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ON

Demonstration Of Interworking Via Optical Networks

Summary Of Results

Demonstration of Interworking Via Optical Networks

Summary Of Results

The European Parliament took in 1992 the initiative to stimulate the demonstration of Optical Communications in the Community by helping interconnect broadband technology trials, such as "Broadband Islands", and High Performance Computer Centres in different Member States. This initiative was based on the R&D work already undertaken within the Third Framework Programme of Community Research and Technology Development (1990-1994).

This initiative has paved the way for the Trans-European Networks, Integrated Broadband Communications (TEN-IBC) by complementing the already significant work done within the Member States and through the framework of Union RDT Programmes.

Broadband Islands have emerged in all European countries - stimulated either by national initiatives, or through the RACE¹ Programme - and have created an extended European platform for cooperation towards IBC. They contributed significantly to the development of advanced telecommunications equipment, services, and applications, such as high speed switching and transmission systems. Most Broadband Islands are the results of joint efforts of researchers, industry and network operators.

For achieving this stimulation, the European Commission launched a call² for expression of interest open to any center of excellence in high performance computing or communications. This call resulted in four projects³ running for a period up to 12 months. These projects offered broadband services, including multimedia and multi-party cooperative working. The financial support provided by the Union was applied only to part of operational costs of interworking incurred within the Member States, i.e. communications charges and specialized equipment within the provisions of the budget available (4 MEcus) for this action.

These projects were

Isabel that interconnected broadband islands between Spain and Portugal,
Tironet that interconnected broadband islands between Northern Ireland and the Republic of Ireland,
Betel whose objective was to interconnect sites in France and Switzerland, and
HPC-Vision that linked sites between France and Germany.

The projects were operating during the year 1993. The appended technical document details the projects organization. At the end of their work projects were evaluated by independent Auditors. Auditors stated that the results were an *"interesting and significant demonstration, especially in view of the limited budget and limited time span under which that had to be managed."*

¹RACE: Research and Technology Development in Advanced Communications Technologies in Europe.

² O.J.. No C219, 26.8.1992, p. 11

³ Commission Decision E/1848/92, 30.11.1992 and E/2106/92, 22.12.1992.

were facing and the means they used to overcome them. The projects also provided inputs to some RACE Common Functional Specifications. By focusing on interconnecting Broadband Islands during this relatively short time period, the projects built extensively on already existing achievements stemming from other programmes or initiatives. In particular, one must mention:

- Broadband Islands, such as RIA (Portugal) and RECIPA (Spain), developed by the Network Operators in part with the help of some RACE projects.
- Broadband applications, such as ESPRIT Project VIMP.
- Experimental Pilot Projects, such as RACE Project TIM and DELTA Project EAST.
- Existing networks, such as a Metropolitan Area Network in Dublin and the STAR⁴ network in Belfast.
- Existing products and prototypes, such as high-speed switches (ATM and routers).

The initiative helped develop a telecommunications service infrastructure and form a basis for the promotion and the expansion of broadband communications: operators, users and manufacturers have used the broadband platforms for real life testing. For example, the projects offered the first trans-national ATM based services with a relevant impact on the development of the future European Information Infrastructure.

Projects have implemented on a trial basis a wide array of already existing or adapted broadband applications. These broadband applications might form in a near future the basis for providing broadband communications to end-users. These are:

- Video conferencing.
- Audio-video mail facility.
- Electronic white board.
- Shared data processing performed by High Performance Computing systems.
- Remote provision of super computing facilities.
- Vision based on line inspection of manufactured parts.
- Cooperative working.
- Robotics applications.
- Multimedia desktop conferencing.
- Distance learning by sharing classes in remote locations.

As a result of the initiative, broadband users have had the opportunity to experiment a large number of broadband applications from various organizations, providing them an early opportunity to understand the benefits they will draw from IBC applications, thus creating a future demand pull for IBC.

The experience gained by the Public Network Operators (PNO) through interworking for solving user specified applications has strengthened their knowledge on the opportunities offered by similar broadband applications. They also had a better understanding on technical issues in distributed broadband applications over high bandwidth links, for example to define billing rules for ATM services. While feedback from users was of direct value for PNOs future developments, the impact on the European market was indirect, through the migration of the experience gained by the PNOs in their own developments. The

⁴ Special Telecommunication Action for Regional Development: the objective of the STAR Programme was to improve the telecommunication infrastructure capable of hosting advanced telecommunication services.

projects output, if correctly exploited, can thus strongly contribute to European cohesion and competitiveness.

Manufacturers of cross-connects, routers and other terminal equipment have been able to test their equipment in real life usage conditions. In addition, they have collaborated with operators to define the quality of service parameters relevant to broadband facilities.

Building on these achievements, most projects have decided to pursue their venture by offering their infrastructure to research projects in the RACE framework and the Trans-European Networks -- Integrated Broadband Communications (TEN-IBC) initiative. By doing so, they offer the opportunity to build on the expertise developed in experimenting broadband communications across Europe. In addition, they offer a platform for real life experiments, that are key for understanding the issues in deploying broadband applications. They are further investigating the opportunity to participate to the broad task of interconnecting the ACTS⁵ National Hosts.

⁵ Specific Programme for research and technological development in the field of Advanced Communications Technologies and Services.

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EXECUTIVE SUMMARY

In the last few years, there has been a high growth in the installation of optical fiber cables all over Europe, providing a large transmission capacity. This will lead to a great improvement of services offered to users as this capacity will allow networks to carry multimedia applications.

The RACE Programme (Research and Technology Development in Advanced Communications in Europe) has been developing the technology that would make this possible. Before this technology is made available for deployment, it is required to test if the applications and equipment from different sources (Network operators, vendors, and users) interwork.

The European Parliament took in 1992 the initiative to stimulate this demonstration. The European Commission launched a call for proposal that resulted in four trans-European projects offering broadband services, including multimedia and multi-party cooperative working.

The initiative helped develop a telecommunications service infrastructure and form a basis for the promotion and the expansion of broadband communications: operators, users and manufacturers have used the broadband platforms for real life testing, and the initiative has implemented on a trial basis a wide array of broadband applications. For example, the projects offered the first trans-European ATM based services with a relevant impact on the development of the future European Information Infrastructure.

ACKNOWLEDGMENT

This report has been prepared with the help of the four projects involved in the Fiber Interconnection initiative. Further technical information is available from the project managers:

Project	Project Manager
I2001	Mr. Pedro Luis Chas Alonso Telefonica I+D Emilio Vargas, 6 Madrid, 28043 Spain Email: plchas@tid.es
I2002	Mr. Fred Rix British Telecom Northern Ireland Churchill House, 20-30 Victoria Street Belfast, BT1 4BA United Kingdom Email: Fred.Rix@btplc.bsb56.gold400.gb
I2003	M. Jalal Samain France Télécom Expertel 25 rue des jeûneurs Paris, 75002 France Email: Europe@altern.com
I2004	Prof. Ernest Hirsch Université Louis Pasteur Strasbourg-I Boulevard Sebastien Brant Illkirch Graffenstaden, 67400 France Email: hirsch@andromede.u-strasbg.fr

THE FIBER INTERCONNECTION INITIATIVE

- | | |
|----------------------|----------------------------------------------------------------------------------------------------|
| • Demonstrate | a pilot action to show the potential for effective broadband communications based on optical Fiber |
| • Provide | a solid foundation of European collaborative research experience |
| • Address | the issues of interoperability and interworking of networks |
| • Capture | the attention of major sector actors |

In a specific action, the European Parliament took the initiative to stimulate the demonstration of optical fiber-based communications for illustrating the interworking between centres of excellence. This action was to be seen in the context of preparing for the Trans-European Broadband Networks.

The scope of the action was to financially participate in interconnection costs among IBC Islands and High Performance Computer Centers to advance the capability of interworking of these sites and to contribute to common functional specification for trans-European network operation following international standards.

The Commission prepared and launched a call for proposal for interested parties willing to participate¹². Participation was open to any center of excellence in high performance computing or communications. Contracts were awarded, for a period up to 12 months, on the basis of competitive bidding of consortia of at least two centers, independent of each other and established in different Member States, wishing to demonstrate interworking via optical fibre networks. The financial support provided by the Union was applied only to part of operational costs of interworking incurred within the Member States, i.e. communications charges and specialized equipment within the provisions of the budget available (4 MEcus) to this action.

Four projects participated:

I2001 Isabel

I2002 Tironet

I2003 Betel

I2004 HPC-Vision

Interworking and interoperability of networks and services are a prerequisite for the pan-European telecommunications infrastructure. This initiative intended to prepare for the Trans-European Broadband Networks by complementing the already significant work done

¹O.J., No C219, 26/08/92

² Commission Decisions: C(92) 2910, 30/11/92 and C(92) 3309, 22/12/92

within the Member States and through the framework of Community Programmes. Testbeds for Integrated Broadband Communications (IBC) and High Performance Computing (HPC) will benefit from interworking on a Community level. "Broadband Islands" have emerged in all European countries, stimulated either by national initiatives, or through the RACE Programme. RACE has created an extended European platform for cooperation towards IBC and has significantly contributed to the development of advanced telecommunications equipment, services, and applications, such as ATM systems, transmission systems, etc. Practically all islands are the results of joint efforts of researchers, industry and public network operators.

This action has improved the conditions for testing and analyzing the impact of the new services, applications or end-systems in the networks, and has contributed to the development of fibre connectivity and produced an organizational structure to promote and expand the use of broadband communications.

THE CONTEXT

The projects were operating during the year 1993. By focusing on interconnecting Broadband Islands during this relatively short time period, the projects built extensively on already existing achievements stemming from other programmes or initiatives. In particular, one must mention:

- Broadband Islands, such as RIA and RECLA, developed by the Network Operators in part with the help of some RACE projects.
- Broadband applications, such as ESPRIT Project P2091-VIMP.
- Experimental Pilot Projects, such as RACE Project R2078-TIM and DELTA Project D2016-EAST.
- Existing networks, such as a MAN in Dublin and the STAR³ network in Belfast.
- Existing products and prototypes, such as ATM cross-connects and Routers.

Due to their high involvement in addressing interconnection issues, the projects participated heavily in the RACE concertation process where projects contribute by exchanging technical information on the issues they are facing and the means they use to overcome them. They exchanged valuable information within the RACE Project Line 8, Test Infrastructure and Interworking. Through this concertation process, they also provided inputs to some RACE Common Functional Specifications.

The Commission Services monitored the projects' progress through Monthly Management Reports and ad-hoc contacts as needed. At the end of their work projects were evaluated by independent Auditors. Auditors noted in their report that results were viewed as an *"interesting and significant demonstration, especially in view of the limited budget and limited time span under which that had to be managed."*

KEY RESULTS

Achievements

The Initiative helped develop a telecommunications service infrastructure and form a basis for the promotion and the expansion of broadband communications: operators, users and

³ Special Telecommunication Action for Regional Development: the objective of the STAR programme was to improve the telecommunication infrastructure capable of hosting advanced telecommunication services.

manufacturers have used the broadband platforms for real life testing, and the initiative has implemented on a trial basis a wide array of applications. These are:

- Video conferencing.
- Audio-video mail facility.
- Electronic white board.
- Shared data processing performed by High Performance Computing systems.
- Remote provision of super computing facilities.
- Vision based on line inspection of manufactured parts.
- Cooperative working.
- Robotics applications.
- Demonstration and transfer of technology.
- Multimedia desktop conferencing.
- Distance learning by sharing classes in remote locations.

Who Benefited?

Users have had the opportunity to experiment various networking arrangements leading to a greater network efficiency. A key element of the Initiative was the large number of applications from various organizations. Users have had an early opportunity to understand the benefits they will draw from IBC applications, thus creating a future demand pull for IBC.

Public Network Operators have drawn lessons on the usage of the new infrastructure. The traffic patterns have been analyzed and studied to understand the behavior of broadband traffic. Improvements, enhancements, adaptations and administrations of a broadband trans-European service are results of the Initiative.

Manufacturers of cross-connects, routers and other terminal equipment have been able to test their equipment in real life usage conditions. In addition, they have collaborated with operators to define the quality of service parameters relevant to broadband facilities.

What Did We Learn?

The experience gained in distributed applications over high bandwidth links can be used by the Public Network Operators, for example to define invoicing rules for ATM services. Thus, feedback to the public network operators is of value for their future developments. Impact on the European market is however only indirect, through integration of the experience gained by the Public Network Operators in their own developments. The projects output, if correctly exploited by the public network operators, can thus strongly contribute to European cohesion and competitiveness.

Also, the experience gained through interworking with the concerned Operators for solving user specified applications can strengthen their cooperation with respect to similar end-user defined applications. Since most projects included public network operators as participants, their experience was readily applicable. However as pointed out by a project, one of the major difficulties appeared to be the linkage between the PNOs, and the user specific requirements. This was particularly true with respect to services and tarification. Technical problems, as experienced within the project, were fortunately marginal.

DETAILED INFRASTRUCTURE AND ACHIEVEMENTS

Physical Coverage of the Projects

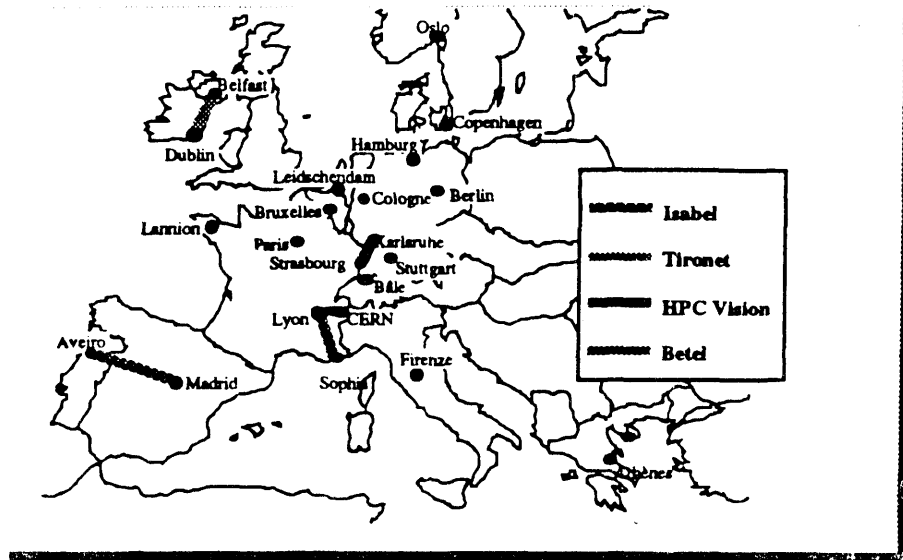


Figure 2: Geographical Coverage

12001 - Isabel

Isabel has interconnected two existing IBC islands, RIA in Aveiro (Portugal) and RECIBA in Madrid (Spain) in two successive steps.

- The first step made available two 2 Mbit/s links from the beginning of the project.
- The second step consisted in the introduction of ATM in the two islands, transporting the ATM cells through a plesiochronous link working at 34 Mbit/s.

12002 - Tironet

Tironet has implemented a broadband service connection between a Metropolitan Area Network in Dublin and an SDH network in Northern Ireland, based on the existing optical infrastructure, with enhancements to existing nodes to ensure a minimum throughput of 4 Mbit/s. British Telecom Northern Ireland owns the optical link to the South and was responsible for the transnational link. The link had a minimum capacity of 4 Mbit/s with a further increase to 34 Mbit/s.

12003 - Betel

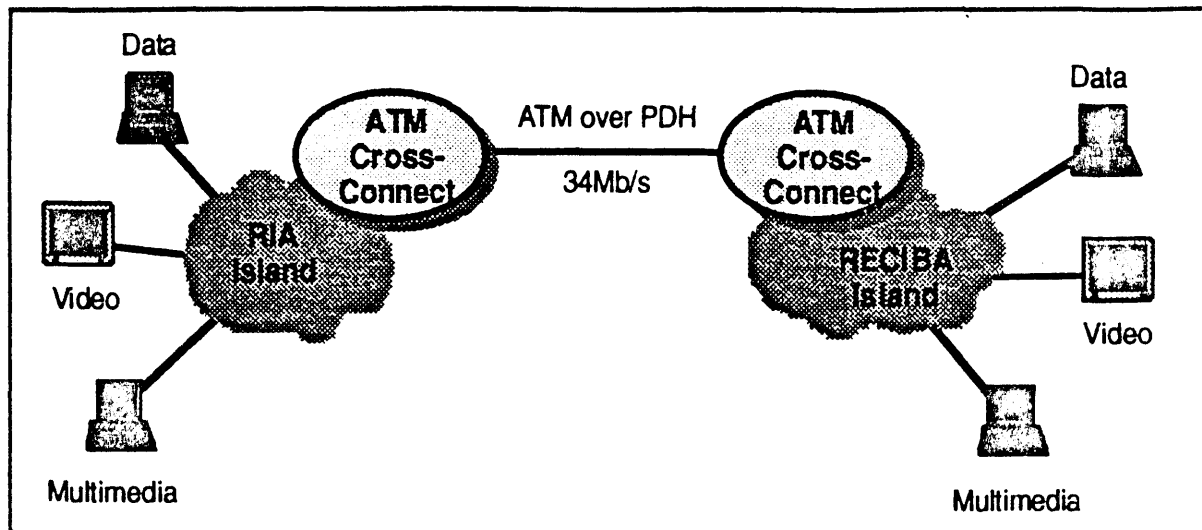
Betel has established a 34 Mbit/s cross-connect platform over trans-European borders. This platform has interconnected FDDI LANs in Geneva, Lyon and Sophia-Antipolis. A Connectionless Broadband Data Service was provided and each end terminal connected to BETEL using a E.164 addressing scheme.

2004 - HPC Vision

HPC-Vision has set-up a 34 Mbit/s link over trans-European borders using existing facilities between Strasbourg and Karlsruhe. The project has used the connection to join existing systems installed in both locations.

Projects Achievements

I2001 - Isabel



The Isabel project has interconnected two IBC islands, RECIBA from Telefonica in Madrid (Spain), and RIA from Telecom Portugal in Aveiro (Portugal) using ATM over PDH at 34 Mbit/s.

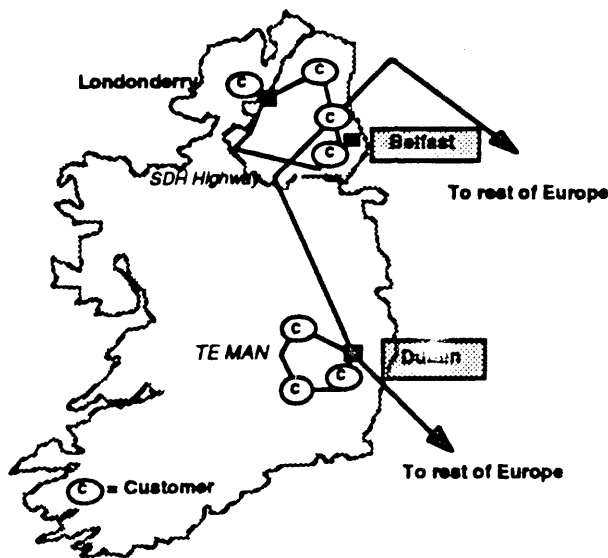
As a main objective, the project has verified the interworking between two different ATM technologies. The RIA island is equipped with an Alcatel cross-connect, while the RECIBA island is equipped with a cross-connect developed by Telefónica. From the terminals, access was done through an Ethernet LAN and a router.

Two bearer services were supported on top of ATM: LAN interconnection and circuit emulation at 2 Mbit/s. Isabel mixes different technologies, N-ISDN and ATM over PDH transport networks. The two Broadband Islands are interconnected by optical fiber. They are directly managed by the R&D Centers of Telecom Portugal and Telefonica, thus ensuring a smooth interconnection.

The Isabel network, first phase, has been used during the BRAIN Summer school in July 1993, while the second phase, operational since December 1993, will be used for the 1994 edition of this Summer school. This infrastructure supports two major types of broadband applications: Cooperative working and distance learning

Participants:	Country
Telefonica I+D	Spain
Centro de Estudos de Telecomunicações	Portugal

I2002 - Tironet

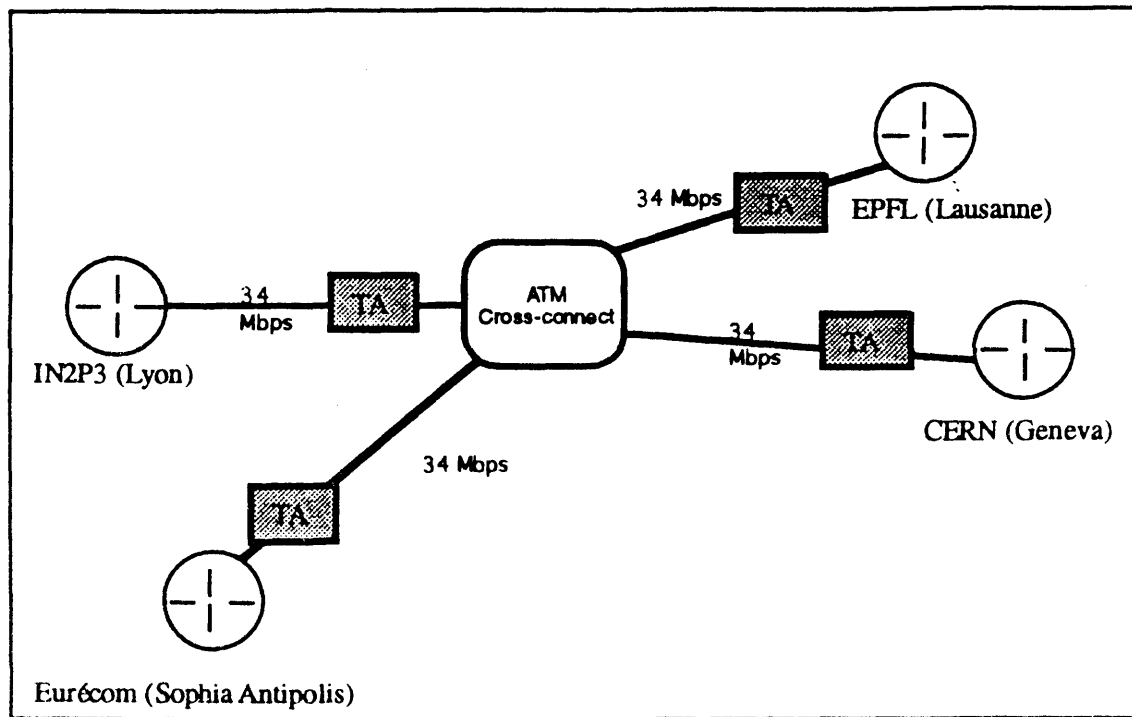


TIRONET's principal objective was to put in place a network facility open for a growing body of users and applications. To achieve this general growth and expansion, TIRONET has established an ongoing conference of users and PNOs, the Advanced Telecommunications Users Conference (ATUC). The ATUC has mapped out a strategy for the development of both the infrastructure and the value added services and applications using that infrastructure.

The project has demonstrated the first transborder connection between Belfast and Dublin. On this network, Tironet has performed the following experiments:

- **Two services:**
 - Provision of a super computing facility by a university in Belfast to application users in Dublin.
 - Provision of shared full text and multimedia electronic documents (journals, etc.) by three university libraries involved in the consortium, with the possibility of extending this to other universities in the British Isles and the European mainland.
- **One Service Development**
 - Application of desktop conferencing technology to the cooperative development of multimedia materials.
- **Two Experimental Pilots**
 - The Tourism Information and Marketing (TIM) project in RACE involves the tourist board from both the Republic of Ireland and Northern Ireland, and the availability of this broadband connection will provide an excellent opportunity for a TIM trial between these two organisations.
 - The Educational Access and Support Tools (EAST) project in DELTA is developing a set of tools for accessing, interrogating and managing multimedia databases of educational material. Two of the universities in TIRONET are involved in the project and will use the network connection for testing and evaluating the use of shared educational resources.

Participants:	Country
University of Ulster	United Kingdom
British Telecom Northern Ireland	United Kingdom
University College Dublin	Ireland
Nynex Media Communications Ltd	United Kingdom
Queens University Belfast	United Kingdom
Telecom Eireann	Ireland
University College Dublin	Ireland
MAI Northern Ireland	United Kingdom



The Betel project has demonstrated multimedia applications with high data rate transmission over optical fiber links. The optical platform was between Geneva (CH), Lausanne (CH), Sophia Antipolis (F) and Lyon (F).

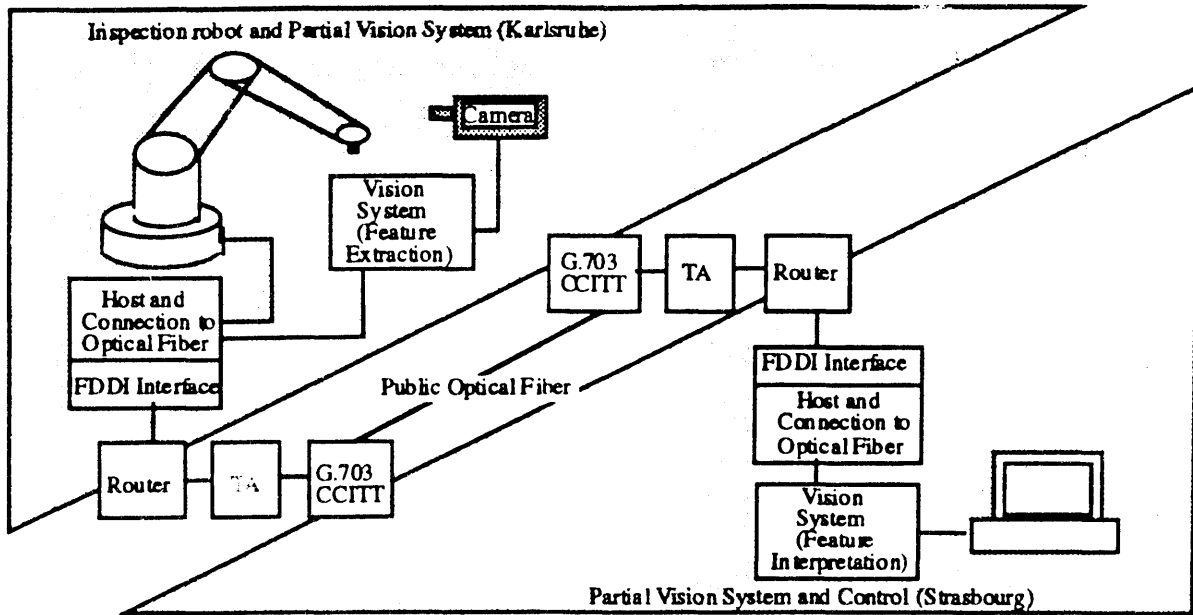
The project was based on a trans-European broadband cross-connect infrastructure, using asynchronous techniques with a connection oriented facility. This connection has been the first international network using ATM technology. The BETEL project experimented broadband techniques, providing a significant advance for understanding the broadband issues.

The project has used existing products. It has build a 34 Mbit/s cross-connect trans-European platform with the following main objectives:

- to test a cross-connect platform for trans-border links,
- to support suitable multimedia applications, such as Tele-teaching or Physics Analysis Workstation ,
- to give a broadband access to high computing resources, and
- to test asynchronous transfer techniques.

Participants:	Country
Institut National de Physique Nucléaire et de Physique des Particules	France
Ecole Polytechnique Fédérale de Lausanne	Switzerland
Institut Eurécora	France
Ecole Polytechnique Fédérale de Lausanne	Switzerland
France Télécom Expertel	France
Centre d'Etudes et de Recherches Nucléaires	Switzerland
Alcatel CIT	France

12004 - HPC Vision



The project has interconnected two vision systems based on parallel systems (e.g. specialized processors and transputer networks), thus extending the availability of distributed vision systems. The data transfer was done through a trans-national optical network with a rate high enough to be compatible with real time applications. Also, friendly man-machine interfaces hid the network characteristics of the system allowing users to use the system as a whole. This approach opens the doors for new applications through cooperation of two geographically distributed systems, and intensifies the common research activities of the partners.

The distributed system was also open to industries of the partners' regions, in the framework of a border crossing demonstration and transfer of technology for the industrial application of computer vision. The existence of a public optical link between the project partners and the commitment of the regional telecommunication agencies of the partners' countries to provide the required transfer rate of 34 Mbit/s has greatly facilitated the extension of the existing distributed systems using local networks (e.g. FDDI) to a larger public networked system

The existing applications used and adapted were the following:

- Set-up of a distributed high computing power parallel structure based on transputers for computer vision applications.
- Vision-based on-line inspection of manufactured parts.
- Robotics applications.
- Set-up of a geographically distributed demonstration and transfer of technology center for vision applications.

Participants:	Country
Université Louis Pasteur Strasbourg-I	France
Fraunhofer Institut - IITB	Germany

Press References, Demonstrations, and Publications

- Public Network, December 1993 / January 1994.
- Communications Week International, September 20, 1993
- Internet Society newsletter, October 7, 1993, Olivier Martin, *International IP connectivity at 34 Mbps*"
- Demonstration at Interop Europe exhibition, Paris, October 23-27, 1993.
- SMDS conference, Amsterdam, November 22, 1993, Olivier Martin, *BETEL*"
- The Packet, Cisco Magazine, January 1994.
- Broadband Islands Conference, Athens, June 15-16, 1993; *An Overview of RECIBA, RIA, and Isabel.*
- Advanced Telecommunications Users Conference Event, University College Dublin, May 18, 1993
- Summer School on Advanced Telecommunications, Aveiro, July 1993
- Communication'93 exhibition, Dublin, 12-14 October 1993.
- Demonstration of Interworking Via Optical Networks, Proceedings of Broadband Islands, Athens, 1993, Elsevier

Participating Organizations

Project	Participants:	Country
Isabel	Telefonica I+D	Spain
	Centro de Estudos de Telecomunicações	Portugal
Tironet	University of Ulster	United Kingdom
	British Telecom Northern Ireland	United Kingdom
	University College Dublin	Ireland
	Nynex Media Communications Ltd	United Kingdom
	Queens University Belfast	United Kingdom
	Telecom Eireann	Ireland
	University College Dublin	Ireland
MARI Northern Ireland	United Kingdom	
Betel	Institut National de Physique Nucléaire et de Physique des Particules	France
	Ecole Polytechnique Fédérale de Lausanne	Switzerland
	Institut Eurécom	France
	Ecole Polytechnique Fédérale de Lausanne	Switzerland
	France Télécom Expertel	France
	Centre d'Etudes et de Recherches Nucléaires	Switzerland
Alcatel CIT	France	
HPC-Vision	Université Louis Pasteur Strasbourg-I	France
	Fraunhofer Institut - IITB	Germany

List of Major Deliverables

The projects prepared and delivered a number of Deliverables describing specifications, project plans and achievements. The most significant Deliverables are listed below.

ISABEL	Specification of the interconnection Services and applications Evaluation report on the interconnection of the two broad band islands Final report on co-operative working Final report on distance education
TIRONET	Implemented Network Implemented Application Evaluation Report TIM Application Pilot Specification Interoperability Test Report Evaluation Report
BETEL	Demonstrator Specifications Primary Testing Report
HPC Vision	Report on the Implemented Distributed Structure Report on the Implemented Applications

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DOCUMENTS

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