The role of the National Host platforms in the European scenario.

Case study: the Spanish National Host at the UPC

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Abstract

As the National Host Forum estates in a press release the NH initiative provides a unique opportunity to link together advanced communications research organisations on a pan European basis. However, the success of this initiative depends on its level of utilisation. If the facilities are developed and nurtured, they could live on beyond the fourth framework programme, thus providing a ongoing asset to Europe's research community. This unique opportunity exists to be exploited.

Technically, the NHs provide facilities only for support of ACTS projects, but in practice the facilities are open for almost any organisation which plans to develop or enhance broadband oriented applications, providing such usage is not for short-term commercial gain. The NH services will particularly facilitate the involvement in research programmes by Small to Medium Enterprises (SMEs). Such participation is consistent with the stated aims of the European Commission, as it is felt that maximum creativity will be achieved by having research consortia composed of a mix of small and large organisations.

National Hosts are usually equipped with the newest technologies available and congregate expert technicians. This fact must be exploited. The main goal for each NH platform is to provide the required services, but a joint collaboration among NHs performing traffic measurements and quality of service measurements during the trials (even if they are not required by the project itself) may result in a very valuable expertise.

This paper presents a set of activities that have been carried out in the Spanish National Host platform located at the Polytechnic University of Catalunya (Barcelona) during 1996. With the above mentioned purpose in mind, these activities cover not only trials that correspond to ACTS projects but other research activities and services as well. Furthermore, for each activity a detailed plan of tests is prepared including traffic measurements both at ATM cell level and IP level. If these measurements were performed on a regular basis by all the NH involved in a trial very useful findings and practical rules might be derived.

1. Introduction

The idea of "National Host" arose as part of the Fourth General Plan for Research and Development of the European Union, within the sub-programme of “Advanced Communications Technologies and Services” (ACTS). The purpose of these "National Hosts" is to link and coordinate the activities and pilot networks that already exist in each country in the field of networks and services based on advanced broadband communications, with a view to make them available for ACTS projects. This would permit experimentation with advanced communication services designed to incorporate the end users, a basic aspect of programmes such as ACTS.

In Spain, the National Host was set up in 1994 under the guidance of the Spanish Administration. The Spanish National Host (SNH) comprises five organizations that offer their resources (equipment, technical staff, auditoriums, etc.) to research and development projects in the field of advanced communications - (ACTS, for example) - generally implying the participation of end users. Each partner in the SNH contributes with resources that belong to its own specific NH communications platform. Taken together, these platforms build up the complete infrastructure of the SNH.

These platforms are interconnected by means of the ATM Pilot Network of Telefónica and interconnected to National Hosts of other European countries through the pan European ATM Pilot Network which is provided by the PNOs as part of the JAMES project (Joint ATM Experimental on European Services).

The SNH is composed of the following partners: Telefónica, the Telecommunications School of the Polytechnic University of Madrid, Telefónica Investigación y Desarrollo (Telefónica I+D), the Advanced Broadband Communications Centre (CABA)[1] of the Polytechnic University of Catalunya (UPC), and the Fundació Catalana per a la Recerca. The overall structure of the SNH is shown in figure 1.

The paper is organized as follows. In section 2, the SNH platform at the UPC is described. Next sections describe the different activities carried out in this SNH platform. The last section summarizes the role of this example of National Host in the present R&D scenario.

[1] CABA is the acronym of the catalan name of this laboratory (Comunicacions Avançades en Banda Ampla).

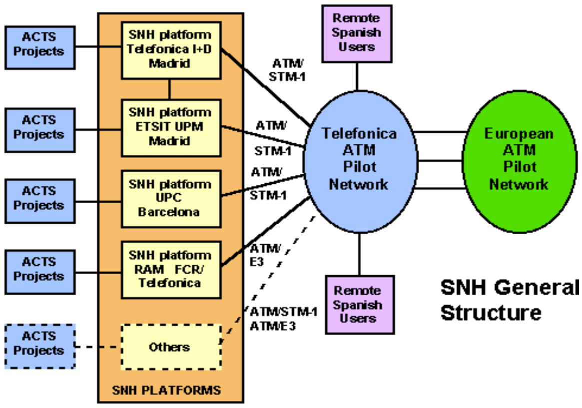

Figure 1. Structure of the SNH

2. Advanced Broadband Communications Centre (C. CABA): SNH platform at the UPC

The platform provided by the Polytechnic University of Catalunya (UPC) is shown in the following figure:

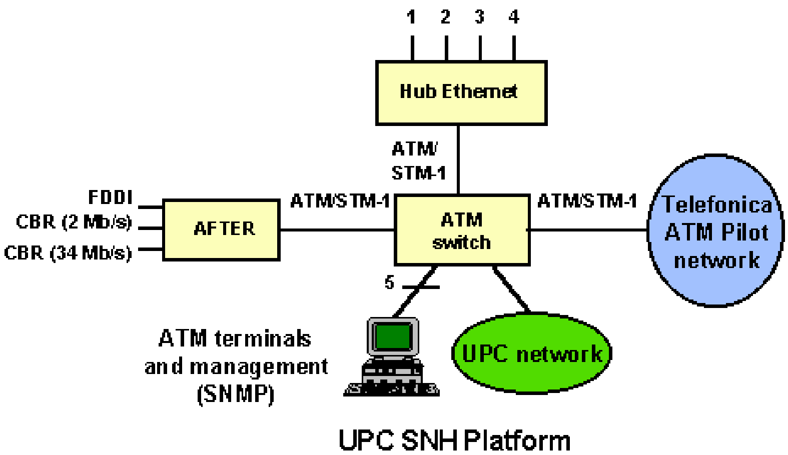

Figure 2. Advanced Broadband Communications Centre platform

The basic components of the ATM LAN are: an ATM switch, an Ethernet-ATM hub, and a FDDI and CBR (E1 and E3) to ATM adapter (AFTER[2]). The switch is a ForeSystems-ASX200BX equipped with ten 155 Mbit/s ATM/STM-1 ports (8 multimode and 2 singlemode). The Ethernet-ATM hub (Fore Systems LAX-20) has four

10 Mb/s Ethernet ports and one ATM/STM-1 multimode port. The AFTER equipment includes two constant-bit-rate ports (2 and 34 Mbit/s), an additional FDDI port (DAS) and one ATM/STM-1 multimode port. The laboratory has several Sun workstations with ATM cards (Fore SBA-200E). Also, the laboratory provides with different multimedia equipment, such as, video boards and cameras. Furthermore, the UPC has an ATM backbone used for interconnecting all the LANs of the Campus and different auditoriums for distributed presentations within the Campus.

The platform is linked to the European ATM Pilot network through the ATM node in Barcelona of the Telefónica ATM Pilot network by means of a single-mode fiber-optic access.

Currently this platform is capable of providing the following communication services: ATM native user-network-interfaces on multimode fibers using STM1/ATM interfaces at 155.52 Mbit/s; Native ATM access through Classical IP (RFC1577) and Fore IP; ATM Forum based LAN Emulation (V.: 1.0) on top of ATM; Interconnection of LANs through ATM, giving support to 802.3 and FDDI. Also, it includes SMDS services; Circuit Emulation through ATM at 2 Mbit/s and 34 Mbit/s; N-ISDN Basic Access; Multicast IP services. Mbone access (tunneling facilities); and Internet Access.

In the next future the platform will provide also these services: Upgraded Ethernet / ATM hub; Network Management Tool for integrated management of all the equipment; ATM native user-network-interfaces on UTP5; ISDN Primary Access; Monitoring and Measurement ATM/SDH equipment; ATM traffic generation equipment with MPEG analyzer module; Computer network access through mobile terminals (DECT); and IPv6 routing facilities when commercially available.

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[2] AFTER is a prototype developed in one of the projects of the Spanish Broadband Program (PlanBA).

3. WatchPoint of the Fourth International Distributed Summer School on Advanced Broadband Communications (ABC'96)

The ABC'96 was organized by the NICE project (AC110) within the ACTS programme, and follows the three Summer School organized by the BRAIN (R2095) and IBER (M1011) projects. The ABC'96 took place from July 9th to 12th, 1996. The ABC'96 was a distributed event with lecture rooms in most European countries [1].

A multimedia Computer Supported Co-operative Work (CSCW) tele-education application joined the lecture rooms, located in different physical sites, creating a single virtual conference room with full interaction between local/remote lecturers and participants.

The ABC'96 Summer School interconnected more than 20 lecture rooms in Europe and North-America, which were divided in 3 categories: Main Sites, Secondary Sites and Watch Points. The Main Sites were those in which lectures and presentations were physically given and attended by registered audiences. The five Main Sites were: Aveiro, Berlin, Brussels, Madrid and Naples. The rest of sites were divided in Secondary Sites and Watch Points. The Secondary Sites did not hold any lecture, but could interact sending questions and occasional speeches. The Watch Points could only receive audio/video/data sent from the Main Sites. The UPC site in Barcelona falls in this third category.

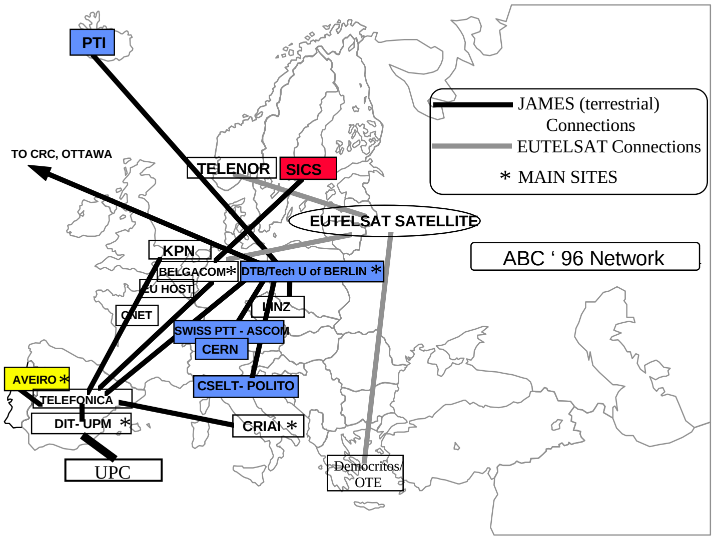

Figure 3. ABC'96 network

The distributed event was controlled from a single site (that remotely controlled the configuration of all the multimedia applications located in the different sites), in this case was the DIT-UPM (Madrid). The network infrastructure was based on: International ATM links provided by the JAMES project, national ATM links provided by the different National Hosts, satellite ATM links by EUTELSAT, and Mbone for interconnection to Internet.

The central component of the ABC'96 platform was ISABEL, a distributed multimedia CSCW application which was developed in the ISABEL and IBER projects. ISABEL has been designed to support the interconnection of audiences, not individuals, with full interactivity. It supports N to N bi-directional communication for all the exchanged media. It includes integrated event management in order to facilitate the operation of large distributed events. The two main target areas are tele-education and tele-work. ISABEL runs on UNIX and includes the following functions: multi-point audio conference, multi-point video conference, tele-pointer, shared blackboard, shared editor and application management.

The Isabel application requires specific communication services in terms of functionality and performance. A specific network design is required. Isabel application will use two completely separated networks: one to handle unicast IP traffic and another to handle multicast IP traffic. The unicast network was used for transferring slides via ftp, telnet, etc. The multicast network was used to transmit video, audio, shared applications, etc. Both networks shared an underlying tree topology constructed using point to point bi-directional symmetric ATM Virtual Paths from the James Project ATM network. Sites were connected by one point to point bi-directional symmetric ATM VP to the nearest node of the tree. Each of the nodes established a similar ATM VP to the nearest node (or the root itself) towards the root.

ABC’96 at the UPC: Network environment.

As previously mentioned, the U.P.C. at Barcelona was a Watch Point of the ABC’96. The U.P.C. was directly connected to DIT-UPM by an ATM link through the Spanish ATM Network. The ATM link used had one Virtual Path (VP) allowing for a bandwidth of 6 Mb/s (15.6Kcell/s). This bandwidth was shared by two different virtual channels (VCs), allocating 100Kb/s for the unicast VC and 5 Mb/s for the multicast VC. These values were set allowing them to be policed, and the reason for allocating a lower bandwidth than the total available is the unavailability of per-VC shaping function.

The ATM link was connected to the ATM switch. The workstation running the ISABEL application was directly connected to this switch. The switch was necessary because the ATM card used in the workstation only supports VPI=0. The workstation was a Sun-SPARC 10/30 with an ATM board and a Parallax video board.

The ISABEL application uses IP over ATM to receive and transmit the different types of data: video, voice, control information, etc. Classical IP could not be used because there is currently no support for IP multicast datagrams. Fore IP supports the IP multicast service. The Fore IP connections (unicast and multicast) were established by means of permanent virtual circuits (PVCs).

ABC’96 performance at the U.P.C.

The event at the U.P.C. was hosted in the Conference Hall (“Aula Màster”) located in the Campus Nord of the UPC. A direct fiber optics link from the switch (C.CABA Lab) to the workstation running ISABEL at “Aula Màster” was used in the presentation room the workstation screen was displayed using a high definition frontal videoprojection system and the audio output from the workstation was amplified by a HIFI equipment. The topology is shown in the figure 4.

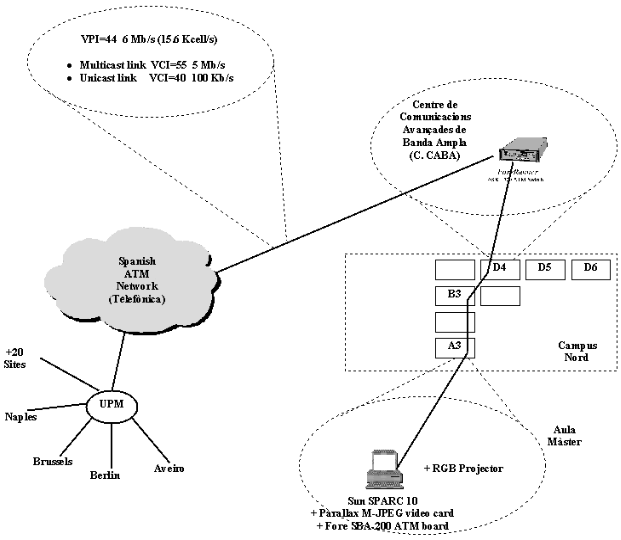

Figure 4. ABC’96 configuration at the UPC

The main problem that had to be solved during the set-up of the platform were due to software and hardware incompatibilities: the processor of the WS, the video board, the drivers for the video board, the version of the OS, the Windows manager version, the ATM driver's version, the multicast patch version, etc.

During the conference, measurements of the received traffic were performed. Figure 5 present some of the result obtained. It shows, from left to right, the histograms for the multicast packets received, multicast cells received, and experienced losses, both CS-PDUs and cells. All cells (and CS-PDUs) are referred to AAL5. Cell losses were measured at the ATM interface of the receiving workstation and correspond to CS-PDUs with incorrect CRC. That means that some cells were lost in the way and incomplete CS-PDUs were received. As the ATM switch did not drop any cells we think these errors were due to occasional non-transmitted cells at the source switch. This fact could not be verified because no measurements are available for that switch, but it is a reasonable hypothesis taking into account that it experienced congestion while performing the distribution to several connections [4]. In future events, measurements should be performed at every site and NH platform. In this way, the different performances may be compared and useful conclusions may be derived.

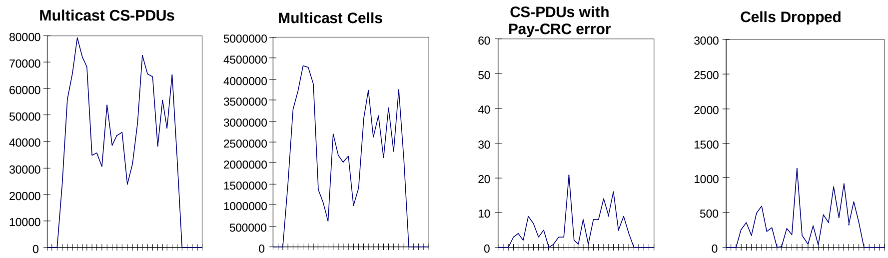

Figure 5. Traffic Measurements: 12th July, from 9:00AM to 5:00 PM (15 minutes/mark)

The performance obtained in this event was very good. Audio quality is critical and echo cancelling was used. Several bit rates may be used depending on the bandwidth available or the desired quality (PCM at 64 Kb/s, and 256 Kb/s, CD quality at 786 Kb/s, and GSM). For the video, depending on the capacity of the connection, three levels of quality may be used (21 fps, 7 fps and 2 fps) and the bit rate ranges from

30 Kb/s up to 2 Mb/s. In our case, as we were using the ATM VP connection the maximum quality for audio and video were selected.

The average bandwidth used was about 1.5 Mbps and the maximum was about 2 Mbps, despite the virtual channel had 5 Mbps. This is another interesting point to be considered. More experience must be gained in order to determine the user requirements (mainly the bandwidth of the connection) for a planned quality of service. Wasted bandwidth may be very important and when tariffing issues are considered it must be minimized.

The attendants could experience a good quality video and audio. ISABEL has a very good design for videoconferencing, for example, slides are shown on the background of the screen, allowing the video window to show the lecturer in a corner of the screen if desired.

4. Platform for MAT (MNET Advanced Trials)

The MAT (MNET Advanced Trials) Project belongs to the TEN-IBC Programme. MAT trial uses a tourism application developed by the TIM project, RACE 2078. This is a market place application which enables points-of-offer (PoO) to create multimedia product descriptions of events, activities, tours, hotels, etc. and to place these on a pan-European distributed database. Points-of-sale (PoS) are able to view the product descriptions and create holiday packages from them. The contents of the market place are the result of individual user behaviour in distributing and retrieving multimedia data in the context of marketing and selling. The hypothesis is that the use of ATM services for the transmission of multimedia would enable application performance closer to the requirements of marketing and selling. The network consists of TCP/IP over a hybrid network of Ethernet LANs and ATM/ISDN/Internet WANs [2].

The regional service provider (RSP) would host a regional server and multimedia file store and would be interconnected with all the other regional servers and file stores via international ATM links. User connections to the regional service provider would be via ATM, or ISDN, or CATV, or other networks. When a point-of-offer user distributes multimedia information to the market place it will be mandatory to distribute it to its regional service provider. The regional service provider will then issue updates of multimedia files to all other regions via the international ATM links. Real time transfer of new multimedia information for application structure will require a high bandwidth connection to their regional service provider, however users may begin with initial low cost connections and migrate to a higher bandwidth in accordance with the development of their business requirements. PoS users may mitigate the effects of a low bandwidth connection to their regional service provider by retrieving a desired set of multimedia product descriptions to cover expected customer demand.

A set of trials were conducted from September to October 1996 using 36 international connections. The objective of this set of trials was to model the future business relationships between users and service providers of the market place with commercially likely configurations of ATM, ISDN, and other networks. The RSP located in Barcelona was able to compare the application behaviour distributing folders through different networks (ATM, ISDN or Internet). Also, clients were allowed to access to the RSP through the three types of networks and the performance and behaviour of the application could be compared.

Network environment.

The trials in Barcelona were carried out by the Institut Cerdà in the C. CABA. Figure 6 shows the network environment for the MAT trials in Barcelona.

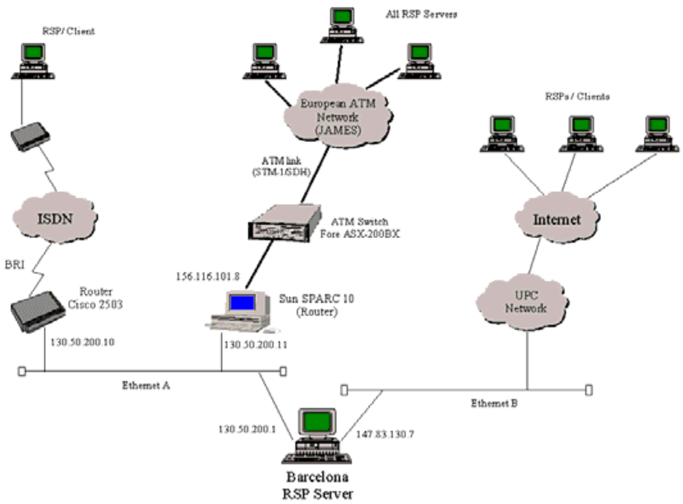

Figure 6. Scenario in Barcelona for the MAT trials

The RSP server was a PC running MS Windows NT with two Ethernet network cards. The server was attached to two separated Ethernet sub-networks, these networks allowed the server to establish connections to all others RSPs and Clients distributed throughout Europe. The first one (Ethernet A) provided access to the WAN connections through ISDN and ATM routers. The second one (Ethernet B) enabled the access to Internet through the UPC-network and the Spanish Academic Network (RedIRIS).

The information distributed and retrieved between the different RSPs were folders with multimedia data: text, image and video. The size of the folders was in the range from less than 1 Mbytes to 15 Mbytes. In the following paragraphs the three test environments are described.

ATM connection

All Regional Service Providers Servers were connected through the European ATM Pilot network. Each RSP server was attached to an Ethernet segment where one

ATM router (Cisco 7000 series, dedicated workstations, ...) was doing gateway functions to interconnect the servers through the ATM network (see figure 7).

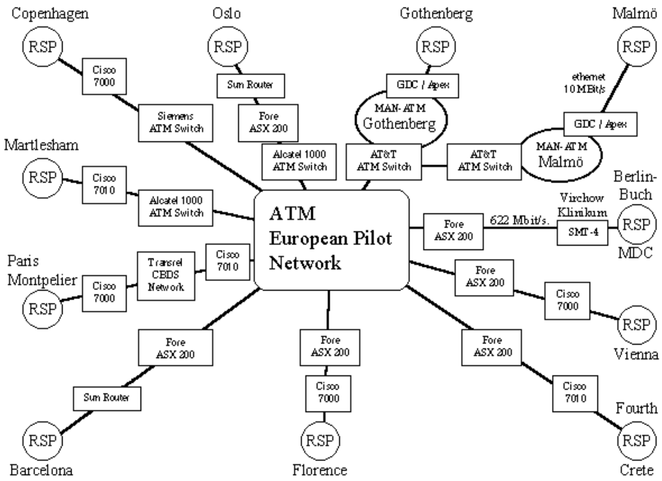

Figure 7. MNET trial ATM network showing Regional Service Providers (RSP)

Each ATM router was a node of this ATM network forming a Logical-IP-Subnet (LIS). The network protocol used was IP-over-ATM based on constant bit-rate Permanent Virtual Circuits (PVCs). IP datagrams were encapsulated (RFC1483) using VC Multiplexing (MUX) and segmented into ATM cells using AAL5. The overall configuration demanded a thorough coordination among the technical staff from the different NH involved. All the problems related with the connectivity and communications were solved by the NH's technicians so that the personnel of the project could be relieved from this burden.

The RSP located in Barcelona had six ATM connections to different cities around Europe (Oslo, Stockholm, Berlin, Linz, Martlesham, and Copenhagen). Each connection had one virtual path (VP) policed with a peak bandwidth rate of 2 Mbps (5000 cell/s). The ATM link from Telefónica was connected to an ATM switch which translated all VPIs to VPI=0. As the Fore LAX-20 (with ATM and Ethernet interfaces) does not support IP-over-ATM with MUX encapsulation over PVCs, a Sun-SPARC 10 workstation directly connected to this switch, was used as ATM router. This workstation had an Ethernet card and an ATM card. The ATM interface was programmed to use Fore IP which supports MUX encapsulation [5].

ISDN connection

The RSP server placed in Barcelona had a narrowband ISDN connection which allowed this server communicate with another RSPs and different clients. The C. CABA Lab. provided one BRI (Basic Rate Interface) access using a router Cisco 2503i to enable the access to the public ISDN network.

The use of ATM showed the significant benefits of broadband transmission for important amount of data in terms of response time for the client applications.

Internet connection

The Barcelona's RSP had also a connection to the rest of RSPs and clients through Internet. This access was achieved attaching the server to the UPC-network which is linked to Internet through RedIRIS, the Spanish academic network. Despite the UPC-network has a fast ATM-based-backbone to interconnect all its sub-nets and an ATM connection to RedIRIS, the Internet access has an important bottleneck in the internetwork nodes around Europe. Then, the service performance was depending very much on Internet traffic congestion.

5. Experimental MBone applications over ATM

RedIRIS, the Spanish national academic and research network managed by the Scientific Research Council (CSIC), provides network services to more than 250 institutions, mainly universities and R&D Centers. These services include Internet access, electronic mail, ftp, www, News, security services (CERT), MBone, etc.

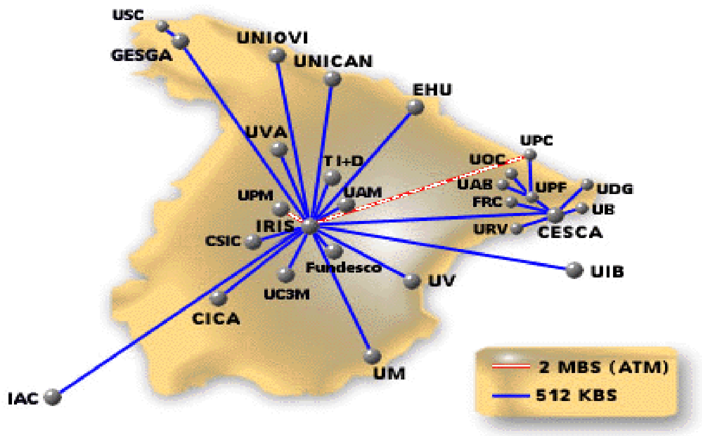

Figure 8. Spanish Mbone map

RedIRIS distributes multicast tunnels from Madrid to the most important Spanish cities, and provides access to the international Mbone. Multicast tunnels are transported over low bandwidth links. The CABA Centre has a multicast tunnel (BW=768 Kbps) over the SNH ATM link consisting in one virtual path with a reserved bandwidth of 2 Mbps. The unicast connection between the multicast routers which supports the tunnel is achieved through Classical IP. In the CABA Centre one SunSPARC workstation was used as multicast router, des/encapsulating multicast datagrams from/to the tunnel (ATM) to/from the laboratory network (Ethernet).

5.1 Experiences in the Mbone

The first sessions were hold in the beginning of 1996. Sessions came from Europe or from the United States. The European ones usually had a good quality. The American ones, heavily depending on the Internet traffic, sometimes had a good quality and sometimes did not. The C.CABA was connected to: an English primary school, a

German Technological trade show, a Russian Universities Rectors meeting, an American mass show, several American and European Universities sessions, the whole preparation of a shuttle for a space travel and the travel itself and a submarine exploration at Florida. These connections allowed us to get expertise using the MBone tools and running the ATM equipment [3].

5.2 MBone connectivity for the INETCCAT'96 Conference

The Catalan Chapter of the Internet Society (ISOCCAT), organized the first annual conference of the Internet in Catalonia, iNETCAT'96, from November 25 to December 1 in Barcelona. This Conference aimed to physically bring together the members of the Internet Community in Catalonia for first time.

During the conference different speeches, tutorials and technical sessions were featured. These events could be followed by all the institutions connected to RedIRIS, because they were distributed through Mbone. The C.CABA provided the Mbone access. One leased line at 2 Mbps provided by Telefónica linked the C.CABA Lab. with the building where the Conference was held. Also, sessions were distributed on the ATM backbone of the campus of the UPC and one workstation was placed in a conference room. In this room took place a distributed Press Conference with on-line connection with the Conference site [7].

6. COST237 Workshop Campus distribution through MBone videoconferencing tools

The Third International COST 237 Workshop on Multimedia Telecommunications and Applications took place in Barcelona from November 25 to 27, 1996.

All the sessions were carried out in the main Conference Hall of the UPC. All these sessions were distributed to another conference room. A Sun-SPARC Ultra1 with an ATM board and a video board was placed in the lecture’s room and used for transmitting video, audio and whiteboard through MBone tools. Another Sun-SPARC 20 was located in the other room receiving all the sessions and showing them on the screen using a videoprojection system. The ATM link between both WSs had a bandwidth of 5 Mbps, using Fore IP which supports the multicast service. A high performance was obtained, with average transmission rate of 3 Mbps. In this case, the bottleneck was the workstation capacity to encode video. Several video coding schemes were tested in order to get the best results.

With this experience we wanted to demonstrate the feasibility of using the Campus optical fiber network to join several conference rooms and to held a distributed event within the campus. Thus, the UPC may provide a Campus distributed videoconference platform linked to other NH conference rooms and other Universities.

Several traffic measurements were performed and several conclusions were derived about the requirements on the equipment and about the optimal configuration of hardware and software platforms and applications [6].

7. Summary

Technically, the National Hosts provide facilities only for support of ACTS projects, but in practice the facilities are open for almost any organisation which plans to develop or enhance broadband oriented applications, providing such usage is not for short-term commercial gain.

Several activities that took place in 1996 supported by the SNH platform at CCABA have been presented. The important issue is not the activities themselves but the opportunity NHs provide for a joint collaboration and the benefits than may be derived from it. In particular, traffic measurements and quality of service measurements may be performed during the trials and experiments and a valuable expertise may come out.

In the next future several activities and projects will take advantage of the NH platform of the UPC. Some of them are: i) To held distributed conferences and courses of the Ph. D. Program between the UPM and UPC on a regular basis. This will allow to test the feasibility of using MBone tools together with the Isabel application. ii) MICC (Mobile Integrated Communications in Construction).ACTS-AC088. This project will use the advanced communications network for testing Virtual LANs (using LAN Emulation), network access through DECT terminals, etc. iii) MSC (Multi-Site Computing). ESPRIT HPCN. This project based in High Performance Computing and Networking will use the advanced communications network and international ATM connections.

8. Acknowledgments

We would like to thank DIT-UPM, NICE Project, Institut Cerdà, MAT Project, and Telefónica for their helpful collaboration in the different projects.

The National Host platform at CCABA has been partially funded by CICYT (Spanish Education Ministry) under grants IN94-0667, TIC95-1405-E, and TEL96-1961-E, and by CIRIT (Catalan Research Commission) under grant PIR94.

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