France Telecom
Expertel

BETEL

"Broadband Exchange over Trans-European Links"

Final Project Report

Editor : Jalal SAMAIN, Expertel

Date : January, 1994

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FOREWORD

Following a European Parliament initiative by July 1992, the European Commission had established a Community budget and launched a Call for Proposals called "Demonstration of Inter-working Via Optical Networks - DIVON". The objective of this one year program, is to stimulate the development of broadband communications in Europe by supporting demonstrations involving centres of excellence located in at least two European States. Expertel, with the help of France Telecom had prepared the Broadband Exchange over Trans-European Links project. It is one of the four projects selected by the European Commission in DIVON program. The total participation of the European Commission in DIVON is 4,411 kECU. BETEL cost is 2,781 kECU with a Commission contribution of 1,264 kECU.

The project is numbered as I.2003, and it started on the 8th of January 1993. This document represents the project final report.

The project team is composed of the following organisations : Expertel, acting as the co-ordinating partner, while Alcatel CIT, C.E.R.N, the European Laboratory for Particle Physics, E.P.F.L, the Lausanne Institutes of Technology in Switzerland, Eurécom Institute, France Telecom, I N2 P3, the National Institute of Nuclear Physics and Particle Physics and Swiss Telecom PTT are acting as sub-contractors.

Many thanks to the project team's leaders in each organisation who did their best so that the BETEL demonstrations become a world-wide success.

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1. INTRODUCTION

This is a unique collaboration where telecom operators, manufacturers from the telecom industry and real users from research and education sectors put together their efforts, budgets, talents, competencies and knowledge in order to build-up the first world-wide real life experiment.

During InterOP Europe'93 in Paris, the first world-wide usage of an international inter-connection between France and Switzerland, using ATM over 34 Mbps virtual connections, was demonstrated thanks to BETEL platform. Just before, the first ATM cell crossed the Franco-Swiss boundaries on September 23, 1993.

In this paper we will first provide some background information about the BETEL participants and objectives. Then an overall description of the project is given. Following this presentation, the future plans regarding the continuation of the BETEL applications over the European ATM pilot infrastructure from July 1994 are summarised. The document ends with a project statistics assessment.

1.1. ACHIEVEMENTS

The work undertaken since the 8th of January 1993, *commencement day* of BETEL project, is completely in line with the planning defined by the BETEL work plan in the project Technical Annex [TA]. The effort was made, at the very beginning of the project, to fix out management, communication and administrations procedures between partners. A handbook was produced which summarises essential information on the project organisation, objectives and rules [HB]. It was for great help for those who were involved in the work from scratch.

In parallel with this management work, technical groups in each partner team were meeting to define very clearly and pragmatically the demonstrations they wish to provide by the end of the project. Indeed, a document, deliverable "Overall Definition of the BETEL Demonstrator" [D01] was produced.

By the end of January 1993, Alcatel CIT launched the manufacturing process of the cross-connect which was used for BETEL platform. This process was progressing without any deviation from the agreed plan, indeed, the cross-connect system was delivered, installed and made operational on September 1993, twelve days before the planned date.

Once the sites, the infrastructure, and the demonstrations were very well defined, each

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participant has started the implementation of its tasks. They consist in installing optical fibres to reach the sites, preparing the sites, installing equipment, adapting products or already existing tools, developing few specific software and hardware, and finally, testing its own components to be integrated in the final demonstrator. This work resulted in a test report produced by the project [D02].

In addition, Cisco Systems Europe was involved as a sponsorship. Cisco's collaboration was very helpful for the BETEL users.

A special communication and marketing group, within the project, has undertaken the tasks of : releasing a *press release*, producing a *leaflet*, producing a *press file* and held a *press conference*, and finally organising the *final demonstration days* in order to have the best impact on the public opinion. These results are summarised in a report on the BETEL public demonstrations [D03].

1.2. SELF-ASSESSMENT

Globally, BETEL activities were carried out better than expected. Especially, because this experiment brought "*valuable results*" to each of BETEL participants and pointed out that in Europe, it is possible to specify, manufacture, develop, integrate and demonstrate real usage over several kilometres of optical fires of *Asynchronous Transfer Mode* techniques, what is to be presented as a challenge on January 1993. All indicators show that this kind of contributions is the most efficient, especially when it comes with a human and professional understanding.

The professionalism of the partners is to be underlined and this was for great help to achieve the challenge of demonstrating a trans-border ATM infrastructure supporting real users applications and to be included in each user's production strategy. The consortium is confident that the results of BETEL will be of great help for future decisions in the field of high speed telecommunication developments. The efforts that each participant spent are proportional to the expectations of each.

Due to the re-allocation of manpower budget, which has been reduced for funding reasons, some technical issues were ignored. Nevertheless, the manpower consumption has largely overdraw the planned budget.

Users are looking towards this technology as a suitable solution for specific applications which are under evaluation. Operators are preparing marketing plans in order to offer advanced telecommunication services with a completely different commercial approach and tariffs from present offers. Telecom manufacturers are now launching new products. The

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overall market is under evaluation, the customers are few and fibre based infrastructures are under deployment.

The BETEL consortium is happy to underline that the work undertaken and achieved is consistent with the objectives of the DIVON programme. High speed data transfer, based on ATM cells over trans-border circuits between two European states, has been demonstrated for the first time. Users involved in BETEL are very motivated by the results they got from this experiment. These results will influence their decisions in 1994 with regards to investments in the area of high speed telecommunications services.

BETEL participants are convinced that this platform represents an important step towards the European ATM Pilot and they expect significant results from integrating broadband telecommunications into their day-to-day work. For these reasons, the quick market introduction of a router integrating ATM' UNI and NNI interfaces is decisive.

1.3. FUTURE PLANS

Users, manufacturers and operators have clear plans for exploitation of the BETEL results. The results permit the users to validate new concepts and new techniques. Evaluation of the usage of high speed circuits for new applications and as a new support for distributing local computing resources to various geographic sites is still to be made in-depth. This ability is of great interest to the CERN and the IN2P3 who are looking to continue developing interactions between their two centres using high speed links and to extend the number of sites.

For this reason, BETEL was a very good occasion to test, validate and exploit these applications. Already some users (physicists) in each site (Geneva and Lyon) are using results of BETEL each day in a production way.

As far as the EPFL and EURECOM plans are concerned, BETEL represents the first experiment which allows to realise, in a real-life environment, a distributed virtual class-room. Up to day, techniques are available but the possibilities given by the communications offerings remain uncertain when considering the economical balance.

EURECOM and EPFL are strongly decided to pursue their actions in this direction and to use, in a production environment, the possibility to provide remote tutoring facilities to their students on temporary connections basis. BETEL will prove if this kind of telecommunication services is possible and economically viable.

The BETEL project demonstrated the availability of ATM technology in Europe, and proved

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that high-speed data communications technologies which use existing products are available today for meeting end-user demands. While the trial project has ended, it served as an important first stage of an experimental cross-border ATM network which includes operators, manufacturers and especially real users. In addition, the operators are expected to offer commercial ATM services over fully operational networks by 1995.

Future plans for CERN-IN2P3

CERN and IN2P3 are confident that high speed networking is a key-development for their computing activities in the future. The follow up of BETEL experiment for the next year will focus on :

- experimenting, in-depth, a production usage of the platform for distributed computer facilities
- analysing and re-engineering the network architecture, as far as the local sites are concerned: replace or enhance the user access equipment, ATM LAN evaluation, migration to an ATM WAN to ATM LAN inter-connection systems etc. in order to enhance the performance (i.e. less overheads), ATM-WAN connection (e.g. Cisco 7000 router with native ATM-ETSI interface and ATM Forum interface)
- introduction of new users (sites)
- introduction of multi-media facilities to allow remote control of physics experiments
- deployment of new communication protocols candidates for high speed and long distance telecommunication (i.e. Extended TCP)
- study and evaluation of the so-called 'file caching' facility to reduce public telecommunication resources usage.

Future plans for EPFL-Eurécom

The tele-teaching application developed within BETEL is validated in one-to-one configuration. In the future, EPFL and Eurécom aim at extending this facility for multi-part connections.

The development of this facility within EPFL will allow the students to get informed, in a best real manner, about Eurécom institute. In addition, diffusion of this facility, in all the departments of EPFL from one side, and within the educational committee from the other

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side, will give to EPFL and Eurécom a sound position for the tele-tutoring future development in Europe.

Enhancement of the ergonomic aspects and the education psychology are also EPFL and Eurécom objectives for the next year.

Eurécom aims at a deployment of the tele-teaching facilities all around the South of Europe, namely Italy, Portugal and Spain.

Tele-education will reduce investments of science institutes by sharing experts courses with means of high speed telecommunications. Experts will have more and more students in various countries staying in their office and distributing their daily schedule all over Europe.

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2. BACKGROUND INFORMATION

2.1. PARTICIPANTS

ALCATEL CIT

Alcatel CIT is Alcatel's leading subsidiary in the *Network Systems* market : Public Switching systems, Line Transmission Systems, Network Integration and Services and Industries.

In collaboration with C.N.E.T., Alcatel CIT began to develop ATM products in 1987. After presenting the world's first operational ATM network at the Telecom 91 ITU exhibition in Geneva, Alcatel has continued its development efforts with a whole range of products and systems using the ATM switching technique.

At InterOP Europe, in October 1993, Alcatel has again demonstrated its know-how in the field of ATM, by showing an operational ATM network offering end-to-end services, and comprising of products that are already commercialised : Alcatel 1000 AX and Alcatel 1000 HSS systems. It is to be noted that the first Alcatel 1000 AX, in a compact version, was installed and made operational within BETEL project on September 1993. More than 1000 kilometres of ATM circuits have been installed and 12 separate sites are interconnected by means of Alcatel 1000 AX distributed in France and Switzerland.

Amongst the different European R&D projects, Alcatel is participating in RACE EDID[1] project.

Contact point: M. Philippe RIX, (33 1) 30 67 92 62.

CERN - THE EUROPEAN LABORATORY FOR PARTICLE PHYSICS

Because of its long standing involvement in networking activities due to the distributed nature and needs of the High Energy Physics (HEP) Community world-wide, it has been rather natural for the European Laboratory for Particle Physics (CERN)[2],to participate in BETEL. It was also a unique opportunity to validate some of the distributed computing concepts recently introduced at CERN in the framework of the SHIFT[3] project over a real high speed wide area ATM network.

1 Environment for Distributed and Integrated Design
2 International Treaty Organization with nineteen member states

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CERN, located on the Franco-Swiss border near Geneva, provides accelerator facilities for particle physics experiments, mainly in the domain of High Energy Physics (HEP). CERN has also well established scientific links with the HEP community world-wide. Quite naturally the distributed nature of the research community using the CERN accelerator facilities has led to heavy and early use of networking. Without exaggeration one can state that CERN would not have been so successful if the community using it had not been linked by "*some kind*" of network.

Before the BETEL project, CERN was already one of the main "*networking hubs*" of the European academic and research community with approximately 17 Mbps[4] of external bandwidth distributed over 21 lines, 12 countries and 3 continents. With BETEL, lines having a capacity of 17 times the speed of the fastest existing links (i.e. 2 Mbps) have been introduced, which is a "*genuine revolution*" in terms of the type of applications that can use such links.

Contact point: M. Olivier, H. MARTIN, (41 22) 767 48 94

E.P.F.L - ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

EPFL, together with ETH in Zurich, is one of the two Swiss Institutes of Technology which are directly supported by the federal government. EPFL provides training to future engineers, mathematicians and architects, conducts research and transfers new technologies to the industries. It is active in the domains of : Chemistry, physics, mathematics, mechanical engineering, electrical engineering, computer science, communication systems, material science, civil engineering, rural engineering and surveying, and architecture.

EPFL's telecommunications, signal processing and electromagnetism and acoustics laboratories (TCOM-LTS-LEMA), are involved in the development of a tele-teaching facility. The EPFL's computer center (SIC) helped in installing the local environment for getting connected to BETEL wide area platform.

BETEL platform was the right place at the right time to demonstrate a tele-teaching environment with real-time audio-video interactions, shared work-spaces and a user-friendly monitoring interface. It is a grateful experiment with very concrete results.

Contact Point: M. Jean-Pierre HUBAUX, (41 21) 693 26 27.

3 Scalable Heterogeneous Integrated computing FaciliTy
4 Megabits per second

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EURÉCOM INSTITUTE

Eurécom institute was founded in 1991 by EPFL and Telecom Paris. It receives students for the final phase of their engineering studies in communications systems. It carries out research and projects in the following areas : corporate, multimedia and mobile communications.

BETEL is a first experiment for Eurécom in the scope of European R&D programs, and it opens the way for more involvement in European technology development projects. The corporate communications and multimedia communications departments have deeply contributed to the tele-teaching demonstration.

Contact point: M. Ernst BIERSACK, (33) 9300 26 11.

FRANCE TELECOM

France Telecom, a world-leading telecommunications operator, offer its customers a full range of high-quality services. To maintain its competitive leadership, France Telecom invests 4% of its revenues in the research and development, especially within the C.N.E.T. (Centre National d'Etudes des Télécommunications). After having developed the world's first ATM platform in the '80, France Telecom has never stop its involvement in developing this new telecommunication means. It also contributed to the recognition of ATM by the International Telecommunications Union, formerly Consultative Committee on International Telegraphy and Telephony, CCITT). France Telecom continues to participate actively in the ongoing standardisation of ATM through its role within ITU-T, European Telecommunications Standards Institute (ETSI) as well as its participation in co-operative European R&D programs such as RACE and EURESCOM.

In Europe, France Telecom's aggressive marketing efforts have spelled leadership for services like *Transpac*, now Europe's leading volume source of business data traffic. *Eunetcom*, the *fifty-fifty* joint venture company of France Telecom and Deutsche Bundespost Telecom is designed to provide multinational companies with global network solutions.

Pursuing ATM developments for public networks, France Telecom launched BREHAT, a five-years project, on 1990. In conjunction to the BREHAT project, BETEL was conducted to refine ATM real usage in a cross-border configuration.

Contact point : M. Pierre ALZUYET, (33 1) 44 44 56 93.

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I N2 P3 - The National Institute of Nuclear Physics and Particle Physics

The National Institute of Nuclear Physics and Particle Physics is a French "Centre National pour la Recherche Scientifique (CNRS)" institute, whose duty is to promote and federate research activities of its member laboratories in the fields of nuclear and particle physics. It finances and co-ordinates the activities of 18 French laboratories and a global computing centre. Researchers, teachers, engineers, technicians and administrative staff work together to provide computing and telecom services for the High Energy Physics community in France.

Because the activity of IN2P3 is closely linked to the CERN activities, the BETEL "*meta-computing*" demonstration involved quite naturally IN2P3. In addition, the telecom high speed services, in preparation for the next years, are of great interest for such an umbrella organisation.

Contact point: M. Jérôme BERNIER, (33) 78 93 08 80.

SWISS TELECOM PTT

Swiss Telecom PTT has 20,000 employees and over four millions telephone lines installed. Expert in every modern communications technology, Swiss Telecom PTT offers to customers a complete panel of services, from Swiss NET2 (ISDN) to Natel D (GSM).

The immediate future of the ATM technology in Switzerland is the opening of a national ATM network in 1994. This is the first step towards the introduction of a B-ISDN network which will allow a new offer, with new services, such as multimedia or visio-conference between several remote sites, or even tele-tutoring.

Contact point: M. Didier BÉTRIX: (41 21) 344 28 43.

2.2. OBJECTIVES

Due to the different partners in BETEL, research centres, telecom operators and manufacturers, the objectives of the project are various. Nevertheless, from the first beginning of the project, the overall objectives were as follows :

- to test asynchronous transfer techniques
- to gain knowledge in the operation of long distance networking based on high speed optical circuits, to guide further developments
- to test a cross-connect platform with trans-border circuits
- to support suitable multimedia applications

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- to give a broadband access to high computing resources
- to evaluate matching between state of the art broadband techniques and user needs
- to be a significant step in the introduction of broadband data transmission facilities within Europe
- to encourage the introduction of asynchronous techniques.

2.3. DEMONSTRATOR DESCRIPTION

The BETEL platform, as shown in the following figure, interconnected FDDI rings of the four BETEL user's sites, located in Geneva, Lausanne, Lyon, Sophia-Antipolis (Nice), in a fully meshed manner, via Cisco routers and Alcatel's ATM Terminal Adapters (TA) located at the user sites, 34 Mbps optical fibre circuits, and the Alcatel's ATM Cross-connect 1000 AX, located in France Telecom premises in Lyon. All BETEL applications are using the Internet Protocol (IP). The three main applications are *tele-teaching*, *Physics Analysis Workstation (PAW* visualization of particle physics events) and *SHIFT* ("meta-computing" facility).

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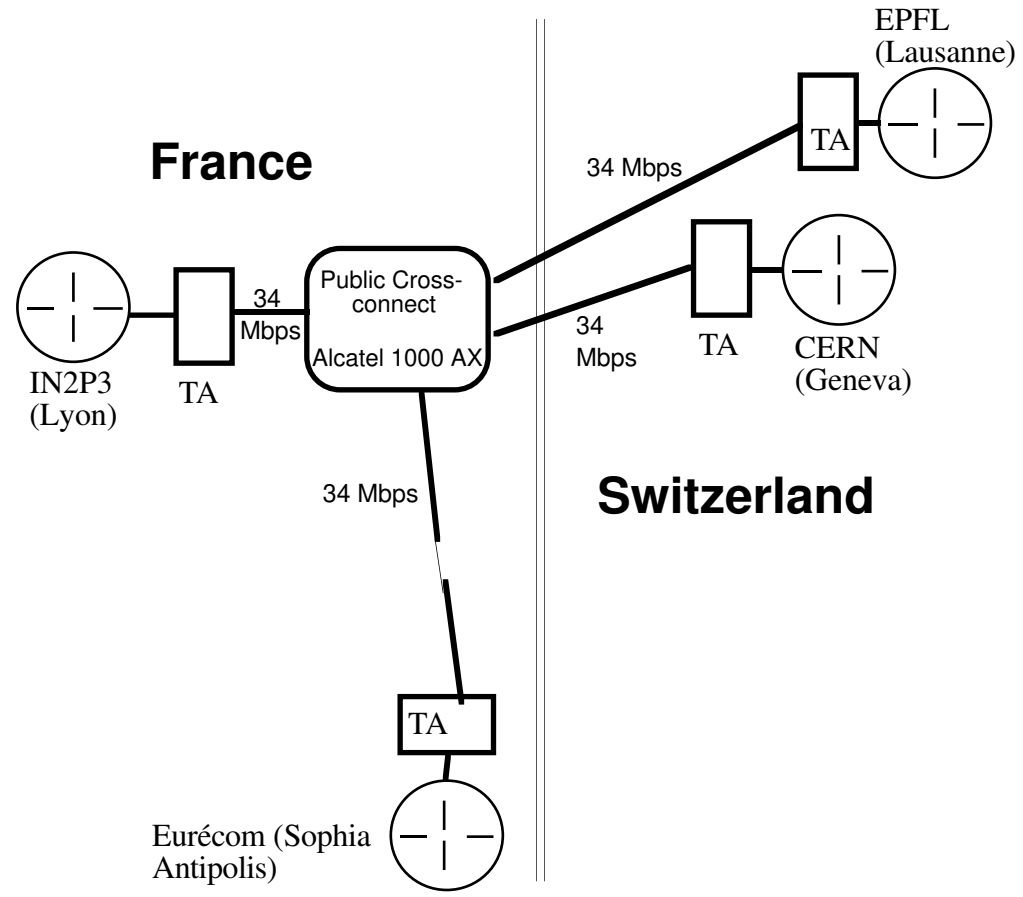

Sites inter-connections

The project used existing products to be able to focus, during a one year period, on a sound economic solution and efficient demonstration.

EPFL and EURECOM have developed applications for communication support of dispersed groups in a teaching environment. The tele-*tutoring* application together with a distributed conference have been demonstrated successfully during the first week of December 1993.

CERN and IN2P3 have implemented real data processing, which is of great interest for the Research community. SHIFT, the Scalable Heterogeneous Integrated computing FaciliTy, is a “GIPS” (Giga Instruction Per Second) assembly of CPU servers from various manufacturers, namely DEC, HP, IBM, SUN and SGI, providing access to over 400 GigaBytes of on-line disk space through disk servers and to the whole CERN tape library, part of which is under tape robot control, through tape servers.

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2.3.1. "SHIFT"

The prime goal of SHIFT is to build computing facilities which could scale in capacity from small systems to several times that of the largest commercially available mainframes. To achieve this objective, an architecture was chosen which allowed a clean separation of the CPU server, disk server and tape server functionality's. A client/server model is used to distribute these "logical" functions across loosely connected servers (i.e. via a LAN or WAN connection). The only requirement is that there exists a TCP connection between the client application and its server at suitably *high speed*, such that expensive resources held by the various servers (e.g. tape units or CPU) are not under-utilised. This modular and distributed approach allowed extension of the system in a very flexible and "easy" manner both on-site, but also "across sites", e.g. in the SHIFT/BETEL experiment between CERN and IN2P3, with the results that a batch job running on a SHIFT/CPU server located at IN2P3 is able to efficiently access files located at CERN by means of a SHIFT/disk server located at CERN.

For the purpose of BETEL, some SHIFT units have been deployed in IN2P3, in order to build a SHIFT/IN2P3 platform which, together with the already existing SHIFT/CERN platform, constitutes the SHIFT/BETEL platform. Both platforms look to the users as a single, or *meta-computing facility* called SHIFT/BETEL.

This meta-computing centre provides various resources, spread between CERN and IN2P3, and accessible in a fully transparent, and location independent manner, to the extent that :

1) batch jobs executing on a CPU server at IN2P3 can make use of disk or tape servers located at CERN and IN2P3.
2) batch jobs executing on a CPU server at CERN can make use of disk or tape servers located at IN2P3 and CERN.

Since the on-line access to the data is required, the tapes files are copied to, and from, local or remote disk servers. The most active part of the tape libraries at CERN and IN2P3 being under control of tape robots, *remote tape copy* between a robot controlled tape drive located at CERN and a disk located at IN2P3, or vice versa, have been demonstrated.

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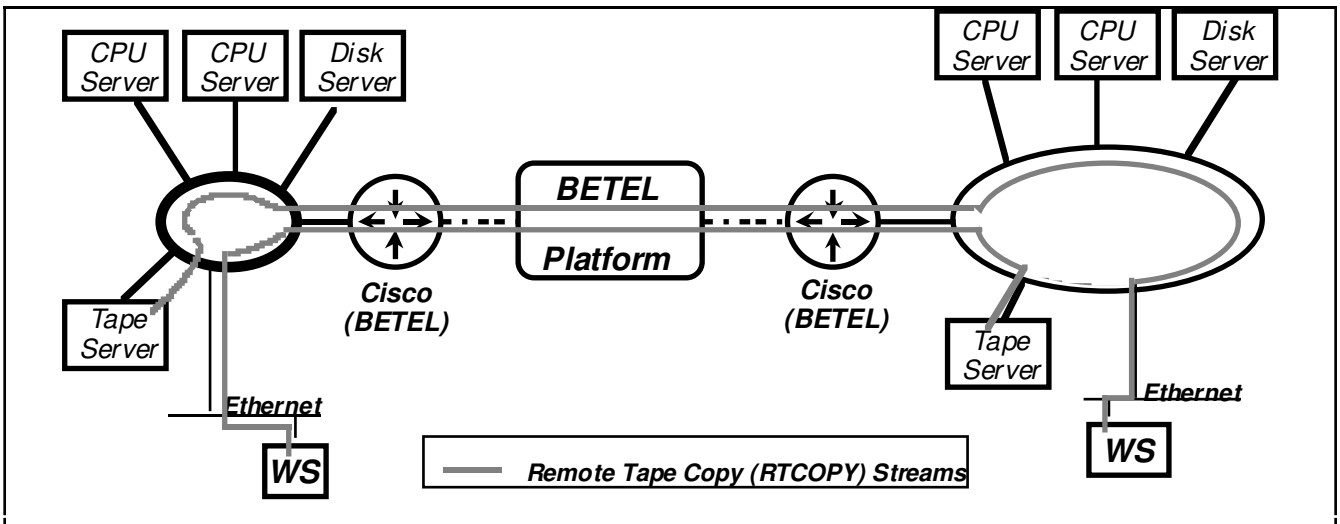
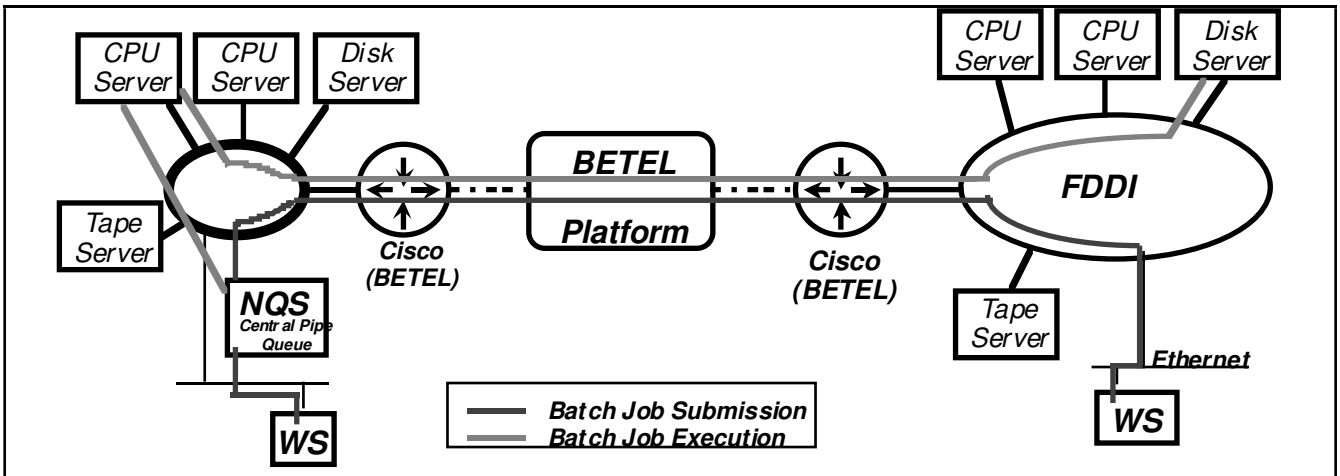


SHIFT/BETEL-Remote Tape Copy Service



SHIFT/BETEL-Batch Job Submission Service

BETEL project being limited in time, the emphasis was naturally placed on "*cloning*" the existing SHIFT set-up at CERN to IN2P3.

2.3.2. "TELE-TEACHING"

The aim of the tele-teaching application is to perform a "conventional" practical exercise session in a distributed way, namely with professor and students located in different places and sites. The teaching environment enables usual behaviours to be remotely reproduced by the different players. The fundamental point for that matter can be summarised in the concept of *virtual presence*.

The tele-teaching application demonstrated consists of students doing practical exercises on workstations with access to a remote expert via multimedia communication capabilities. In this multimedia context, practical exercises seem more appropriate and realistic than, for

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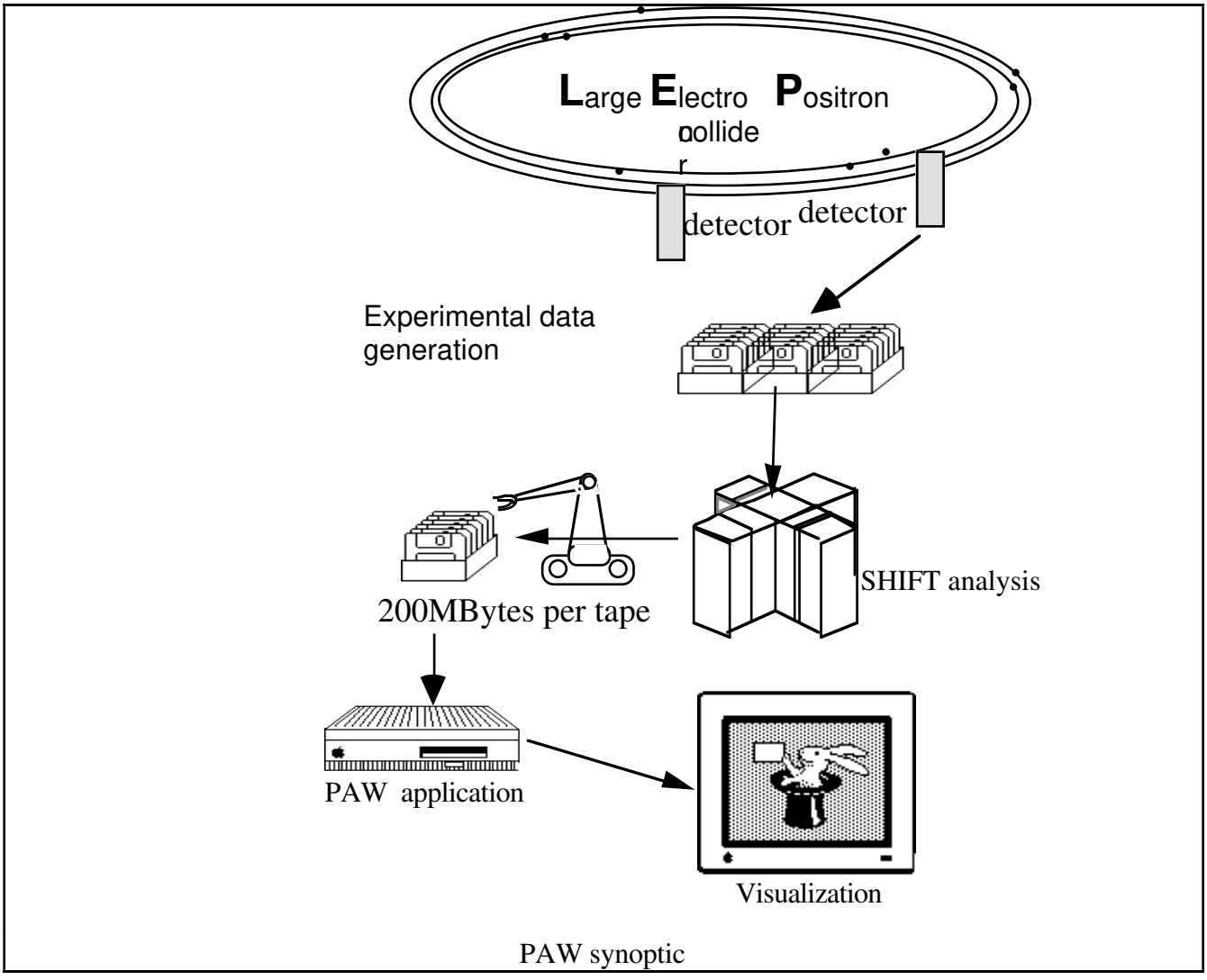
instance, a remote lecture, which requires a lower level of inter-activity and innovation.

2.3.3. "PAW"

This application is conceived as an instrument to assist physicists in the analysis and presentation of experimental data. PAW stands for Physics Analysis Workstation. PAW is primarily intended to be the last component of the physics experimentation done in the HEP (High Energy Physics) community, as shown in the following figure. It provides interactive graphical presentation and statistical or mathematical analysis of experimental data. Its main characteristic is to demonstrate a distributed application with data analysis programs and interactive visualization on different systems and different locations over the network.



PAW synoptic

PAW is conceived as a general-purpose instrument. It provides interactive statistical or mathematical analysis working on objects familiar to physicists like histograms, event files (Ntuples), vectors etc. coupled with powerful and sophisticated interactive graphical presentation facilities, allowing the production of graphical output of publication quality.

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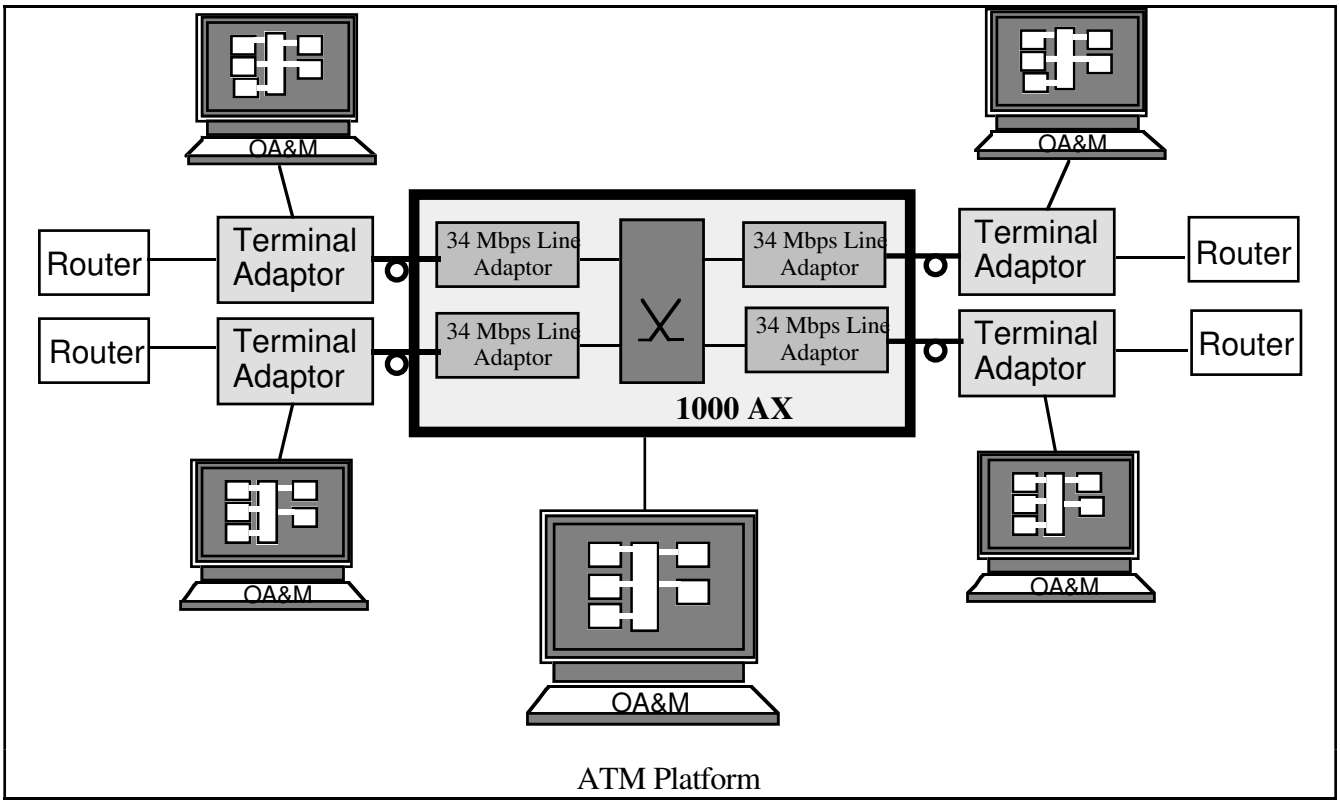
As PAW is based on standards (i.e. TCP sockets, X-Windows etc.), it runs on a large variety of platforms ; HP, IBM, SUN, UNIX workstations, VAX/VMS and VM/CMS.

2.4. ATM PLATFORM

2.4.1. Configuration

The configuration which has been installed at France Telecom premises in Lyon, and at the user sites, for BETEL purposes, is depicted here below :



ATM Platform

The Terminal Adaptors (TA) are connected to the compact 1000 AX through long distance lines at 34 Mbps. The TA and the 1000 AX are operated locally from an OA&M terminal. This OA&M terminal is a dedicated terminal for exploitation purposes. It is used to set-up virtual ATM connections between the terminal adaptors, as required. It acts as a central repository of statistics and maintenance information.

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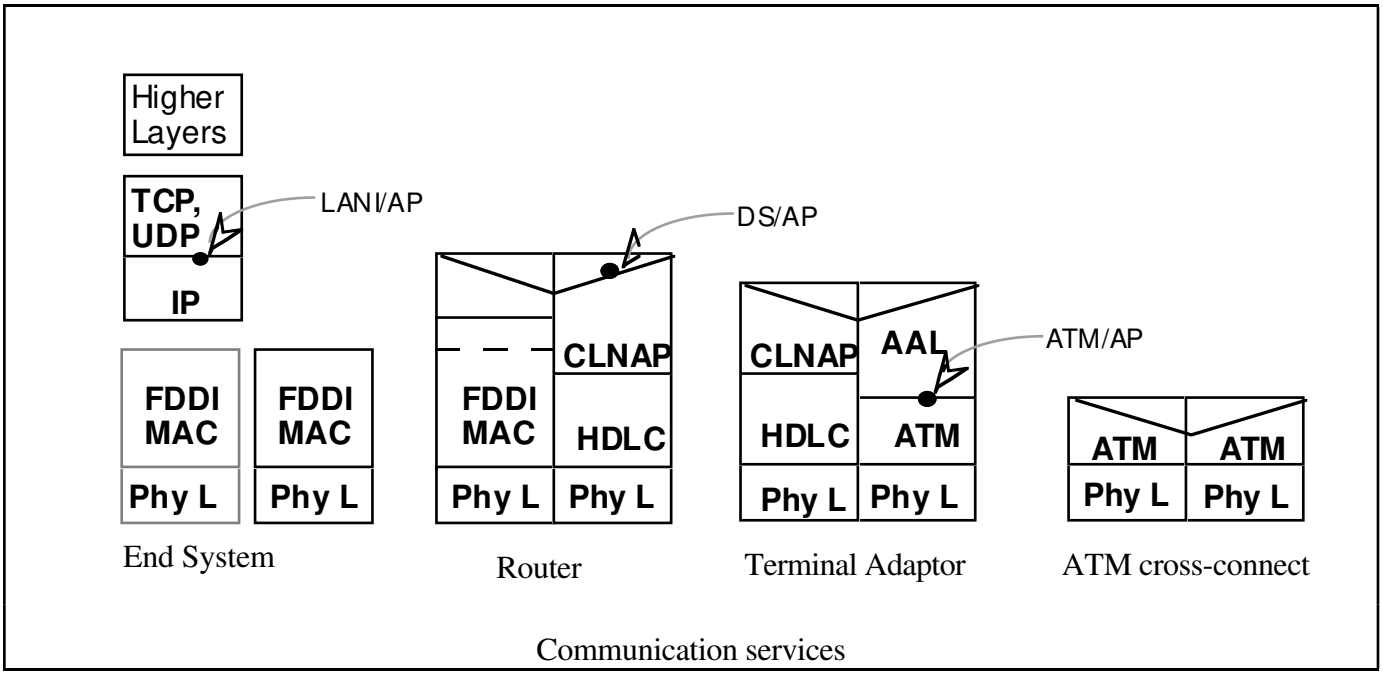
2.4.2. Services

The service offered by the platform are very well detailed in deliverable D01 of BETEL. Hereafter, a quick description of the following is given :



LAN Inter-connection

The FDDI LAN constitutes a sub network in the user's network configuration. Such sub networks need to be combined to form a larger inter-network. The purpose of the LAN inter-connection service, which takes place at the outskirt of the network, is precisely to make possible such larger inter-network.

Data Service over ATM

The data service is an SMDS[5]-like service that provides for the exchange of variable length data units between end-user systems. This connection-less data service is based on CCITT E.164 addressing scheme and provides the users with some facilities such as sender authentication, group addressing and screening. It makes use of the ATM adaptation layers noted AAL3/4, that are best suited to support a connection-less data service over ATM.

ATM Transfer Service

The ATM transfer service offers the transparent transport of ATM cells through the ATM-based network. The access to the ATM transfer service is located within the ATM TA, provided by Alcatel.

5 Switched Multi-megabit Data Service

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3. RELATIONSHIP WITH THE COMMISSION

The main support of RACE is participation to the regular RACE Concertation Meetings (RCM), especially to the Project Line "Test and Interworking". BETEL has been presented at the RCM n°33, on the date of 26/27 January 1993. The papers presented were included in the proceedings.

The functional specifications of the applications to be demonstrated by the end of 1993 were presented at the RCM n°34, on 11/12 March 1993.

Finally, the deliverable D01 was presented at the RCM n°36, on 6/7 July 1993.

Due to the demonstrative option of the work and to the absence of development and research tasks, no support of the development of Common Functional Specifications (CFS) was made.

The project was audited by the Commission on September 20, 1993. For the circumstance, an annual project review report was produced [APRR].

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4. PUBLICATIONS, PUBLIC DEMONSTRATIONS

On September 20, 1993, "Communications Week International" has published an article titled "*ATM Cross-Border*", where BETEL was presented as "*...the world's first international ATM link.*" [D03].

On October 4, 1993, a press release was diffused by France Telecom about the project implementation [D03].

On October 7, 1993, Olivier Martin, from CERN, published an article about " *International IP connectivity at 34 Mbps*" in the Internet Society newsletter [D03].

A promotion leaflet was produced, under the monitoring of the marketing and communication group, for the InterOP Europe exhibition organised in Paris on October 23-27, 1993.

On November 22, 1993, Olivier Martin, from CERN, published a paper about "*BETEL*" for the SMDS conference held in Amsterdam [D03].

A project file press was produced on November 30, 1993 for the occasion of a press conference about BETEL in Paris [D03].

An article in the Cisco' magazine "The Packet" has been submitted and accepted in preparation of its January 1994 release.

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ANNEX A: PROJECT STATISTICS

SCALE OF PROJECT ACTIVITIES

Workpackage	Title
WP0	Project Management
WP1	Demonstrator Specifications
WP2	Demonstrator Primary Tests
WP3	Integration & Demonstration

Manpower in Person per Month[6]

	WP0		**WP1**		**WP2**		**WP3**		Total
	Expend	Planned	Expend	Planned	Expend	Planned	Expend	Planned	Expend
JAN	1,7	1,5	3,05	5,25					4,75
FEB	3,65	3	7,8	10,5	0,3				11,75
MAR	5,15	4,5	13,7	15,75	0,45				19,3
APR	6,8	6	18,35	**21**	2,85		0,1		28,1
MAY	9	7,5	19,25		8	5,85	0,2		36,45
JUN	11,15	9	**19,35**		14,3	11,65	1,25		46,05
JUL	12,6	10,5			21,9	17,5	2,85		56,7
AUG	13,7	12			29,6	23,35	5,4		68,05
SEP	15,2	13,5			33,35	29,15	8,5		76,4
OCT	17,2	15			41	**35**	12,2	5,35	89,75
NOV	19	16,5			**42,65**		21,4	10,65	102,4
DEC	**19,5**	**18**					**25**	**16**	**106,5**

6 The values are cumulated in each line

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CONTRIBUTION OF THE PARTNERS

Organisation Name	Manpower (Person per Month)	
	Expended	Budgeted
FT Expertel	17	18
France Télécom DI	9,85	12
Alcatel CIT	10	12
CERN	13,75	12
IN2P3	17,5	12
EURECOM	19,5	12
EPFL	19	12
PROJECT TOTALS	106,6	90

LIST OF PROJECT REPORTS

Reference	Title	Date Due	Date Submitted
[TA]	Technical Annex of BETEL	October 9, 1992	October 8, 1992
[HB]	Project Handbook	March 8, 1993	March 24, 1993
[D01]	Overall Demonstrator Definition	May 8, 1993	May 26, 1993
[APRR]	Annual Project Review Report	-	September 2, 1993
[D02]	Primary Testing Report	November 8, 1993	December 15, 1993
[D03]	Final Demonstration	January 8, 1994	January 8, 1994
this document	Final Project Report	January 8, 1994	January 8, 1994

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LIST OF PROJECT MEETINGS

Type	Place	Date Due	Minutes reference
N°10	EPFL-Lausanne	November 16-17, 93	0-FTE-1000
BMCG	EXPERTEL-Paris	November 18, 93	n.a.
N°9	France Telecom-Paris	October 22, 93	0-FTE-900
N°8	Telecom PTT-Lausanne	September 16, 93	0-FTE-800
WP3	CERN-Geneva	October 4, 93	0-FTE-703
N°7	EXPERTEL-Paris	July 28, 93	0-FTE-700
BMCG	EXPERTEL-Paris	June 29, 93	0-FTE-603
N°6	EURECOM-Sophia Antipolis	June 10-11, 93	0-FTE-600
N°5	CERN-Geneva	May 6-7, 93	0-EXP-500
N°4	IN2P3-Lyon	April 5-6, 93	0-EXP-400
N°3	EPFL-Lausanne	March 4-5, 93	0-EXP-300
N°2	ALCATEL CIT-Paris	February 1, 93	0-FCR-200
WP1	CERN-Geneva	January 14, 93	n.a.
N°1	FCR-Paris	January 8, 93	0-FCR-100

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