BROADBAND TRIAL INTEGRATION

A. Azcorra (U. Carlos III, Spain), N. E. Andersen (DSC Communications now part of alcatel, Denmark),
J. Carapinha (CET, Portugal), D. Fernández (U. Politécnica de Madrid, Spain),
I. McKay (U. Edinburgh, United Kingdom), S. Nielsen (Telebit, Denmark),
Z. Papir (U. Mining and Metalurgy, Poland), L. Ditmann (Tech. Univ. Denmark), P. Hvas (Teledanmark),
K. Amborski (Telecom. Poland), B. Christensen-Dalsgaard (UNI-C, Denmark)

ABSTRACT

This paper describes the objectives and current achievements of the ACTS Broadband Trial Integration (BTI) project. The project will develop an ATM capable IP router with IPv6 and RSVP protocols. These routers will be connected to the Broadbanloop (BBL) trials based on a PON plus VDSL modems offering ATM interfaces. Different teleeducation applications that require QoS network service will be adapted to IPv6 over ATM with RSVP. The applications will be demonstrated in the BBL trials in Portugal, Denmark and Poland, and will make advantage of the multicast facilities offered by the network infrastructure.

KEYWORDS:

IPv6, RSVP, QUALITY OF SERVICE, BROADBAND ACCESS, xDSL, ATM, TELEEDUCATION.

1 INTRODUCTION

Internet users and providers often consider broadband access technologies as a forthcoming solution for the current low quality Internet access service. However, a broadband access infrastructure only provides a solution for part of the problem. A technology is required that can actually guarantee the required QoS at the IP networks end to end. Additionally, current IP based applications have to be adapted to make advantage of the QoS offered by the network service.

The objective of the Broadband Trial Integration (BTI) project is to develop and demonstrate a concept for controlling network resources and improving the perception of Internet services offered to users. The quality of service (QoS) control is derived from IPv6 over ATM and the Resource Reservation Protocol (RSVP [1]). A number of multimedia applications developed for education are enhanced with QoS control. Students and teachers at Universities and schools connected to the Broadbandloop (BBL [2,3]) Passive Optical Network (PON) field trials in Denmark, Poland, and Portugal will use the application and evaluate the performance. The three field trials will be interconnected via ISDN or ATM to enhance the educational benefits and the evaluation of QoS concept on a larger scale. The objectives are in summary:

- Develop an integrated IPv6 and switched ATM network concept including multicast with well defined QoS support in terms of controlled load, bandwidth and delay
- Enhance educational multimedia applications for PCs with RSVP to work with QoS control and multicast
- Evaluate and understand the implications for users and the network of QoS control when used in connection with educational applications

2 QUALITY OF SERVICE CONTROL

Integration of IP and ATM is used to have applications interworking through a QoS aware communication infrastructure. The access architecture developed by the BBL project and enhanced through BTI is depicted in Figure 1.

The access network (right part of the figure) comprises of a single fiber PON architecture with a splitting ratio of up to 16. The existing PON consists of the APON LT, a single fiber ODN (Optical Distribution Network) and up to 16 ONUs (Optical Network Units) per link. Customers are connected directly to the ONUs or use an VDSL modem in the last drop depending on the application. The broadband service interface for the customers is ATM25. ATM-25 provides transparent ATM transport to the customer premises equipment and is recommended by the Full Service Access Network (FSAN [4]) group.

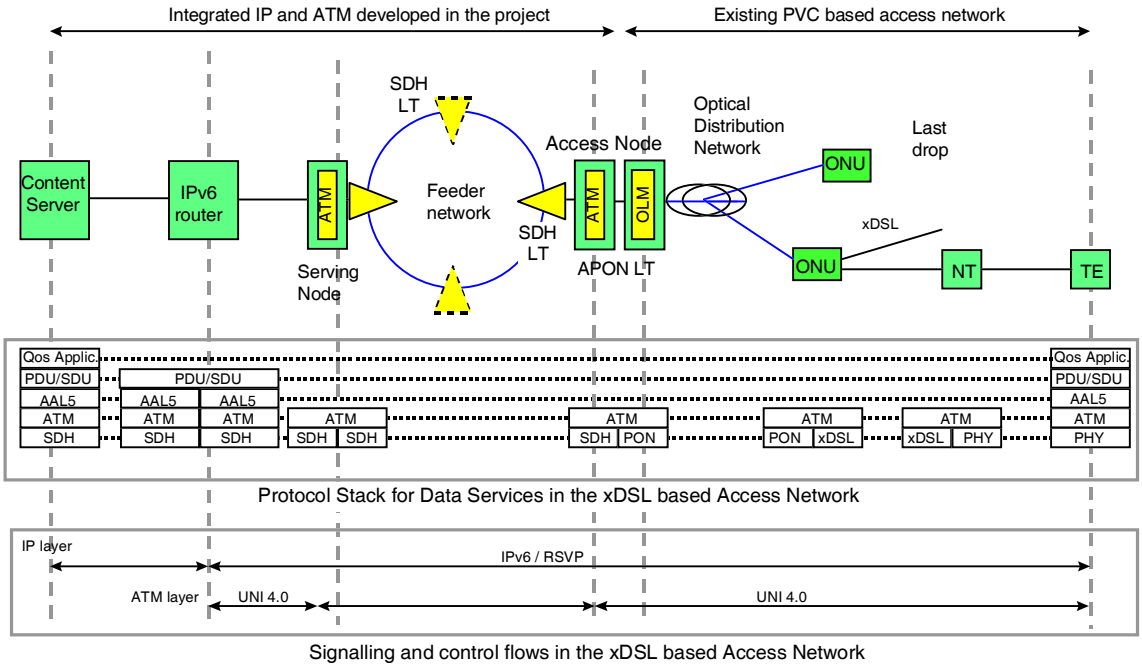

Fig. 1. Architecture of PON / VDSL based access network

The existing implementation of the PON trial supports only ATM connections on Permanent Virtual Circuits (PVC). QoS at the IP layer is obtained through the Integrated Services architecture and signaled through the RSVP protocol. The basic principle applied is, through RSVP signaling, to identify multicast IP flows having specific QoS demands. These flows are mapped to ATM SVCs with QoS parameters equivalent to the QoS requests signaled through the RSVP protocol.

The ATM signaling protocols are used by the end system to request connections to particular destinations with a specific QoS. The ATM network (comprised of both the access ring and the core network) must ensure that connections set up in response to such request can indeed meet the requested QoS.

For support of explicitly signaled QoS parameters, anycast addressing, multicast connections and ABR services, support of UNI 4.0 signaling protocols at the User network interfaces (UNI) will be implemented in the access network. For end users without UNI signaling capabilities soft-PVCs are supported by establishing a manually configured PVC over the UNI, but ATM switch-to-switch signaling is used to setup the connection between the source and the destination switch.

In the BTI project the ATM switching capabilities are added to the existing PVC based access network which in Figure 1 is represented by the block denoted “ATM” in both the Access Node and the Serving Node (in fact the same modules).

The resource management functions in the access network are distributed over the APON LT, the ONUs and the NTs. Different connection types as defined by ATM Forum are dynamically supported in the Access Node and the ONUs, i.e. assignment of service class priority and bandwidth resources are done independently at connection establishment time. In the NT a static resource management functionality is implemented based on service classes (defined by a VP or a group of VPs) in such a way that connections of same service class (CBR or UBR) will be sharing the same resources and controlled commonly. A VB5.2 inspired proprietary resource management- control protocol between the ATM switching function in the Access Node and the ATM multiplexing/concentration functions located in the ONUs and the NTs is implemented.

The access networks will be equipped with IP routers that are capable of supporting IPv6 in conjunction with ATM using RSVP for QoS integration, providing an integration between PIM based IP multicasting and ATM multicasting and providing capabilities for optimized routing using QoS routing and NHRP. The IP router is attached to the access network through an ATM based interface on the Serving Node.

The users, that are attached to PON or VDSL networks, see Figure 1, are connected to the IP router through either SVCs or PVCs, over which encapsulation of IP in ATM (RFC 1483) is used. For those users who do not support RSVP, but have QoS requirements, the routers perform a proxy-RSVP function.

In the first phase of the project, the router performs a proxy-RSVP function for all users having QoS requirements. In the later phases this service will be offered to users who do not support RSVP, but have QoS requirements.

A Serving Node can be used for connection to a server offering ATM native services fed directly onto the feeder ring. The generic ATM based interface of the Serving Node is also used for interconnecting the field trials.

3 APPLICATIONS AND SERVICES

Existing applications and services are enhanced to explore the multicast QoS features offered by the integrated IPv6/ATM network. Testing of the performance of the technical infrastructure will be made together with evaluation of how the availability of advanced network-based educational applications will allow an increase in the productivity of human and non-human educational resources, together with an increase in productivity of the learning process, and an increase in the quality of the education process. The aim here is to identify existing face-to-face (contact) teaching materials and existing proven desk-top teaching materials to be used as a control for the experiments to be undertaken in BTI.

A technical and organisational environment is established that will allow schools and universities to:

- share educational material stored in digital databases and libraries
- share teachers and professors based on virtual presence environments
- allow the interaction between groups of students, groups of teachers/professors, and students and teachers/professors

The applications are taking advantage of multicasting and QoS communication support over a broadband infrastructure. The applications will be tailored to allow client-level

setting of QoS parameters for various tasks within the applications.
The technical approach to be followed involves a detailed user requirements capture with a group of schools and universities to identify the detailed needs of the application areas being developed in an educational context, namely:

- Video Conferencing for Education
- Virtual Workspaces for Education
- Video Servers for Education

The applications consist of a number of end-user tools that can utilize the services offered by the access network and the router components as shown on Figure 2.

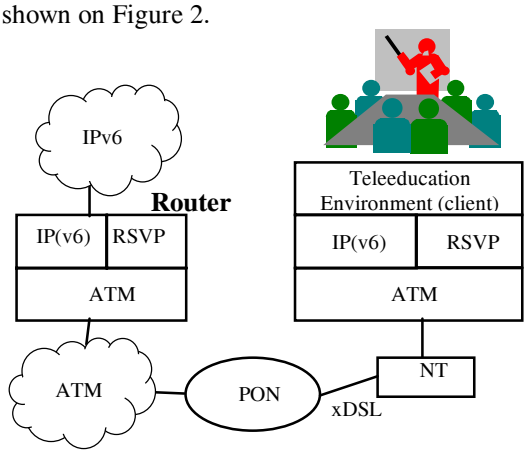

Fig. 1. Educational System for BTI.

The Video Conferencing environment will be based on applications used in current mbone experiences, adapting them to the requirements of the BTI project.

The Virtual Workspace for education will be based on the work of the LEVERAGE project [5]. It is composed of the following data applications, integrated to offer the user a computer based environment for collaborative education:
1. Session Management, which deals with the management of cooperative sessions and all the resources used during synchronous cooperative communications.
2. Shared Editor, which let users share text files in a very simple way. The user controlling the editor can create a new text file, load a text from a disk file, modify the existing text, or save it to a disk file. Other participants can ask for the right to control the editor.
3. Shared Web, which is a synchronized web browser that shows the same document in every participant's window. It is based on Netscape 3.0 and can be controlled by one user at a time. It includes a telepointer functionality to mark documents during navigation, and the possibility to "freeze" the current document loaded at any time and make annotations over it using typical whiteboard tools.
4. Whiteboard, which is a shared paint application in which every participant can draw simultaneously using typical whiteboard tools.
5. Chat Tool, which allows to text-conferencing between participants.
6. Virtual laboratory, which is an internet-based 3D scene where educators allow students to collaborate in a 'shared space' scenario. It allows walk-through and visualization when teaching abstract concepts that lend themselves to a virtual hands-on approach when students co-operate in teams.

The Video Server will consist of a multimedia database and a video stream oriented server with some content focused retrieval services. Access will be provided to the video content stored in the server to pupils (basic/middle schools), students (Electrical Engineering Faculty), and engineers from the Telecoms operator. The "school" part of the server will be uploaded with movies on biology, space exploration, astronomy, mathematics, physics, wild nature etc. The corresponding audio content will be stored in a multilingual format for attracting to the service all schools connected to field trials. The "telecom" part of the server will be devoted to training modern telecommunication technologies and will be accessed by both students and telecom engineers.

The Broadbandloop project has connected universities and schools in Denmark and Portugal which will be testing the applications. They are currently all connected to a first generation ATM based backbone providing IPv4 over ATM, some of them have ATM based LANs. To support the trial the BTI project will provide an IPv6 based service to the participants with multi-casting, QoS, RSVP and other elements being provided by the technical workpackages, eg. the integrated IPv6 router.
The first project milestone has been reached through the demonstration of the Virtual Workspace applications over the BBL infrastructure in EXPO-ACTS 98. The client is placed at Lisbon, where it connects using IP over ATM 25 to the BBL NT, and through VDSL and PON to the ATM network. The ATM network connects the client to the server, that is located at UPM premises at Madrid.

4 MEASUREMENTS AND EVALUATION

The measurement and evaluation approach will include two levels:

1. Technical qualitative and quantitative measurements regarding the service requirements established, e.g. quality of service, traffic profiles and efficiency of IP/ATM mapping.
2. Usability measures based on a concept and tool developed in an ongoing ACTS project. This concept addresses end-user usability of the applications and services, which rely on the new features brought to the network.

A general definition of usability has been proposed by the International Standards Organization (1990) as being

"a concept comprising the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment'"

The BTI project will adopt the ISO definition of usability that involves:

- Satisfaction - to be measured by user attitudes to perceived QoS
- Efficiency - to be measured by QoS settings in the networks
- Effectiveness - to be measured by task performance

Measuring these three aspects of usability will permit statistical analysis of the role played by QoS settings on user perception and performance in controlled tasks when using the applications. It is planned to carry out this statistical analysis based on the Likert approach to assessing the human factor issues involved with the teaching applications being developed for the project. This will allow the creation of usability and perceived QoS as a function of network parameters. Key here will be to ensure that the tasks undertaken by users in the trials are sufficiently generic to extend the QoS results to domains other than teaching.

The protocol to be followed in the field trials and experiments will involve specification of the main usability attributes of each application by mean of a cognitive 'walk-though' exercise to be undertaken by the partners responsible for carrying out the overall assessment. This exercise will be used to derive a set of tasks to explore the various usability features of the applications and which all users will undertake in groups or singly. After completing the task (possibly at several different levels of QoS) users will complete a usability questionnaire.

The methods used to collect data during trials will fall into two basic categories: direct measures of user task completion times and attitude data on the usability of each service derived from the usability questionnaire. Self-report questionnaires are used because of their suitability for obtaining large amounts of information with large numbers of people quickly at relatively low cost, and relatively quickly. After each task of the usability experiment, users will be asked to complete a usability attitude questionnaire, as a means of measuring their perception of the quality and usability of the application and network QoS that they have just used.

5 CONCLUSIONS

There is a growing demand to improve Internet based services by incorporating the possibility of having a guaranteed QoS on a client selectable basis.

Among the different technologies to satisfy this demand, project BTI is focussing on PON/VDSL for access, ATM technology at the subnetwork layer and IPv6 with RSVP for the network service.

In order to validate the network service and infrastructure, the project will adapt an educational environment composed of different applications to make advantage of the services offered by the network.

The complete teleservice, including the applications and the network service, will be tested in the field trials in Portugal, Denmark and Poland.

The trials will serve to obtain a detailed evaluation on technical and usability parameters. Results and comparison of alternative ways of implementation will lead to recommendation for future technological developments.

The first project milestone was achieved by the demonstration of of the Virtual Workspace applications over the BBL infrastructure in EXPO-ACTS 98

ACKNOWLEDGEMENTS

This work has been partly supported by the EU Commission under ACTS project BTI.
Project BTI acknowledges the support of Portugal Telecom and Telefónica de España, which have jointly provided the ATM connection from EXPO-ACTS to Madrid.

REFERENCES

[1] "RSVP and Integrated Services in the Internet: A Tutorial". Paul P. White, IEEE Communications Magazine, May 1997.
[2] Technical Annex. BroadbandLoop (BBL) project. ACTS 038.
[3] "Broadbandloop: A Full-Service Access Network for Residential and Small Business Users", Niels Andersen et. al, IEEE Communications Magazine, December 1997.
[4] "Network Termination – Home Network Requirements", Y. Picault et al., Proc. of the Full Services Access Networks Conference, London, UK, 20 June 1996.
[5] Technical Annex. Learn from Video Extensive Real ATM Gigabit Experiment (LEVERAGE) project. ACTS 109.