART	D
R2060	P	UNIVERSITY ULM	D
R2052	P	VAP VIDEO ART PRODUCTION GMBH	D
R2091	P	VDI/VDE-IT	D
R2116	P	WANDEL & GOLTERMANN	D
R2042	P	WMD GMBH	D
R2046	P	COMPUTER RESOURCES INTERNATIONAL A/S	DK
R2037	A	COURSEWARE SCANDINAVIA	DK
R2037	P	DANISH TECHNOLOGICAL INSTITUTE	DK
R2059	P	DELTA SOFTWARE ENGINEERING	DK
R2104	P	DELTA SOFTWARE ENGINEERING	DK
R2016	P	ELECTROMAGNETICS INSTITUTE DEPT CBT	DK
R2096	P	ELEKTRONIK CENTRALEN	DK
R2029	P	ELEKTRONIKCENTRALEN	DK
R2081	P	ELEKTRONIKCENTRALEN	DK

Participating Organisations

Project	Role*	Company	Country
R2036	P	FORCE INSTITUTTERNE	DK
R2081	S	GNELM	DK
R2037	P	GRUNDFOS	DK
R2014	P	JYDSK TELEFON	DK
R2061	P	JYDSK TELEFON	DK
R2097	P	JYDSK TELEFON	DK
R2103	P	JYDSK TELEFON	DK
R2004	C	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2032	C	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2041	P	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2046	P	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2059	P	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2061	P	KTAS (COPENHAGEN TELEPHONE COMPANY)	DK
R2004	P	L.M. ERICSSON A/S	DK
R2014	S	NETMAN	DK
R2004	P	NKT ELEKTRONIK A/S	DK
R2014	C	NKT ELEKTRONIK A/S	DK
R2034	P	PER UDSEN CO. AIRCRAFT INDUSTRY	DK
R2046	C	SCANDINAVIAN AIRLINES SYSTEM	DK
R2039	P	TECHNICAL UNIVERSITY OF DENMARK	DK
R2083	P	TELE DANMARK A/S	DK
R2017	P	TELE DANMARK RESEARCH	DK
R2082	P	TELECOM DENMARK	DK
R2085	P	TELECOMMUNICATIONS RESEARCH GROUP	DK
R2049	P	TFL TELECOM RESEARCH LAB	DK
R2108	P	UNIVERSITY OF AALBORG	DK
R2078	P	ALCATEL FYCSA	E
R2061	P	ALCATEL SESA	E
R2066	P	ALCATEL SESA	E
R2081	P	ALCATEL SESA	E
R2084	P	ALCATEL SESA	E
R2096	P	ALCATEL SESA	E
R2097	P	ALCATEL SESA	E
R2101	P	ALCATEL SESA	E
R2104	A	ALCATEL SESA	E
R2071	C	APD S.A.	E
R2023	P	BANCO DEL COMERCIO	E
R2030	P	CENTRO DE TEXTOS ELECTRONICO	E
R2038	P	DEPT.FISICA, UNIV. AUTONOMA BARCELONA	E
R2108	P	DETYCOM A.L.E.	E
R2082	P	ENTE PUBLICO RETEVISION	E
R2078	A	GENERALITAT DE CATALUNYA	E
R2053	P	IBERMATICA	E
R2119	A	INMARK	E
R2078	P	INSTITUT CERDA	E
R2080	P	INSTITUT CERDA	E
R2091	C	INSTITUT CERDA	E
R2079	P	MERCOLLEIDA	E
R2043	A	MUSEO ARCHEOLOGICO NACIONAL	E
R2043	A	MUSEO NACIONAL DEL PRADO	E
R2078	A	REAL AUTOMOBIL CLUB DE CATALUNYA	E
R2064	P	RETEVISION	E
R2019	P	SEMA GROUP SAE	E
R2079	C	SEMA GROUP SAE	E
R2054	P	SYSTEMAS AVANCADOS DE CONTROL	E
R2020	P	TELEFONICA DE ESPANA SA	E
R2023	P	TELEFONICA DE ESPANA SA	E
R2024	P	TELEFONICA DE ESPANA SA	E
R2025	P	TELEFONICA DE ESPANA SA	E
R2041	P	TELEFONICA DE ESPANA SA	E
R2055	P	TELEFONICA DE ESPANA SA	E
R2066	P	TELEFONICA DE ESPANA SA	E
R2069	P	TELEFONICA DE ESPANA SA	E
R2072	P	TELEFONICA DE ESPANA SA	E
R2076	P	TELEFONICA DE ESPANA SA	E
R2087	P	TELEFONICA DE ESPANA SA	E
R2117	P	TELEFONICA DE ESPANA SA	E
R2166	P	TELEFONICA DE ESPANA SA	E
R2073	P	TELEFONICA I.R.D.	E
R2016	P	TELEFONICA INVESTIGACION Y DESARROLLO	E
R2061	P	TELEFONICA INVESTIGACION Y DESARROLLO	E
R2092	P	TELEFONICA INVESTIGACION Y DESARROLLO	E
R2043	P	TELEFONICA SISTEMAS	E
R2071	P	TRANSTOOLS	E
R2018	S	UNIVERSITY MADRID (AUTONOMA)	E
R2052	P	UNIVERSITY BALEARIC ISLANDS	E
R2024	P	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2053	C	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2061	P	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2066	A	UNIVERSITY CATALONIA (POLYTECHNIC)	E

Participating Organisations

Project	Role*	Company	Country
R2072	P	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2084	S	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2095	A	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2108	P	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2166	S	UNIVERSITY CATALONIA (POLYTECHNIC)	E
R2043	P	UNIVERSITY MADRID (POLYTECHNIC)	E
R2056	P	UNIVERSITY MADRID (POLYTECHNIC)	E
R2018	S	UNIVERSITY PAIS VASCO	E
R2018	S	UNIVERSITY ZARAGOZA	E
R2046	P	AEROPORTS DE PARIS	F
R2034	A	AEROSPATIALE	F
R2034	P	AEROSPATIALE	F
R2011	P	ALCATEL ALSTHOM RECHERCHE	F
R2015	S	ALCATEL ALSTHOM RECHERCHE	F
R2018	C	ALCATEL ALSTHOM RECHERCHE	F
R2039	C	ALCATEL ALSTHOM RECHERCHE	F
R2048	P	ALCATEL ALSTHOM RECHERCHE	F
R2104	A	ALCATEL ALSTHOM RECHERCHE	F
R2034	P	ALCATEL CIT	F
R2039	P	ALCATEL CIT	F
R2044	S	ALCATEL CIT	F
R2083	P	ALCATEL CIT	F
R2064	P	ALCATEL ESPACE	F
R2074	C	ALCATEL ESPACE	F
R2075	C	ALCATEL ESPACE	F
R2078	P	ALCATEL ESPACE	F
R2117	C	ALCATEL ESPACE	F
R2025	P	ALCATEL ISR	F
R2041	P	ALCATEL ISR	F
R2059	P	ALCATEL ISR	F
R2116	P	ALCATEL ISR	F
R2084	P	ALCATEL RADIOTELEPHONE	F
R2117	P	ALCATEL RADIOTELEPHONE	F
R2064	P	ALCATEL TELSPACE	F
R2074	P	ALCATEL TELSPACE	F
R2078	P	ALCATEL TITN ANSWARE	F
R2034	A	ALLIANCE QUALITE LOGICIEL	F
R2016	P	ARECOM TELECOM PARIS	F
R2064	P	ARECOM TELECOM PARIS	F
R2053	P	ARMINES	F
R2071	P	BAYER DIAGNOSTICS	F
R2050	P	BERTIN ET CIE	F
R2080	C	BOUYGUES	F
R2051	S	BULL ASSOCIATED USERS	F
R2076	P	BULL S.A.	F
R2058	P	BULL SA ECHIROLLES	F
R2003	P	CAP GEMINI INNOVATION	F
R2017	S	CAP GEMINI INNOVATION	F
R2047	P	CAP SESA REGIONS	F
R2003	P	CAP SESA TELECOM	F
R2017	P	CAP SESA TELECOM	F
R2115	P	CAP SESA TELECOM	F
R2045	P	CCETT	F
R2064	P	CCETT	F
R2072	P	CCETT	F
R2038	P	CEMA, UNIVERSITY DE RENNES	F
R2072	P	CENTER MORPHOLOGICAL MATH.	F
R2025	P	CETIA	F
R2096	P	CLEMESSEY ELECTRONIQUE	F
R2081	P	CLEMESSEY SA	F
R2088	P	CLEMESSEY SA	F
R2006	P	CNET FRANCE TELECOM	F
R2014	P	CNET FRANCE TELECOM	F
R2017	P	CNET FRANCE TELECOM	F
R2018	P	CNET FRANCE TELECOM	F
R2028	P	CNET FRANCE TELECOM	F
R2034	P	CNET FRANCE TELECOM	F
R2039	P	CNET FRANCE TELECOM	F
R2049	P	CNET FRANCE TELECOM	F
R2057	P	CNET FRANCE TELECOM	F
R2062	P	CNET FRANCE TELECOM	F
R2066	P	CNET FRANCE TELECOM	F
R2067	A	CNET FRANCE TELECOM	F
R2072	P	CNET FRANCE TELECOM	F
R2075	P	CNET FRANCE TELECOM	F
R2082	C	CNET FRANCE TELECOM	F
R2084	P	CNET FRANCE TELECOM	F
R2087	C	CNET FRANCE TELECOM	F
R2110	C	CNET FRANCE TELECOM	F
R2111	P	CNET FRANCE TELECOM	F

Participating Organisations

Project	Role*	Company	Country
R2113	P	CNET FRANCE TELECOM	F
R2078	A	COMITÉ DÉP. DU TOURISME DE L'HÉRAULT	F
R2054	P	COMPAGNIE GENERALE DE PROTECTION ET SECE	F
R2070	P	CORNING EUROPE	F
R2109	C	CORNING EUROPE	F
R2007	P	DASSAULT AUTOMATISMES ET TELECOMMUNICAT.	F
R2057	P	DASSAULT AUTOMATISMES ET TELECOMMUNICAT.	F
R2088	P	DASSAULT AUTOMATISMES ET TELECOMMUNICAT.	F
R2113	P	DASSAULT AUTOMATISMES ET TELECOMMUNICAT.	F
R2037	P	DIGITAL EQUIPMENT FRANCE	F
R2056	P	DIGITAL ETM/IC	F
R2036	P	ELECTRICITE DE FRANCE	F
R2034	P	EUROPEAN AEROSPACE NETWORK SERVICES	F
R2043	A	EUTELIS	F
R2023	P	EUTELSAT	F
R2064	C	EUTELSAT	F
R2074	P	EUTELSAT	F
R2035	P	FCR FRANCE TELECOM	F
R2014	S	FRAMATOME CONNECTORS FRANC	F
R2021	P	FRAMENTEC	F
R2083	P	FRANCE TELECOM	F
R2107	P	FRANCE TELECOM EXPERTEL	F
R2112	P	FRANCE TELECOM EXPERTEL	F
R2064	P	FRANCE TELECOM STI	F
R2086	P	GEMINI CONSULTING	F
R2051	C	GROUPE BULL SA	F
R2004	P	GSI ERLI	F
R2027	P	GSI-TECSI	F
R2107	P	HOTEL DE VILLE CHATEAU DU LOIR	F
R2004	P	IBM FRANCE	F
R2017	C	IBM FRANCE	F
R2020	P	IBM FRANCE	F
R2027	C	IBM FRANCE	F
R2034	C	IBM FRANCE	F
R2035	P	IBM FRANCE	F
R2041	P	IBM FRANCE	F
R2046	P	IBM FRANCE	F
R2058	P	IBM FRANCE	F
R2068	P	IBM FRANCE	F
R2112	P	IBM FRANCE	F
R2115	C	IBM FRANCE	F
R2078	P	IDATE	F
R2119	A	IDATE	F
R2005	A	IEMN DHS LILLE UNIVERSITY	F
R2079	A	IGIA-CENTRE POLYTECHNIQUE SAINT LOUIS	F
R2095	A	INS. DE FORMAT. D'ANIMAT. E CONS. ENTR	F
R2001	P	INSTRUMENTS SA JOBIN-YVON	F
R2001	P	ITIS	F
R2072	P	ITIS	F
R2071	P	ITMI	F
R2053	P	LABORATOIRES D'ELECTRONIQUE PHILIPS	F
R2055	A	LABORATOIRES D'ELECTRONIQUE PHILIPS	F
R2061	P	LABORATOIRES D'ELECTRONIQUE PHILIPS	F
R2072	P	LABORATOIRES D'ELECTRONIQUE PHILIPS	F
R2117	P	LABORATOIRES D'ELECTRONIQUE PHILIPS	F
R2067	P	LABORATOIRES D'ELECTRONIQUE PHILIPS MICROWAVE	F
R2004	A	MARBEN	F
R2079	P	MARBEN	F
R2079	P	MARCHE DU PORC BRETON	F
R2020	P	MATRA COMMUNICATION	F
R2023	P	MATRA COMMUNICATION	F
R2030	P	MATRA COMMUNICATION	F
R2055	P	MATRA COMMUNICATION	F
R2072	P	MATRA COMMUNICATION	F
R2023	P	MATRA MARCONI SPACE FRANCE	F
R2111	S	MERCURE	F
R2016	C	MET COMMUTATION	F
R2023	C	MET COMMUTATION	F
R2085	A	MET COMMUTATION	F
R2087	P	MET COMMUTATION	F
R2078	S	MINISTÈRE DU TOURISME	F
R2059	P	MONETEL S.A.	F
R2043	P	MUSEE DORSAY	F
R2031	C	ONERA	F
R2034	P	ONERA	F
R2029	P	OST - OUEST STANDARD TELEMATIQUE	F
R2034	P	OST - OUEST STANDARD TELEMATIQUE	F
R2030	P	PBS-TRG	F
R2050	C	PROTEXARMS	F
R2001	P	RADIALL	F
R2112	P	RENAULT SA	F

Participating Organisations

Project	Role*	Company	Country
R2021	P	SEMA-GROUP	F
R2032	P	SGS THOMSON MICROELECTRONICS S.A.	F
R2023	P	SGS-THOMSON MICROELECTRONICS SRL	F
R2035	P	SIEMENS AUTOMOTIVE S A	F
R2112	P	SIEMENS AUTOMOTIVE S A	F
R2014	S	SILEC	F
R2034	P	SLX	F
R2014	P	SOCIETE ANONYME DE TELECOMMUNICATION	F
R2083	P	SOCIETE ANONYME DE TELECOMMUNICATION	F
R2087	P	SOCIETE ANONYME DE TELECOMMUNICATION	F
R2076	A	SOCIETE FRANCAIS DE GENIE LOGICIEL S.A.	F
R2034	A	SOCIETE POUR L'INFORMATIQUE INDUSTRIELLE	F
R2042	P	SOGITEC S.A.	F
R2103	P	SOITEC SA	F
R2071	P	SOPHA MEDICAL	F
R2029	P	SYSECA S.A.	F
R2086	C	TECHNOLOGY INVESTMENT PARTNERS	F
R2074	P	TELECOM PARIS	F
R2084	P	TELECOM PARIS-ARECOM, PARIS, FRANCE	F
R2097	P	TELECOMMUNICATIONS RADIO ELECTRIQUES	F
R2007	C	TELEDIFFUSION DE FRANCE	F
R2064	P	TELEDIFFUSION DE FRANCE	F
R2075	P	TELEDIFFUSION DE FRANCE	F
R2023	P	TELESYSTEMES	F
R2041	P	TELESYSTEMES	F
R2049	P	TELESYSTEMES	F
R2058	A	TELESYSTEMES	F
R2078	P	TELESYSTEMES	F
R2080	P	TELESYSTEMES	F
R2092	P	TELESYSTEMES	F
R2114	P	TELESYSTEMES	F
R2043	C	TELESYSTEMES INNOVATION	F
R2079	P	TELMART SA	F
R2116	P	TELMAT COMMUNICATIONS	F
R2095	P	THESEUS INSTITUTE	F
R2102	P	THESEUS INSTITUTE	F
R2039	P	THOMSON CSF	F
R2055	P	THOMSON CSF	F
R2075	P	THOMSON CSF	F
R2083	P	THOMSON CSF	F
R2096	P	THOMSON CSF	F
R2110	P	THOMSON CSF	F
R2067	A	THOMSON CSF CNI	F
R2005	P	THOMSON CSF LCR	F
R2006	P	THOMSON CSF LCR	F
R2029	P	THOMSON CSF LER	F
R2045	P	THOMSON CSF LER	F
R2052	C	THOMSON CSF LER	F
R2064	P	THOMSON CSF LER	F
R2067	A	THOMSON CSF LER	F
R2072	P	THOMSON CSF LER	F
R2082	P	THOMSON CSF LER	F
R2001	P	THOMSON CSF LER/LCR	F
R2067	A	THOMSON CSF RCC	F
R2067	P	THOMSON CSF SEMICONDUCTORES SPECIFIQUES	F
R2062	P	THOMSON HYBRIDES	F
R2047	S	UNION REGIONALE COOPERATIVES ELEVAGE	F
R2067	A	UNIVERSITY LILLE	F
R2018	S	UNIVERSITY RENNES	F
R2017	A	VERILOG SA	F
R2017	P	VERILOG SA	F
R2088	C	VERILOG SA	F
R2055	P	VITEC	F
R2106	P	01 PLIROFORIKI	GR
R2059	P	ALPHA SYSTEM ANALYSIS INTEGRATION LTD	GR
R2104	P	ALPHA SYSTEM ANALYSIS INTEGRATION LTD	GR
R2116	C	ALPHA SYSTEM ANALYSIS INTEGRATION LTD	GR
R2074	P	CENTRE OF PLANNING & ECONOMIC RESEARCH	GR
R2119	P	EPSILON INTERNATIONAL SA	GR
R2057	C	EXPERTNET	GR
R2113	C	EXPERTNET	GR
R2009	P	FOUNDATION OF RESEARCH AND TECHNOLOGY	GR
R2043	A	GOULANDRIS MUSEUM OF CYCLADIC ART	GR
R2022	A	HELLENIC MINISTRY OF AGRICULTURE	GR
R2022	P	INTEGRATED INFORMATION SYSTEMS	GR
R2008	P	INTRACOM SA	GR
R2016	A	INTRACOM SA	GR
R2037	P	INTRACOM SA	GR
R2041	P	INTRACOM SA	GR
R2045	P	INTRACOM SA	GR

Participating Organisations

Project	Role*	Company	Country
R2049	P	INTRACOM SA	GR
R2088	P	INTRACOM SA	GR
R2110	P	INTRACOM SA	GR
R2114	P	INTRACOM SA	GR
R2116	P	INTRACOM SA	GR
R2076	P	INTRASOFT SA	GR
R2093	P	INTRASOFT SA	GR
R2093	P	ITEL LTD	GR
R2030	P	KATO ACHAJA HEALTH CARE CENTRE	GR
R2043	P	L-CUBE INFORMATION SYSTEMS SA	GR
R2106	S	LAMBRAXIS FOUNDATION	GR
R2040	A	MARAC ELECTRONICS	GR
R2022	A	NAT. RESEARCH CENTRE DEMOKRITOS	GR
R2106	A	NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	GR
R2066	P	OTE SA	GR
R2106	S	OTE SA	GR
R2166	P	OTE SA	GR
R2019	P	PLANET SA	GR
R2030	P	REGIONAL UNIVERSITY HOSPITAL OF PATRAS	GR
R2022	A	S.BEIS SERVICE PROVIDER	GR
R2040	A	TECHNISYSTEMS LTD	GR
R2102	P	UNION OF YOUNG FARMERS	GR
R2057	P	UNIVERSITY AEGEAN	GR
R2113	P	UNIVERSITY AEGEAN	GR
R2119	A	UNIVERSITY AEGEAN	GR
R2015	P	UNIVERSITY ATHENS	GR
R2073	P	UNIVERSITY ATHENS	GR
R2087	P	UNIVERSITY ATHENS	GR
R2022	P	UNIVERSITY ATHENS (AGRICULTURAL)	GR
R2005	P	UNIVERSITY ATHENS (NTUA)	GR
R2007	P	UNIVERSITY ATHENS (NTUA)	GR
R2016	P	UNIVERSITY ATHENS (NTUA)	GR
R2022	A	UNIVERSITY ATHENS (NTUA)	GR
R2023	P	UNIVERSITY ATHENS (NTUA)	GR
R2024	P	UNIVERSITY ATHENS (NTUA)	GR
R2037	P	UNIVERSITY ATHENS (NTUA)	GR
R2040	P	UNIVERSITY ATHENS (NTUA)	GR
R2044	A	UNIVERSITY ATHENS (NTUA)	GR
R2061	P	UNIVERSITY ATHENS (NTUA)	GR
R2064	P	UNIVERSITY ATHENS (NTUA)	GR
R2078	P	UNIVERSITY ATHENS (NTUA)	GR
R2095	A	UNIVERSITY ATHENS (NTUA)	GR
R2097	P	UNIVERSITY ATHENS (NTUA)	GR
R2104	P	UNIVERSITY ATHENS (NTUA)	GR
R2106	A	UNIVERSITY ATHENS (NTUA)	GR
R2114	A	UNIVERSITY ATHENS (NTUA)	GR
R2116	P	UNIVERSITY ATHENS (NTUA)	GR
R2118	P	UNIVERSITY ATHENS (NTUA)	GR
R2022	S	UNIVERSITY PATRAS	GR
R2030	P	UNIVERSITY PATRAS	GR
R2045	A	UNIVERSITY PATRAS	GR
R2045	P	UNIVERSITY THESSALONIKI	GR
R2053	P	ZENON S.A.	GR
R2066	P	ALCATEL FACE	I
R2067	P	ALCATEL FACE	I
R2084	P	ALCATEL FACE	I
R2083	P	ALCATEL ITALIA SPA	I
R2166	P	ALCATEL ITALIA SPA	I
R2075	P	ALCATEL TELETTRA	I
R2075	P	ALENIA SPAZIO	I
R2078	P	ALITALIA	I
R2102	P	ASS. REGION. PUGLIESE TECNICI E RIC. IN AGR.	I
R2023	P	BANCA POPOLARE DI MILANO	I
R2009	C	CONSIGLIO NAZIONALE RICERCHE	I
R2048	P	CORONA	I
R2029	C	COSI SRL	I
R2088	P	COSI SRL	I
R2030	P	CRAI	I
R2102	P	CROSSOVER SRL	I
R2003	P	CSELT SPA	I
R2009	P	CSELT SPA	I
R2017	P	CSELT SPA	I
R2018	P	CSELT SPA	I
R2020	P	CSELT SPA	I
R2024	P	CSELT SPA	I
R2025	P	CSELT SPA	I
R2028	P	CSELT SPA	I
R2039	P	CSELT SPA	I
R2041	P	CSELT SPA	I
R2044	P	CSELT SPA	I

Participating Organisations

Project	Role*	Company	Country
R2049	P	CSELT SPA	I
R2058	P	CSELT SPA	I
R2066	P	CSELT SPA	I
R2072	P	CSELT SPA	I
R2082	P	CSELT SPA	I
R2087	P	CSELT SPA	I
R2117	P	CSELT SPA	I
R2166	P	CSELT SPA	I
R2028	P	ERICSSON FATME SPA	I
R2044	P	ERICSSON FATME SPA	I
R2068	C	ERICSSON FATME SPA	I
R2083	P	ERICSSON FATME SPA	I
R2049	P	FONDAZIONE UGO BORDONI	I
R2066	A	FONDAZIONE UGO BORDONI	I
R2068	P	FONDAZIONE UGO BORDONI	I
R2084	P	FONDAZIONE UGO BORDONI	I
R2166	A	FONDAZIONE UGO BORDONI	I
R2080	P	FRATELLI DIOGUARDI SPA	I
R2078	P	IBIEF-GEIE	I
R2076	P	INTECS SISTEMI SPA	I
R2012	A	IROE	I
R2012	P	ISTITUTO GUIDO DONEGANI	I
R2020	S	ITALTEL S.I.T. SPA	I
R2024	P	ITALTEL S.I.T. SPA	I
R2028	P	ITALTEL S.I.T. SPA	I
R2066	A	ITALTEL S.I.T. SPA	I
R2082	P	ITALTEL S.I.T. SPA	I
R2083	P	ITALTEL S.I.T. SPA	I
R2096	P	ITALTEL S.I.T. SPA	I
R2118	C	ITALTEL S.I.T. SPA	I
R2080	P	MIDGER CONSORTIUM	I
R2013	C	PIRELLI CAVI SPA	I
R2028	P	PIRELLI CAVI SPA	I
R2015	P	PIRELLI SPA	I
R2064	P	RAI RADIO TELEVISIONE ITALIANA	I
R2075	P	RAI RADIO TELEVISIONE ITALIANA	I
R2082	P	RAI RADIO TELEVISIONE ITALIANA	I
R2111	P	RAI RADIO TELEVISIONE ITALIANA	I
R2078	P	SARITEL SPA	I
R2089	P	SARITEL SPA	I
R2093	C	SARITEL SPA	I
R2055	P	SELECO SPA	I
R2082	P	SELECO SPA	I
R2029	P	SEVA - SERVIZI A VALORE AGGIUNTO SPA	I
R2082	P	SGS THOMSON MICROELECTRONICS SRL	I
R2016	P	SGS-THOMSON MICROELECTRONICS SRL	I
R2023	P	SGS-THOMSON MICROELECTRONICS SRL	I
R2055	P	SGS-THOMSON MICROELECTRONICS SRL	I
R2083	P	SIP	I
R2041	P	SIRTI SPA	I
R2058	P	SIRTI SPA	I
R2064	P	SPACE ENGINEERING SRL	I
R2074	P	SPACE ENGINEERING SRL	I
R2050	P	SYNTAX SISTEMI SOFTWARE	I
R2102	C	TECNOPOLIS CSATA NOVUS ORTUS	I
R2086	P	TEKNIBANK	I
R2064	A	TELESPAZIO SPA	I
R2102	P	TELESPAZIO SPA	I
R2117	P	TELESPAZIO SPA	I
R2117	P	UNIVERSITY FIRENZE	I
R2042	P	UNIVERSITY GENOVA, DIBE	I
R2016	A	UNIVERSITY TORINO (POLYTECHNIC)	I
R2035	P	UNIVERSITY TRENTO	I
R2112	P	UNIVERSITY TRENTO	I
R2078	A	BORD FAILTE / IRISH TOURIST BOARD	IRL
R2022	P	BRAY INFORMATION TECHNOLOGY	IRL
R2004	P	BROADCOM EIREANN RESEARCH LTD	IRL
R2008	P	BROADCOM EIREANN RESEARCH LTD	IRL
R2017	P	BROADCOM EIREANN RESEARCH LTD	IRL
R2021	C	BROADCOM EIREANN RESEARCH LTD	IRL
R2041	C	BROADCOM EIREANN RESEARCH LTD	IRL
R2066	P	BROADCOM EIREANN RESEARCH LTD	IRL
R2166	P	BROADCOM EIREANN RESEARCH LTD	IRL
R2033	P	CABLE MANAGEMENT INTL SERVICES LTD.	IRL
R2054	P	CABLE MANAGEMENT INTL SERVICES LTD.	IRL
R2105	P	CABLE MANAGEMENT INTL SERVICES LTD.	IRL
R2119	P	CABLE MANAGEMENT INTL SERVICES LTD.	IRL
R2075	P	CABLE MANAGEMENT IRELAND LTD	IRL
R2075	A	CABLE MANAGEMENT IRELAND LTD	IRL
R2008	P	CIRCUITS TEST AND SYSTEMS TECHNOLOGY LTD	IRL

Participating Organisations

Project	Role	Company	Country
R2115	A	CREDCO LTD.	IRL
R2104	P	EOLAS-THE IRISH SCIENCE&TECHNOLOGY AGENC	IRL
R2027	A	FINANCIAL COURSEWARE LIMITED	IRL
R2047	P	INFORMATION TECHNOLOGY CENTRE	IRL
R2066	A	IRISH SCIENCE AND TECHNOLOGY AGENCY	IRL
R2166	A	IRISH SCIENCE AND TECHNOLOGY AGENCY	IRL
R2033	A	NATIONAL REHABILITATION BOARD	IRL
R2106	P	NEXUS	IRL
R2019	P	NEXUS EUROPE LTD	IRL
R2091	P	NEXUS EUROPE LTD	IRL
R2027	P	NORCONTEL	IRL
R2033	A	NORTH WESTERN HEALTH BOARD	IRL
R2103	P	OPTRONICS IRELAND	IRL
R2119	A	RADIO TELEFIS EIREANN	IRL
R2105	P	SCREENPHONES LTD	IRL
R2119	C	SCREENPHONES LTD	IRL
R2095	P	SHIP SYSTEMS SERVICES	IRL
R2008	P	SOFTWARE AND SYSTEMS ENGINEERING	IRL
R2033	S	STAR TELEMATICS LTD	IRL
R2075	S	STAR TELEMATICS LTD	IRL
R2119	A	STAR TELEMATICS LTD	IRL
R2047	P	TEAGASC OAKPARK RESEARCH CENTRE	IRL
R2022	P	TELECOM EIREANN	IRL
R2113	P	TELTEC	IRL
R2112	A	TIRAC	IRL
R2022	A	UDARAS NA GAELTACHTA	IRL
R2106	P	UDARAS NA GAELTACHTA	IRL
R2021	S	UNIVERSITY DUBLIN CITY	IRL
R2066	A	UNIVERSITY LIMERICK	IRL
R2166	A	UNIVERSITY LIMERICK	IRL
R2012	C	UNIVERSITY TRINITY COLLEGE DUBLIN	IRL
R2015	P	UNIVERSITY TRINITY COLLEGE DUBLIN	IRL
R2021	A	UNIVERSITY TRINITY COLLEGE DUBLIN	IRL
R2022	A	WICKLOW COUNTY COUNCIL	IRL
R2091	P	WORK RESEARCH CENTRE	IRL
R2086	S	PALO ALTO MANAGEMENT GROUP/TI PARTNERS	L
R2086	S	T. I. PARTNER /TV SA	L
R2017	A	ABB CORPORATE RESEARCH	N
R2017	P	ABB CORPORATE RESEARCH	N
R2117	P	ABB CORPORATE RESEARCH	N
R2061	P	ALCATEL TELECOM NORWAY AS	N
R2078	P	NORSK REGNESENTRAL	N
R2001	P	NORSK RIKSKRINGKASTING	N
R2017	A	NORWEGIAN COMPUTING CENTER	N
R2017	P	NORWEGIAN COMPUTING CENTER	N
R2041	P	NORWEGIAN TELECOM RESEARCH	N
R2060	P	NORWEGIAN TELECOM RESEARCH	N
R2061	P	NORWEGIAN TELECOM RESEARCH	N
R2067	P	NORWEGIAN TELECOM RESEARCH	N
R2087	P	NORWEGIAN TELECOM RESEARCH	N
R2060	P	SIEMENS AS	N
R2033	P	SINTEF SI CENTER FOR INDUSTRIAL RESEARCH	N
R2078	A	TROLL PARK LILLEHAMMER OLYMPIC DEV. ASS.	N
R2010	P	AKZO ELECTRONIC PRODUCTS GROUP	NL
R2115	P	AND SOFTWARE BV	NL
R2024	C	AT&T NETWORK SYSTEMS BV	NL
R2044	P	AT&T NETWORK SYSTEMS BV	NL
R2061	P	AT&T NETWORK SYSTEMS BV	NL
R2062	P	AT&T NETWORK SYSTEMS BV	NL
R2066	A	AT&T NETWORK SYSTEMS BV	NL
R2066	P	AT&T NETWORK SYSTEMS BV	NL
R2083	P	AT&T NETWORK SYSTEMS BV	NL
R2097	P	AT&T NETWORK SYSTEMS BV	NL
R2109	P	AT&T NETWORK SYSTEMS BV	NL
R2166	P	AT&T NETWORK SYSTEMS BV	NL
R2022	P	BURIE ONDERZOEK EN ADVIES B.V.	NL
R2019	P	BURIE ONDERZOEK EN ADVIES BV	NL
R2063	P	COMPUTER TASK GROUP (EUROPE)	NL
R2022	A	COMTEL BV	NL
R2022	A	DE 12 REGIOS	NL
R2063	P	DELTA LLOYD VERZEKERINGSGROEP N.V.	NL
R2063	C	DIGITAL EQUIPMENT ENTERPRISE BV	NL
R2054	S	DOORNHEID DE VRIES INTERNATIONAL	NL
R2020	P	ERICSSON BUSINESS MOBILE NETWORKS B.V.	NL
R2003	P	ERICSSON TELECOMMUNICATIE B. V.	NL
R2079	P	IDE	NL
R2009	P	INSTITUTE FOR REHABILITATION RESEARCH	NL
R2033	P	INSTITUUT VOOR DOVEN	NL

Participating Organisations

Project	Role*	Company	Country
R2043	P	MUSEON	NL
R2077	P	N.V. DE STERRENBORG	NL
R2026	C	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2062	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2065	C	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2069	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2073	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2081	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2105	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2110	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2111	P	NEDERLANDSE PHILIPS BEDRYVEN BV	NL
R2031	P	NLR	NL
R2022	A	P. KARSTEN HOLDING LTD.	NL
R2022	A	PBC GRONINGEN	NL
R2070	P	PHILIPS	NL
R2083	P	PHILIPS COMMUNICATION SYSTEMS BV	NL
R2097	P	PHILIPS COMMUNICATION SYSTEMS BV	NL
R2079	P	PRODUKTSCHAP VOOR VEE EN VLEES	NL
R2022	P	PROVINCIE FRIESLAND	NL
R2009	A	ROYAL PTT NEDERLAND NV	NL
R2017	P	ROYAL PTT NEDERLAND NV	NL
R2021	P	ROYAL PTT NEDERLAND NV	NL
R2060	P	ROYAL PTT NEDERLAND NV	NL
R2065	P	ROYAL PTT NEDERLAND NV	NL
R2094	P	ROYAL PTT NEDERLAND NV	NL
R2001	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2003	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2024	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2025	C	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2032	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2042	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2044	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2045	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2049	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2061	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2065	A	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2066	C	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2072	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2081	C	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2087	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2096	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2097	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2101	P	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2166	C	ROYAL PTT NEDERLAND NV PTT RESEARCH	NL
R2076	A	STICHTING MATHEMATISCH CENTRUM	NL
R2117	P	TNO PHYSICS & ELECTRONICS LAB.	NL
R2073	S	UNIVERSITY DELFT	NL
R2026	A	UNIVERSITY DELFT (TECHNICAL)	NL
R2045	A	UNIVERSITY DELFT (TECHNICAL)	NL
R2070	S	UNIVERSITY DELFT (TECHNICAL)	NL
R2024	P	UNIVERSITY NIJMEGEN	NL
R2061	P	UNIVERSITY NIJMEGEN	NL
R2044	A	UNIVERSITY TWENTE	NL
R2049	P	UNIVERSITY TWENTE	NL
R2066	A	UNIVERSITY TWENTE	NL
R2166	A	UNIVERSITY TWENTE	NL
R2119	P	WIERDA, OVERMARS & PARTNERS	NL
R2002	P	ALCATEL PORTUGAL SA	P
R2047	P	AGSOCIO DESENVOLVIMENTO DA EABL	P
R2002	C	CET TELECOM PORTUGAL	P
R2005	P	CET TELECOM PORTUGAL	P
R2007	P	CET TELECOM PORTUGAL	P
R2019	C	CET TELECOM PORTUGAL	P
R2022	P	CET TELECOM PORTUGAL	P
R2041	P	CET TELECOM PORTUGAL	P
R2047	P	CET TELECOM PORTUGAL	P
R2049	P	CET TELECOM PORTUGAL	P
R2059	P	CET TELECOM PORTUGAL	P
R2060	P	CET TELECOM PORTUGAL	P
R2061	P	CET TELECOM PORTUGAL	P
R2065	P	CET TELECOM PORTUGAL	P
R2074	P	CET TELECOM PORTUGAL	P
R2076	P	CET TELECOM PORTUGAL	P
R2095	C	CET TELECOM PORTUGAL	P
R2117	P	CET TELECOM PORTUGAL	P
R2095	P	CIFAG SA	P
R2011	P	COMPANHIA PORTUGUESA RADIO MARCONI SA	P
R2041	P	COMPANHIA PORTUGUESA RADIO MARCONI SA	P
R2067	C	COMPANHIA PORTUGUESA RADIO MARCONI SA	P
R2074	P	COMPANHIA PORTUGUESA RADIO MARCONI SA	P

Participating Organisations

Project	Role*	Company	Country
R2117	P	COMPANHIA PORTUGUESA RADIO MARCONI S.A	P
R2010	P	FACULD. DE CIENC. UNIVERSIDADE DO PORTO	P
R2033	P	FACULDADE DE MOTRICIDADE HUMANA	P
R2017	P	INESC	P
R2030	P	INESC	P
R2032	P	INESC	P
R2033	P	INESC	P
R2061	P	INESC	P
R2064	P	INESC	P
R2068	P	INESC	P
R2097	P	INESC	P
R2060	P	INTERSIS	P
R2022	P	MUNICIPALITY MANGUALDE	P
R2054	P	PROSECOM	P
R2008	P	TELECOM PORTUGAL SA	P
R2014	P	TELECOM PORTUGAL SA	P
R2030	P	TELECOM PORTUGAL SA	P
R2083	P	TELECOM PORTUGAL SA	P
R2033	P	TELEFONES DE LISBOA E PORTO SA	P
R2041	P	TELEFONES DE LISBOA E PORTO SA	P
R2005	P	UNIVERSITY AVEIRO	P
R2011	P	UNIVERSITY AVEIRO	P
R2014	P	UNIVERSITY AVEIRO	P
R2076	A	UNIVERSITY AVEIRO	P
R2087	P	UNIVERSITY AVEIRO	P
R2095	P	UNIVERSITY AVEIRO	P
R2011	S	UNIVERSITY COIMBRA	P
R2005	S	UNIVERSITY LISBON (IST)	P
R2011	S	UNIVERSITY LISBON (IST)	P
R2067	P	UNIVERSITY LISBON (IST)	P
R2072	P	UNIVERSITY LISBON (IST)	P
R2073	S	UNIVERSITY LISBON (IST)	P
R2008	P	ELLEMTEL TELECOMMUNICATION SYSTEMS LAB	S
R2020	P	ERICSSON RADIO SYSTEMS AB	S
R2066	P	ERICSSON RADIO SYSTEMS AB	S
R2166	P	ERICSSON RADIO SYSTEMS AB	S
R2017	P	ERICSSON TELECOM AB	S
R2028	P	ERICSSON TELECOM AB	S
R2049	P	ERICSSON TELECOM AB	S
R2083	P	ERICSSON TELECOM AB	S
R2042	P	HASSELBLAD ELECTRONIC IMAGING AB	S
R2069	P	INDUSTRIAL MICROELECTRONICS CENTER	S
R2017	S	TELELOGIC MALMO AB	S
R2003	P	TELIA AB	S
R2014	P	TELIA AB	S
R2017	P	TELIA AB	S
R2020	P	TELIA AB	S
R2028	P	TELIA AB	S
R2033	P	TELIA AB	S
R2041	P	TELIA AB	S
R2058	P	TELIA AB	S
R2068	P	TELIA AB	S
R2017	S	TELIA PROMOTOR UPPSALA AB	S
R2037	A	ABO AKADEMI UNIVERSITY	SF
R2057	P	CCC SOFTWARE PROFESSIONALS UG	SF
R2119	A	EUROCONSEILS	SF
R2008	P	HELSINKI TELEPHONE COMPANY	SF
R2061	A	HELSINKI TELEPHONE COMPANY	SF
R2105	P	HELSINKI TELEPHONE COMPANY	SF
R2057	P	INSTITUTE OF INFORM. PROCESSING SCIENCE	SF
R2040	A	NESTE SHIPPING OY	SF
R2059	P	NOKIA CORPORATION	SF
R2061	P	NOKIA CORPORATION	SF
R2066	P	NOKIA CORPORATION	SF
R2068	P	NOKIA CORPORATION	SF
R2087	P	NOKIA CORPORATION	SF
R2166	P	NOKIA CORPORATION	SF
R2084	P	NOKIA CORPORATION RESEARCH CENTER	SF
R2094	P	NOKIA CORPORATION RESEARCH CENTER	SF
R2084	S	NOKIA MOBILE PHONES	SF
R2066	A	OY L M ERICSSON AB	SF
R2166	A	OY L M ERICSSON AB	SF
R2066	S	POSTS AND TELECOMMUNICATIONS OF FINLAND	SF
R2105	P	RESEARCH INSTITUTE FOR INFORMATION TECHN	SF
R2056	P	RITT-SPL	SF
R2033	A	SONDI OY	SF
R2087	P	TELECOM FINLAND	SF
R2040	P	UNIVERSITY HELSINKI (TECHNOLOGY)	SF
R2113	P	UNIVERSITY OF OULU	SF

Participating Organisations

Project	Role*	Company	Country
R2006	P	UNIVERSITY TAMPERE (TECHNOLOGY)	SF
R2008	P	UNIVERSITY TAMPERE (TECHNOLOGY)	S
R2040	A	VISTA COMMUNICATIONS INSTRUMENTS	SF
R2008	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2009	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2032	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2033	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2036	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2066	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2067	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2115	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2166	P	VTT TECHNICAL RESEARCH CENTRE FINLAND	SF
R2040	A	ABB-NERA LTD	UK
R2047	P	ABERDEEN AND NORTHERN MARTS	UK
R2022	P	ALBANET	UK
R2016	A	ANALYSYS LTD	UK
R2019	P	ANALYSYS LTD	UK
R2085	C	ANALYSYS LTD	UK
R2087	P	ANALYSYS LTD	UK
R2091	P	ANALYSYS LTD	UK
R2049	S	ARCHITECTURE PROJECTS MANAGEMENT LTD	UK
R2043	A	ASMOLEAN MUSEUM	UK
R2007	P	AT&T NETWORK SYSTEMS UK LTD	UK
R2054	C	AUTOMATED SECURITY HOLDINGS	UK
R2080	P	BIOC PLC	UK
R2030	P	BIS	UK
R2001	P	BNR EUROPE LTD	UK
R2006	P	BNR EUROPE LTD	UK
R2016	P	BNR EUROPE LTD	UK
R2049	P	BNR EUROPE LTD	UK
R2062	C	BNR EUROPE LTD	UK
R2063	P	BNR EUROPE LTD	UK
R2103	C	BOOKHAM TECHNOLOGY LTD	UK
R2080	P	BOVIS CONSTRUCTION LTD	UK
R2043	P	BRAMEUR	UK
R2117	P	BRITISH AEROSPACE SPACE SYSTEMS LIMITED	UK
R2001	C	BRITISH BROADCASTING CORPORATION	UK
R2052	P	BRITISH BROADCASTING CORPORATION	UK
R2055	P	BRITISH BROADCASTING CORPORATION	UK
R2065	P	BRITISH BROADCASTING CORPORATION	UK
R2067	P	BRITISH BROADCASTING CORPORATION	UK
R2082	P	BRITISH BROADCASTING CORPORATION	UK
R2110	P	BRITISH BROADCASTING CORPORATION	UK
R2001	P	BRITISH TELECOM PLC	UK
R2012	P	BRITISH TELECOM PLC	UK
R2014	P	BRITISH TELECOM PLC	UK
R2020	P	BRITISH TELECOM PLC	UK
R2021	P	BRITISH TELECOM PLC	UK
R2022	A	BRITISH TELECOM PLC	UK
R2034	P	BRITISH TELECOM PLC	UK
R2039	P	BRITISH TELECOM PLC	UK
R2063	P	BRITISH TELECOM PLC	UK
R2066	P	BRITISH TELECOM PLC	UK
R2067	P	BRITISH TELECOM PLC	UK
R2068	P	BRITISH TELECOM PLC	UK
R2081	P	BRITISH TELECOM PLC	UK
R2083	P	BRITISH TELECOM PLC	UK
R2096	P	BRITISH TELECOM PLC	UK
R2101	P	BRITISH TELECOM PLC	UK
R2104	P	BRITISH TELECOM PLC	UK
R2166	P	BRITISH TELECOM PLC	UK
R2015	P	BRITISH TELECOM LABORATORIES	UK
R2016	P	BRITISH TELECOM LABORATORIES	UK
R2018	P	BRITISH TELECOM LABORATORIES	UK
R2028	C	BRITISH TELECOM LABORATORIES	UK
R2044	C	BRITISH TELECOM LABORATORIES	UK
R2049	P	BRITISH TELECOM LABORATORIES	UK
R2061	P	BRITISH TELECOM LABORATORIES	UK
R2070	P	BRITISH TELECOM LABORATORIES	UK
R2080	P	BRITISH TELECOM LABORATORIES	UK
R2112	P	BT PLC - SYNTegra	UK
R2018	P	BT&D TECHNOLOGIES LTD	UK
R2048	P	BT&D TECHNOLOGIES LTD	UK
R2073	P	BT&D TECHNOLOGIES LTD	UK
R2033	S	CAMDEN BOROUGH COUNCIL	UK
R2117	P	CENTRE FOR SATELLITE ENG. RESEARCH	UK
R2063	P	COMMERCIAL UNION ASSURANCE PLC	UK
R2050	P	COMPUTER INDUSTRY RESEARCH UNIT	UK
R2063	P	COMPUTER INDUSTRY RESEARCH UNIT	UK
R2112	P	COMPUTER VISION UK LTD	UK

Participating Organisations

Project	Role*	Company	Country
R2034	P	CRANFIELD INSTITUTE OF TECHNOLOGY	UK
R2024	P	CRAY COMMUNICATIONS LTD	UK
R2041	P	CRAY COMMUNICATIONS LTD	UK
R2049	C	CRAY COMMUNICATIONS LTD	UK
R2059	C	CRAY COMMUNICATIONS LTD	UK
R2114	C	CRAY COMMUNICATIONS LTD	UK
R2116	P	CRAY COMMUNICATIONS LTD	UK
R2037	P	CROSFIELD	UK
R2042	P	CROSFIELD ELECTRONICS LTD.	UK
R2038	C	DEPT.MAT.TECH, BRUNEL UNIV. CO-ORDINATOR	UK
R2107	C	DIGITHURST LIMITED	UK
R2042	P	DISCLOSURE LTD.	UK
R2009	P	DUNDEE UNIVERSITY MICROCOMPUTER CENTRE	UK
R2012	S	ERA TECHNOLOGY LTD	UK
R2012	S	ERA TECHNOLOGY LTD	UK
R2015	P	ERA TECHNOLOGY LTD	UK
R2108	C	ERA TECHNOLOGY LTD	UK
R2023	P	EUROBELL LIMITED	UK
R2119	A	EUROPEAN COMMUNITY TELEWORKING FORUM	UK
R2069	S	GAYTON PHOTONICS LTD	UK
R2005	P	GEC MARCONI MATERIALS TECHNOLOGY LTD	UK
R2065	S	GEC MARCONI MATERIALS TECHNOLOGY LTD	UK
R2001	P	GEC-MARCONI DEFENCE SYSTEMS	UK
R2070	S	GEC-MARCONI HIRST RESEARCH CENTRE	UK
R2115	P	GEC-MARCONI LIMITED	UK
R2069	P	GEC-MARCONI MATERIALS TECHNOLOGY LTD	UK
R2070	P	GEC-MARCONI MATERIALS TECHNOLOGY LTD.	UK
R2070	S	GEC-MARCONI MATERIALS TECHNOLOGY LTD.	UK
R2073	C	GEC-MARCONI MATERIALS TECHNOLOGY LTD.	UK
R2073	S	GEC-MARCONI MATERIALS TECHNOLOGY LTD.	UK
R2086	P	GENERAL TECHNOLOGY SYSTEMS LTD	UK
R2095	P	GENERAL TECHNOLOGY SYSTEMS LTD	UK
R2014	P	GPT LTD.	UK
R2065	P	GPT LTD.	UK
R2070	P	GPT LTD.	UK
R2073	P	GPT LTD.	UK
R2083	P	GPT LTD.	UK
R2118	P	GPT LTD.	UK
R2042	P	GRATTAN PLC	UK
R2063	P	GUARDIAN ROYAL EXCHANGE ASSURANCE PLC	UK
R2049	P	HEWLETT PACKARD LABORATORIES	UK
R2022	C	HIGHLAND REGIONAL COUNCIL	UK
R2106	C	HIGHLAND REGIONAL COUNCIL	UK
R2030	P	HIGHLANDS AND ISLANDS ENTERPRISE	UK
R2092	C	HUSAT RESEARCH INSTITUTE	UK
R2112	P	HUSAT RESEARCH INSTITUTE	UK
R2054	S	I2I VISION LTD	UK
R2034	P	IAD AEROSPACE	UK
R2051	S	ICL ASSOCIATED USERS	UK
R2078	S	IFC RESEARCH	UK
R2090	P	IFC RESEARCH LTD	UK
R2091	P	IFC RESEARCH LTD	UK
R2082	P	INDEPENDANT TELEVISION COMMISSION	UK
R2110	P	INDEPENDENT TELEVISION COMMISSION	UK
R2111	C	INDEPENDENT TELEVISION COMMISSION	UK
R2001	P	INDEPENDENT TELEVISION NEWS	UK
R2040	P	INMARSAT	UK
R2033	P	INTERACTION DESIGN LTD	UK
R2030	P	INTERACTIVE DEVELOPMENT ENVIRONMENTS	UK
R2035	C	INTERNATIONAL AUTOMOTIVE DESIGN	UK
R2051	P	INTERNATIONAL COMPUTERS LIMITED	UK
R2058	P	INTERNATIONAL COMPUTERS LIMITED	UK
R2076	P	IPSYS SOFTWARE PLC	UK
R2119	P	K-NET LTD.	UK
R2015	C	KINGS COLLEGE LONDON	UK
R2040	A	LIVEWIRE DIGITAL LIMITED	UK
R2033	S	LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY	UK
R2071	P	LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY	UK
R2094	P	LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY	UK
R2042	P	MACMILLAN PUBLISHERS LTD.	UK
R2078	P	MARI (NORTHERN IRELAND) LTD	UK
R2030	C	MARI COMPUTER SYSTEMS	UK
R2019	P	MARI COMPUTER SYSTEMS LTD	UK
R2047	C	MARI COMPUTER SYSTEMS LTD	UK
R2076	C	MARI COMPUTER SYSTEMS LTD	UK
R2089	C	MARI COMPUTER SYSTEMS LTD	UK
R2093	P	MARI COMPUTER SYSTEMS LTD	UK
R2114	P	MARI COMPUTER SYSTEMS LTD	UK
R2023	P	MARI GROUP	UK
R2106	A	MENTEC LTD	UK
R2038	P	MERCK LTD UK	UK

Participating Organisations

Project	Role*	Company	Country
R2078	A	NORTHERN IRLAND TOURIST BOARD	UK
R2033	S	NORTHWOLD SYSTEMS AND SERVICES LIMITED	UK
R2001	P	NTE OPTOELECTRONICS DIVISION	UK
R2089	A	OCTACON LTD	UK
R2105	C	OCTACON LTD	UK
R2018	P	OPTOELECTRONICS RESEARCH CENTRE	UK
R2038	P	ORC, SOUTHAMPTON UNIV., UK	UK
R2080	P	OVE ARUP & PARTNERS	UK
R2071	P	OXFORD BROOKES UNIVERSITY	UK
R2068	P	OXFORD UNIVERSITY	UK
R2090	C	PALACE LTD	UK
R2020	S	PHILIPS RESEARCH LABORATORIES	UK
R2105	P	PHILIPS RESEARCH LABORATORIES	UK
R2037	P	PIRA INTERNATIONAL	UK
R2042	P	PIRA INTERNATIONAL	UK
R2028	A	PIRELLI GENERAL PLC	UK
R2002	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2021	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2024	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2052	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2061	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2072	P	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2095	A	QUEEN MARY AND WESTFIELD COLLEGE	UK
R2066	S	ROKE MANOR RESEARCH LTD	UK
R2084	S	ROKE MANOR RESEARCH LTD	UK
R2118	S	ROKE MANOR RESEARCH LTD	UK
R2118	S	ROKE MANOR RESEARCH LTD	UK
R2166	S	ROKE MANOR RESEARCH LTD	UK
R2112	C	ROVER GROUP	UK
R2033	P	ROYAL NATIONAL INSTITUTE FOR DEAF PEOPLE	UK
R2056	P	RUTHERFORD APPLETON LABORATORY	UK
R2071	P	RUTHERFORD APPLETON LABORATORY	UK
R2106	A	SABHAL MOR OSTAIG	UK
R2041	P	SALFORD NETWORKING INTERNATIONAL LIMITED	UK
R2041	S	SALFORD SOFTWARE SERVICES	UK
R2022	A	SCOTTISH COUNCIL FOR VOLUNTARY ORGANIS.	UK
R2022	A	SCOTTISH HOMES	UK
R2110	A	SNELL AND WILCOX LTD	UK
R2109	P	SOUTHAMPTON OPT. RES. CENTRE	UK
R2086	P	SPRU	UK
R2001	P	SWINDON SILICON SYSTEMS LTD	UK
R2119	P	SYSTEMS SYNTHESIS LTD.	UK
R2112	P	TRW SSL	UK
R2045	P	UK ATOMIC ENERGY AUTHORITY	UK
R2059	P	UNIPRO LIMITED	UK
R2006	P	UNIVERSITY BATH	UK
R2117	P	UNIVERSITY BRADFORD	UK
R2007	P	UNIVERSITY BRISTOL	UK
R2108	P	UNIVERSITY BRISTOL	UK
R2071	P	UNIVERSITY BUCKINGHAM	UK
R2115	P	UNIVERSITY CAMBRIDGE	UK
R2004	A	UNIVERSITY COLLEGE LONDON	UK
R2089	P	UNIVERSITY COLLEGE LONDON	UK
R2114	P	UNIVERSITY COLLEGE LONDON	UK
R2005	P	UNIVERSITY COLLEGE OF NORTH WALES	UK
R2076	P	UNIVERSITY COLLEGE OF WALES	UK
R2095	A	UNIVERSITY COLLEGE-NORTH WALES	UK
R2028	P	UNIVERSITY ESSEX	UK
R2111	S	UNIVERSITY ESSEX	UK
R2030	P	UNIVERSITY NEWCASTLE UPON TYNE	UK
R2095	A	UNIVERSITY NEWCASTLE UPON TYNE	UK
R2074	P	UNIVERSITY SALFORD	UK
R2075	P	UNIVERSITY SALFORD	UK
R2056	P	UNIVERSITY SHEFFIELD	UK
R2015	P	UNIVERSITY SOUTHAMPTON	UK
R2036	P	UNIVERSITY STRATHCLYDE	UK
R2084	P	UNIVERSITY STRATHCLYDE	UK
R2105	P	UNIVERSITY STRATHCLYDE	UK
R2074	P	UNIVERSITY SURREY	UK
R2094	P	UNIVERSITY SURREY	UK
R2033	S	UNIVERSITY VICTORIA MANCHESTER	UK
R2070	A	UNIVERSITY WALES/BANGOR	UK
R2003	P	VODAFONE LTD	UK

*Role:

C = Coordinator

P = Partner

A = Associated Partner

S = Subcontractor

Annex III

Statistics on participation

Participations by Type of Organisation (ManMonths)

Type of Organisation

A = University or other Educational Establishment

D = Telecom/IT Industry

G = National and Local Public Organisation

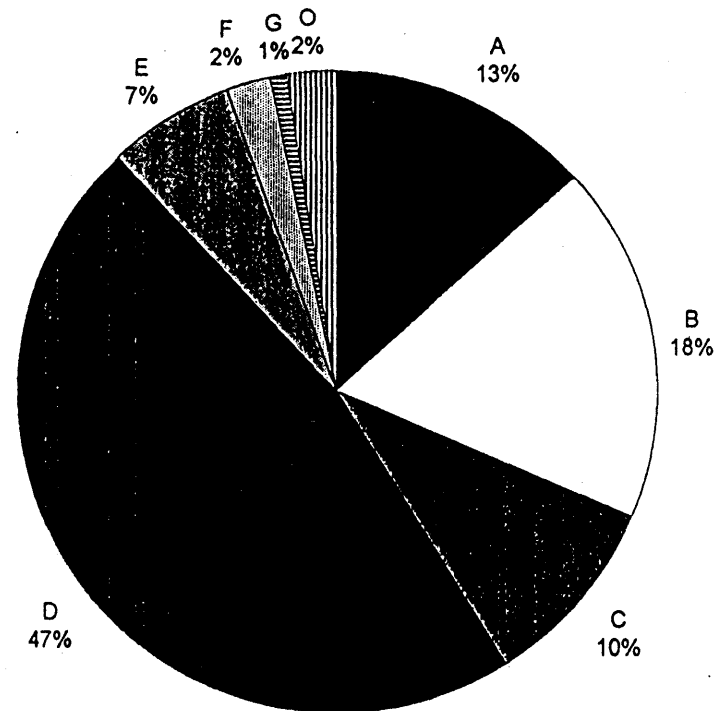
B = Telecommunications Operator's Organisation

E = Telecom/IT User

O = Other

C = Government or other Research Establishment

F = Service Provider Organisation



Participations by Type of Organisation (N. of Partners)

Type of Organisation

A = University or other Educational Establishment

D = Telecom/IT Industry

G = National and Local Public Organisation

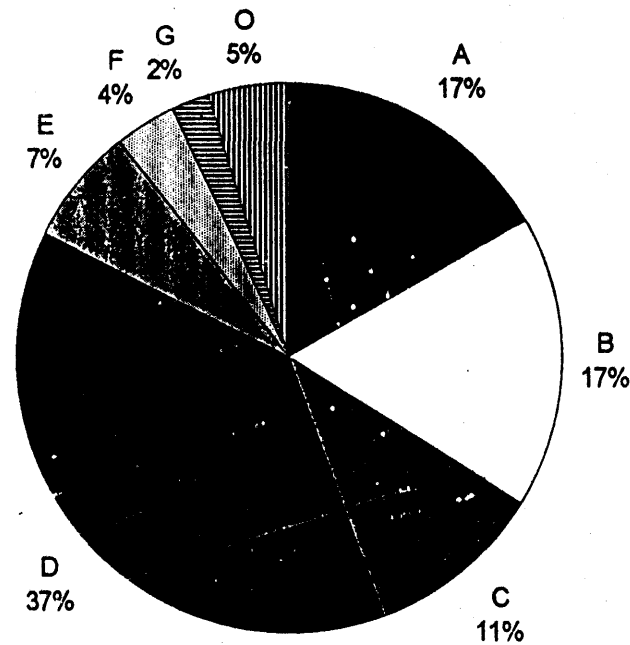
B = Telecommunications Operator's Organisation

E = Telecom/IT User

O = Other

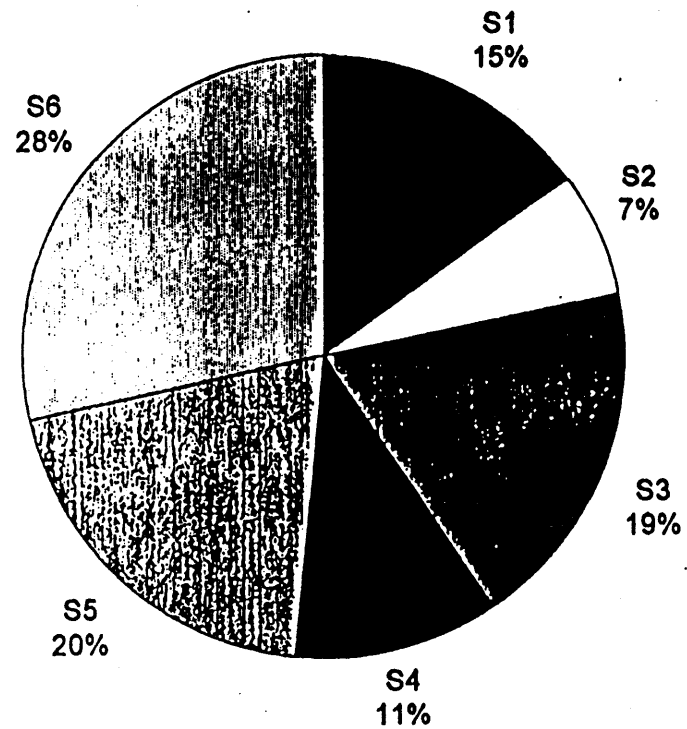
C = Government or other Research Establishment

F = Service Provider Organisation



**Participations by Size of Organisation
(N. of Partners)**

No. of Employees	Less than 50	51 - 100	101 - 500	501 - 1000	1001 - 5000	Over 5000
Code	S1	S2	S3	S4	S5	S6



Participations by Size of Organisation (ManMonths)

No. of Employees
Code

Less than 50
S1

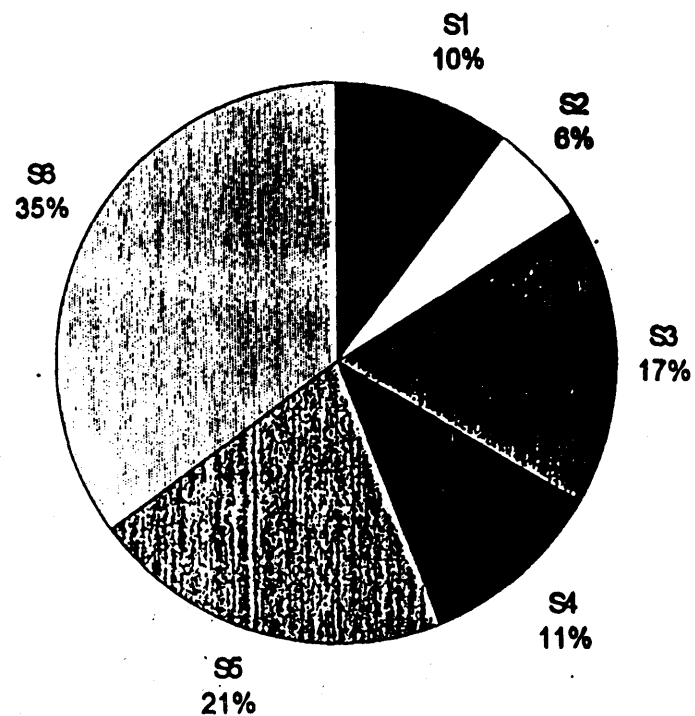
51 - 100
S2

101 - 500
S3

501 - 1000
S4

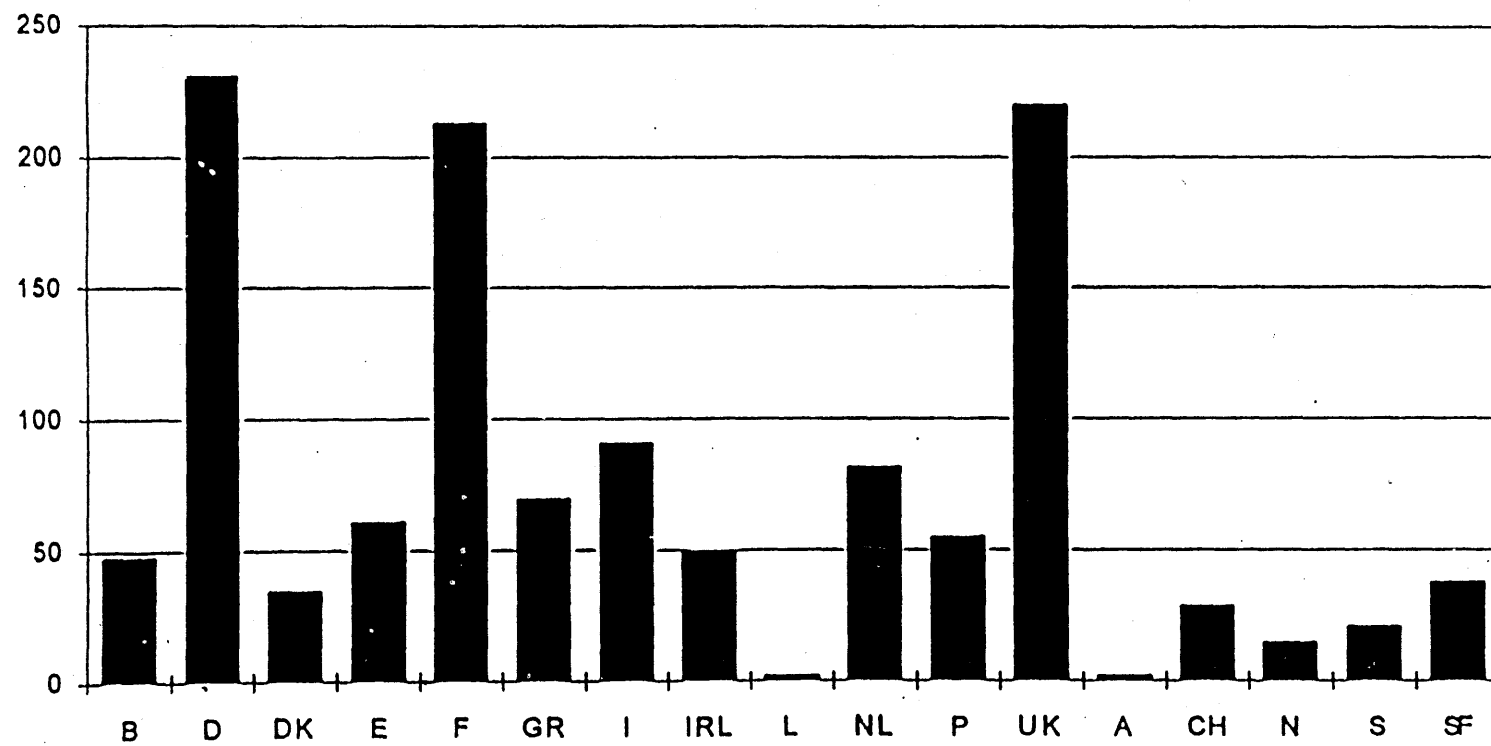
1001 - 5000
S5

Over 5000
S6



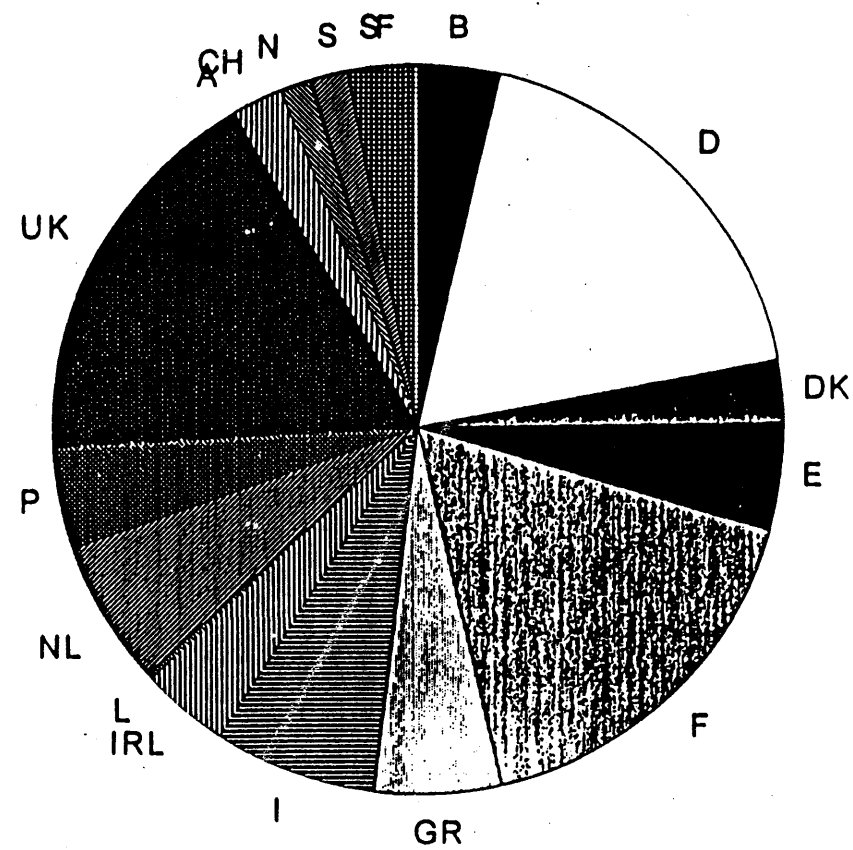
Participations by Country
(N. of Partners)

Country	B	D	DK	E	F	GR	I	IRL	L	NL	P	UK	A	CH	N	S	SF
%	3.80	18.29	2.77	4.83	16.86	5.54	7.21	3.96	0.16	6.49	4.35	17.42	0.16	2.30	1.19	1.66	3.01



Participations by Country
(N. of Partners)

Country	B	D	DK	E	F	GR	I	IRL	L	NL	P	UK	A	CH	N	S	SF
%	3.80	18.29	2.77	4.83	16.86	5.54	7.21	3.96	0.16	6.49	4.35	17.42	0.16	2.30	1.19	1.66	3.01



Annex IV

Recommendations of the Strategic Audit Panel in 1993

**ADVANCED COMMUNICATIONS
FOR ECONOMIC DEVELOPMENT
AND SOCIAL COHESION
IN EUROPE**

**Strategic Audit of the development of advanced
communications in Europe.**

EXECUTIVE SUMMARY AND RECOMMENDATIONS FOR ACTION

Telecommunications services are crucial for balanced economic development. They are a vital link between industry, the services sector and market as well as between peripheral areas and economic centres. They are also a prerequisite for social cohesion and cultural development. It takes a long time to develop a new technology and even longer to deploy it. Nevertheless, Europe needs rapid development of advanced communications to address new economic and social problems: pollution, transport congestion, and economic restructuring.

We live in a European community that needs to work together, and we need the best telecommunication services we can achieve. The Community will grow, and transparent networks need to grow with it. Advanced communication services will multiply the benefits of more traditional services. In the US, Japan and Europe, some major corporations have already realised the advantages that can accrue: lower costs, improved productivity and competitive advantages. Europeans are at a disadvantage. There is still a gap between the potential of technology and the reality of applications.

The first two phases of RACE focused on integrated broadband networks and demonstrations of how services could exploit such networks. Establishing common standards was an essential theme. The programme has been a success, but it is now urgent to stimulate innovative use. Users now insist that networks meet their requirements rather than accept what network operators find it convenient to give them. *For future EC actions*, a paradigm shift is needed away from technology development to a broader policy stimulating use.

Community-led research and technology development is certainly still needed in selected areas: there are still many problems that are too big for any one player to solve on his own. However, a major shift in emphasis is needed to stimulate new uses of networks, to ensure that the Community exploits communications fully for business efficiency and for its social needs. The Community must stimulate such uses - to give them a kick-start. Experience shows that innovative use develops best when driven by consortia of interested users together with manufacturers and network providers.

One example of the kind of use we have in mind is computer-supported co-operative working, including dial-up video conferences, with a terminal on the desk for meetings as and when required with widely scattered people and all the necessary papers visible. The time saving would be enormous: no need to sit in cars and aeroplanes; perhaps 10% fewer cars on the roads. Such services are increasingly used in the USA. In Europe, virtually all the base technology is there, but the marketable products and service are not. There are many other examples.

All these uses assume the availability of the service-oriented networks and open access for service providers, leading to sensible tariffs. We are too slow in achieving this across Europe. There seems to be general acceptance that liberalisation of network and service provision can speed things up, and the recent review of the situation in the telecommunications services sector has clarified how fast it can happen. The challenge of the 21st century will be one of managing diversity in infrastructures, institutions and services. This will require a sharing of regulatory responsibilities between the EC and Member States, and coordination of national regulatory activities across the Community. Different things will happen in different countries, if only because they start from different network and tariff structures, but there must be a common vision of where we are going. There is no doubt that the current diversity of regulations will inhibit many of the user innovations one wants to see.

Innovative usage trials, in particular, require an enabling regulatory environment. The Treaty on European Union makes provision for the "*Community to contribute to the establishment and development of trans-European networks in the area of telecommunications*", and could provide the appropriate framework. European PNOs and industry should jointly investigate how Trans-European Broadband Networks can be realised in the most economical way, and the Commission should investigate how this framework could be used to stimulate usage innovation.

With the Treaty on European Union, EC R&D ceases to be only a basis for innovation and a key to competitiveness; it must also make a contribution to answering society's needs. European R&D in communications remains indispensable. "Networking" research should concentrate on the interworking and integration of mobile communication systems, universal personal communications and the distribution of network and service intelligence. However, we must not stop technology development: We must have the courage to address a number of "high-risk", "high potential" concepts, but we must be selective. The emphasis on standards is still vital, and the EC should assign a "mandatory" status, either directly or indirectly, to key standards.

The telecommunications field is tremendously dynamic and there should be a close and continuous interaction between the RACE management and the major players through appropriate channels - the network operators, industry, governments and probably regulators. They should advise the Commission on a continuing basis and help to identify priority research areas.

Most business activities are world-wide, and telecommunications must therefore operate globally. The mergers that are going on in major industries, including telecommunications, emphasise this global dimension. Global co-operation will be needed in applications development, and could be of mutual benefit in the development of networking technologies.

These observations, and the following "Calls for Action" are the outcome of the *Strategic Audit* of advanced communications in Europe carried out by three panels of key figures from industry, academia, governments, telecommunications network operators and service providers in early 1993. The views expressed are those of the Participants.





A "Call for Action"

Telecommunications is crucial for balanced economic development, for social cohesion and for cultural development in Europe. The EC urgently needs advanced communications to stay competitive and meet social objectives. The following recommendations for action have been identified by Panel I¹⁾:

Highest priority is for the RACE programme to be followed with two new initiatives: a continuing effort in European communications technology development; and a new framework for larger-scale usage innovation, procurement and stimulation in areas of public interest.

- ✓ The European Commission should propose a new financial framework and ways for usage innovation, procurement and stimulation.
- ✓ Regulatory bodies should remove constraints to integration of services and liberalisation of markets in an appropriate timetable.
- ✓ Public Network Operators, in conjunction with the CEC and regulatory bodies, should take further actions to ensure the full inter-operability of their networks.
- ✓ The European Commission should indicate what forms of cooperation between public and private operators can be encouraged. It should initiate consultation on new regulatory frameworks for interactive video services.
- ✓ European research and standardisation institutions must now have a global perspective. The European Commission should enable and encourage R&D cooperation with USA and Japan on the basis of mutual interest.
- ✓ The new democracies of eastern and central Europe should be encouraged to participate in ETSI. The EBRD and the World Bank should give more attention to telecommunications for industrial and market development in eastern and central Europe.
- ✓ EC R&D should continue to stimulate standardisation, and should address selected areas of communications technology development, including both digital TV distribution and interactive video services. A strengthened management link with PNOs, industry, regulators and Governments will be important.

¹⁾ This part of the audit, on economic and policy issues, was carried out by Mr. Alvey (Chairman); Mr. M. Allione of STET; Mr. J. Cornu of Alcatel; Mr. T. Hardiman of IBM; Mr. B. Lasserre of the French Ministry of Telecommunications; Professor C. Salema of the Instituto Superior Tecnico in Portugal; Dr. G. Tenzer of the DBP Telekom, and Mr. S. Temple of the UK DTL.

While we have a rich portfolio of advanced communications technology, its take-up in usage is slower than in Europe's main competitors: we lack the right conditions for innovation in usage. We need a common infrastructure, equal access, lower prices and common specifications. The Panel of key figures of major user organizations and service providers²⁾ has recommended that:

- ✓ PNOs need to increase their awareness of customer needs, strengthen their service and distribution channels, and support usage innovation.
 - ✓ PNOs should introduce switched broadband services for corporate users, with flexible bandwidth management and commercially attractive tariffs by 1995, and in the context of a realistic "business-case driven" design for public advanced communications.
 - ✓ We must solve the problems of SMEs, as well as those of large companies. The first step is to specify generic applications, and compatible services and equipment; then to stimulate their take-up.
 - ✓ Europe needs a new framework for articulation of demand which all actors cooperate in developing concepts and specifications for both corporate and generic service infrastructures. In this framework, the EC should support trials to test the technical and economic viability of advanced communications usage in "closed user groups".
 - ✓ One focus should be on development of TransEuropean "Inter-Organisational Systems" to provide a common platform for inter-organisational communication, information exchange and cooperation, including joint teleworking in different organisations, and office interworking.
 - ✓ We must make the transition from Electronic Data Interchange (EDI) to Electronic Process Integration (EPI) to facilitate flexible inter-organisational links; promote usage of switched broadband telecommunications infrastructure, and provide a common platform for inter-organisational communication.
 - ✓ There is a demand for personal mobility within and across a wide variety of telecommunications networks and through multi-service environments. Research in 1994-1998 should focus on development of systems which provides for full mobility.
-

²⁾ This part of the audit, on trends in demand and the re-structuring of supply, was carried out by Mr. M. Ross (Chairman) of A.D. Little; Mr. D. Claude of European Aerospace Network; Mr. A. Graziani of Telesoft; Mr. W. Johansen of Deutsche Bank; Mr. P. Kinnzow of Detecon; Mr. G. Mogensen of TeleDenmark; Mr. L. Ottoson of SAS, and Mr. H. Soboll of Daimler-Benz AG.

Solid bases have been established on which to base a reasonably clear vision of the networks of the first decade of the 21st century. Basic technology exists, and in the short term, work needs to focus on achieving lower costs and higher reliabilities. We need market stimulation, and very selective further technology development to fill some gaps and enable PNOs to exploit technologies. These observations and the following recommendations are the outcome of the 3rd part of the Strategic Audit³⁾ of advanced communications in Europe.

- ✓ For terminals and digital video, technology for integrating data, image and voice exists today, but there is a need to cut costs by development of integrated devices (VLSI) for image compression, variable Bit-rate coding, and high-efficiency modulation techniques. Beyond this, new technologies are needed for hypermedia presentations, network interfaces, displays and mass storage.
- ✓ For service creation, management and user control, "Service Independent Building Blocks" are starting to produce practical results, but the process of specification, validation, and service engineering must be continued. Realistic prototypes must be produced, and "operating systems" for advanced communication services developed.
- ✓ For network integrity and management, new systems must be developed on standards-based platforms using high-performance distributed databases, artificial intelligence and open distributed processing.
- ✓ The European PNOs and industry should jointly investigate how Trans-European high-speed networks and LAN-LAN interconnection can be realised in the most economical way. For inter-operation, application interfaces, in addition to protocols, are essential to achieve transparent network interoperation. New client-server paradigms and object-oriented programming may help to guarantee their interoperability, portability and reusability.
- ✓ Mobile service provision on fixed networks needs real-time databases; further development is limited by these technologies, security issues and complexity of billing. Priorities for R&D are the integration of access and network signalling, increased processing capabilities in customer equipment and terminals, and development of new signalling protocols to support distributed databases and security requirements. Increased R&D efforts are also needed in ISDN-UMTS interworking and satellite systems for rapid service development in rural areas.
- ✓ For optical systems, breakthroughs required are in integrated optical subsystems, free packaging techniques for optical components, mass-manufacturing techniques, and optical cross-connects. Priority should also be given to R&D on multiwavelength networks.
- ✓ Finally, Europe cannot give up on new enabling technologies: We can already identify some of the key technologies for 21st century: holographic displays for 3D autostereoscopic vision; virtual presence technologies; life-images recognition and synthesis; hypermedia objects; high-capacity data storage; new generacoding techniques, e.g. for mobile applications, and human visual perception studies.

³⁾ This part of the audit, on technology development issues, was carried out by Mr. A. Chynoweth; Mr. L. Citti of Alcatel; Mr. J. Linares of Telefonica; Mr. C. Mossotto of CSELT; Mr. P. Nordeste of CET; Mr. H. Ohnsorge of Alcatel SEL; Dr. K.U. Stein of Siemens and Mr. M. Ward of GPT.

Annex V

GLOSSARY OF TECHNICAL TERMS

Explanation of commonly used terms and acronyms

Note: Detailed prescriptive definitions, published by the various regulatory and standardisation bodies, exist for many of the terms used in telecommunications technology. The glossary below is intended to provide less technical descriptions appropriate to the non-specialist reader.

Applications: Specific Applications: Generic Applications

The function or use to which a telecommunications service is put. Functions which are highly specific, e.g. personal telebanking, are described as Specific Applications. Functions of a general nature which may underlie many Specific Applications - e.g. as a system of high-speed, high security data transfer is required for personal telebanking but also many other financial services - are referred to as Generic Applications.

ADSL (Asynchronous Digital Subscriber Loop)

A transmission technique which allows three or four channels of video to be transmitted over short distances on copper local loops. Currently being tested in the USA and Europe.

ATM (Asynchronous Transfer Mode)

A system for organising a digital signal in such a way as to allow very high speed transmission of the signal while making optimum use of the network's transmission capacity. A standard agreed for B-ISDN networks.

Bearer Services

In ISDN terminology, bearer services are the basic telecommunications facilities, such as switched 64 Kilobit per second channels or digital leased circuits, which are the medium for carrying out teleservices (see below).

B-ISDN: Broadband Network

An integrated services digital network (see ISDN) permitting the user to make transmissions at speeds above 2 Megabits per second i.e. one particularly suitable for high quality multimedia services.

Bit

A single element of binary code (i.e. a 0 or a 1). See Transmission, Digital

Kilobit - one thousand (10^3) bits

Megabit - one million (10^6) bits

Gigabit - one billion (10^9) bits

Terabit - one trillion (10^{12}) bits

CATV (Community Antenna Television, Cable Television)

A public network for the delivery of television programmes to the home by cable. Existing systems use coaxial cable and are limited in Europe to approximately 30 channels of television. Future broadband systems will carry up to 500 channels to the viewer.

Cellular Telephone

A system of mobile telephony whereby a country is divided into a thousands of small areas ("cells"), each of which is served by its own "base station" for low-powered radio transmissions. This permits a user in one cell to transmit on the same frequency as another user in a geographically distant cell without their conversations interfering with each other. Thus, cellular networks may have many more users than non-cellular networks, where the number of users is limited to the number of wavelengths available. Cellular telephone networks may employ analogue or digital transmission. Existing networks are largely analogue, new networks use the European GSM digital standard.

Compression

The technique of reducing the amount of data in a signal, so as to be more economical in the amount of transmission capacity needed, the signal being reconstructed in its original form at the receiving end. A device to do this is a codec (coder-decoder)

CPE (Customer Premises Equipment)

The telecommunications equipment which is located on the customers' premises - principally terminals (phones, fax machines etc.) or an internal telephone network controlled from a private switchboard - sometimes referred to as CPN, Customer Premises Network or SPN Subscriber Premises Network.

CT2 (2nd Generation Cordless Telephone, "Telepoint")

An economical system of cellular telephony. Unlike full cellular, the user may not move from cell to cell during the call. The service is commercialised as Bi-Bop in France, Greenpoint in the Netherlands, Pointer in Finland etc.

Digital Superhighway

A US government initiative to provide for that country a nation-wide system of broadband communications

Economy of integration

Reduction in cost due to the sharing of facilities and services.

Economy of scale

Reduction in cost due to large volume of production and service provision.

Economy of scope

Reduction in cost due to quick recovery of investment related to rapid user uptake of widely available services.

ERMES (European Radio Messaging System)

A pan-European standard for radio paging systems, currently being deployed in Europe.

FTTC (Fibre To The Curb): FTTH (Fibre To The Home)

Future optical fibre networks may extend the optical fibre to the individual home (FTTH), or the fibre may terminate at a "black box" located in the street, where the optical signal is converted to an electrical signal and carried the remaining distance to each home on the pre-existing copper wiring (FTTC).

GSM (Groupe Spéciale Mobile, Global System for Mobile Communications)

See Cellular Telephone

HDTV (High Definition Television)

A service of high image-quality television displayed on a wide screen (in the aspect ratio of 16:9 rather than the conventional television screen of 4:3). Such a service is currently being broadcast in Japan (Hi-Vision), a European standard has been established (HD-MAC), though no service has been deployed as further work in the United States, involving both American and European manufacturers, is currently developing an advanced digital standard.

Interactivity

Interactivity in a service implies a close control by the user of the service by means of an ongoing system of two-way communication between user and service provider. Thus an interactive TV broadcast of, say, a sporting event, would allow the viewer to select his own camera angles throughout the broadcast.

Interconnectivity

Devices demonstrate interconnectivity if they can send and receive data between each other.

Interoperability

Devices demonstrate interoperability if, in addition to communicating with each other, they can also work together to execute a common task.

IBC (Integrated Broadband Communications)

The global term for the future overall communications environment, embracing Broadband-ISDN, Narrowband-ISDN, mobile telephony and existing conventional telephone services together with data communications and cable TV.

IN

See Networks, Intelligent

Internet

The world's largest computer communications system. Originated in the United States, though now operating world-wide, the Internet is a loose confederation of principally academic and research computer networks, and is run by a group of volunteers based in Reston, Virginia.

ISDN (Integrated Services Digital Network): N-ISDN: B-ISDN

A single network capable of carrying several different types of service - based on voice, text, data, still image or moving image - by means of digital transmission techniques. The ISDN currently being deployed in Europe carries a communication of up to 2 Megabits per second (Narrowband ISDN). Future networks will carry higher speed communications (Broadband ISDN).

LAN (Local Area Network)

A network for communication between computers, confined to a single building or closely located group of buildings, permitting users to exchange data, share a common printer or master computer etc. Linked groups of LANs extended over a larger area are termed Wide Area Networks (WANs). Networks which extend over city-wide areas are called Metropolitan Area Networks (MANs).

LEO (Low Earth Orbit), LEOS (Low Earth Orbit Satellite)

Proposed systems of personal telecommunications based on communication via a number of satellites in low (non-geosynchronous) orbit. The best known of these proposals is called the "Iridium" project.

Local loop

The section of the telephone transmission network between the local telephone exchange and the subscriber's premises. This is currently in copper wiring. In future, optical fibre or wireless will also be used.

MAN (Metropolitan Area Network)

See LAN.

Modem

Computer data is in digital form. To send it on the existing telephone network it is necessary to convert it to analogue (electrical wave) form, and then reconvert it to its original digital form on arrival. The device to do this is called a modem (modulator-demodulator). As the existing telephone network is not well adapted for data transmission, modems send their data at a relatively slow rate so as to avoid transmission errors. Users requiring more reliable or higher speed data transmission subscribe to ISDN or certain specialised data networks (see Networks, Data)

Multimedia

The concept of closely combining voice, text, data, still image and moving image. A multimedia database, for example, would contain textual information, images, video clips, tables of data, all equally easily accessed. A multimedia telecommunications service (such as B-ISDN) would permit the user to send or receive any of these forms of information, interchangeably at will.

Multiplexing

The technique whereby many conversations may be carried simultaneously on a single line. This may be by transmitting each conversation at a different frequency (Frequency Division Multiplexing); or by transmitting small sections of each conversation at slightly different time intervals (Time Division Multiplexing); or, in optical fibre networks, by transmitting each conversation in a different colour of light (Wavelength Division Multiplexing). A device to do this is called a multiplexer or mux.

Network

A complete system of communications between users' terminals. Networks may be "point to point" (the transmission goes from a fixed origin to a fixed destination), "switched" (the transmission is switched so as to reach a single destination out of many possibilities) or "broadcast" (the transmission goes simultaneously to multiple destinations). Networks may be "public" (owned by an operator and open to any member of the public who subscribes) or "private" (owned or leased by an individual or company or group of companies exclusively for own use). A network may be "real" (physically separate from the public network) or "virtual" (using public network facilities, which revert to public use when no longer required in the private network).

Networks, Data

Networks specialised in the transmission of data rather than voice. Among such networks are Circuit Switched Data Networks (CSDN; which include the so-called X.21 networks), Packet Switched Data Networks (PSDN, X.25 networks), Frame relay networks, Switched Multimegabit Data Services networks (SMDS).

Networks, Speed of

"Speed", when used of a digital network, refers to the number of bits per second it can carry, thus it is a measure of the capacity of the network. To carry voice, the industry in Europe has standardised on a speed of 64 Kilobits per second. Still images may also be transmitted adequately at this rate. Full-colour moving images require transmission speeds of the order of 150 Megabits per second, though using various compression techniques, moving images (though of less than normal TV quality) can be transmitted at 2 Megabits per second. Trunk connections, which carry many calls at once (see Multiplexing), require of course multiples of these speeds.

Networks, Intelligent

An "intelligent" network (IN) includes sophisticated features above those of the ordinary telephone service, advanced software allowing the customisation of the services provided to individual customers. For example, it allows the called party to redirect calls intended for him to another terminal (e.g. from home phone to his office phone during the working day). It allows calls to be billed wholly or in part to someone other than the caller ("freephone" services). It provides virtual private network services (see Networks) etc.

Networks, Optical Fibre

Telecommunications networks based on fine glass fibres, down which signals may be sent by flashing a laser. Earliest networks were "multimode", newer "monomode" networks have a higher transmission capacity.

NREN (National Research and Education Network)

Based on the initiative of US Vice President Al Gore, the NREN is a US high speed network linking a number of research and educational institutes throughout the USA. It is seen as a forerunner of the proposed Digital Superhighway (see above).

PABX (Private Automatic Branch Exchange): PBX (Private Branch Exchange)

The private switchboard located on his premises, with which a business subscriber controls the calls on his own internal telephones.

PAL (Phase Alternation Line)

The standard for colour TV broadcasting currently in use in most West European countries

PCN (Personal Communications Networks)

A form of cellular telephone network specifically adapted for personal portable use, based on a technology known as DCS 1800. Such services are currently being deployed in Europe. Similar services in the USA are referred to as PCS (Personal Communications Services).

PDA (Personal Digital Assistant)

A personal computer of pocket size, where text is input by handwriting on a screen (rather than conventionally via a keyboard) is known as a "notepad" computer. A notepad computer with advanced features and communications facilities is referred to as a Personal Digital Assistant.

Portability

Used of a computer programme, implies the programme can be executed on a number of different computers with no or only minimal adaptation.

PSTN (Public Switched Telephone Network)

The everyday telephone network, used for the transmission of voice conversations, fax images and for low speed data transmission. The basic voice service is also sometimes referred to as POTS (Plain Old Telephone Service).

QoS (Quality of Service)

For a telecommunications service; a measure of the level of performance required by the user, including for example maximum permissible call set-up time, error rate, amount of echo, noise, distortion etc.

Sécam (Système Electronique Couleur avec Mémoire)

The standard for colour TV broadcasting currently in use in France and most East European countries

Service

An activity which a service provider carries out on request of a client. In a telecommunications network, a service (e.g. voice telephony, E-Mail, file transfer, fax transmission etc.) is the means by which the user carries out his application (see Application).

Teleservice

In ISDN terminology; teleservices are the application-orientated services (e.g. facsimile, videotex, message handling) which are implemented on the bearer services (see above).

Teleworking

The capability to carry out one's work at a location other than the one usually used, by means of telecommunications facilities.

Transmission, Analogue

Historically, telephone or radio signals were transmitted in the form of a wave of electrical energy, the shape of the wave representing the original sound. Thus the electrical wave is analogous to the original sound wave.

Transmission, Digital

In a digital telecommunications service, the original source is transformed into and transmitted as a series of digits in binary code (i.e. 0s or 1s). This has a number of important advantages. It permits direct computer-to-computer communications without modulation-demodulation (see Modem). It gives a high level of reception quality, since the receiver at each moment must only detect whether it has received a signal (a 1) or not (a 0); thus even a severely degraded transmission can be reconstructed to reproduce perfectly the original source. Voice, text, image or data are all equally capable of being coded as a digital signal, so a single network can handle all four forms of transmission (see ISDN, Multimedia). The string of binary digits can be abbreviated and then re-expanded on arrival, thus economising on transmission capacity (see Compression). Different strings of binary digits can be interleaved and transmitted together, thus permitting several separate conversations on a single line (see Multiplexing). The string of digits can be encrypted prior to transmission, to ensure a high level of information security and privacy.

VANS: VAS (Value Added Network Service: Value Added Service)

Hitherto in most countries, a certain basic level of telecommunications service has been defined and reserved as a monopoly for the national operator. Most frequently, this is the service of voice communication in real time. Services other than this may be offered by other service suppliers; they use the national network as the basic transmission medium but "add value" to the basic transmission facility in some way, e.g. by storing and forwarding the transmission at a later date, by distributing it to multiple destinations, by processing the information contained in the transmission then forwarding the result etc. Exactly what comprises a basic, and what a value-added, service therefore depends on the regulatory situation in the country concerned.

VI & P (Visual, Intelligent and Personal Communications service)

The planned Japanese national B-ISDN network.

VR (Virtual Reality)

A system whereby the user is supplied with computer-generated images and sounds, to the exclusion of his real surroundings, giving a strong impression of reality to the input he is receiving. (Virtual in this sense means "apparent", "seeming"). The user interacts with the artificial world, by means of sensors which detect his head and hand movements. Future work in VR is directed towards increasing the impression of reality received (for example by means of 3D images) and to telecommunicating VR "worlds" to users located remotely from the source computer.

WAN (Wide Area Network)

See LAN.

TELECOMMUNICATIONS-RELATED PROGRAMMES, INSTITUTES AND ORGANISATIONS

AIM*	Advanced Informatics in Medecine
CADDIA*	Co-operation in Automation of Data and Documentation for Imports/exports and the management of financial control of the Agricultural market
CCIR	Comité Consultatif International des Radiocommunications
CCITT	Comité Consultatif International Télégraphique et Téléphonique
CCTS	Comité de Coordination pour les Télécommunications par Satellite
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CEPT	Conférence Européenne de Postes et des Télécommunications
COST	Co-operation for R&D in Science and Technology
DELTA*	Developing European Learning through Technical Advance
DRIVE*	Dedicated Road Infrastructure for Vehicle safety in Europe
EBU	European Broadcasting Union
ECMA	European Computer Manufacturers' Association
ENS*	European Nervous System
ESPRIT*	European Strategic Programme for R&D in Information Technology
ESA	European Space Agency
ETIS	European Telecommunications Information Services foundation
ETNO	European Telecommunications Network Operators group
ETSI	European Telecommunications Standards Institute
EURESCOM	European Institute for Research and Strategic Studies in Telecommunications
EUTELSAT	European Telecommunications Satellite Organisation
FCC	(US) Federal Communications Commission
IEE	Institution of Electrical Engineers
IEEE	(US) Institute of Electrical and Electronic Engineers
INFOSEC*	Information Security

INMARSAT	International Maritime Satellite Organisation
INTELSAT	International Satellite Organisation
INTUG	International Telecommunications Users' Group
ISO	International Standards Organisation
ITU	International Telecommunications Union
ITU - RS	International Telecommunications Union - Radio and Satellite (formerly CCIR)
ITU - T	International Telecommunications Union - Telecommunications (formerly CCITT)
JPEG	Joint Photographic Expert Group
MPEG	Moving Picture Expert Group
ORA*	Opportunities for application of information and communication technologies in Rural Areas
RACE*	R&D for Advanced Communications in Europe
RARE	Réseaux Associés pour la Recherche Européenne
RIC	RACE Industrial Consortium
SPAG	Standards Promotion and Application Group
TEDIS*	Trade Electronic Data Interchange Systems
TEN-IBC*	Trans-European Networks - Integrated Broadband Communications
WARC	World Administrative Radio Conference
WTSC	World Telecommunications Standardisation Conference

***European Commission R&D programme**

Annex VI

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