Multimedia Multiparty Services to Native ATM Desktops

H. Ouibrahim
J. A. van den Broecke
Bell Laboratories
Lucent Technologies
Botterstraat 45
P.O. Box 18
1270 AA Huizen
The Netherlands
Phone: +31 35 687 4763
Fax: +31 35 687 5954
E-Mail: h.ouibrahim@lucent.com

Abstract

Telecommunications, Computing, and Video Technologies are rapidly converging, creating a new multimedia industry that will serve emerging markets on the information highways. To support these evolving communications demands, computer vendors, switching product providers, communications carriers, and users are looking to ATM as the unifying technology to provide seamless services. ATM, if brought to the user, will indeed provide him with increased power and performance. This promise however can be fulfilled only by bringing the virtues of ATM to the desktop.

This paper introduces a European Project set up two years ago to tackle on one hand the challenge of bringing ATM to the desktop and on the other hand adding value to ATM. Bringing ATM to the end user has meant bridging the ATM Control Plane functions with those of the User Plane using a middleware type functionality. To add value to and optimize the use of ATM, a service platform making use of this middleware was designed and implemented.

Introduction

Many scientists, among which Sir Oliver Lodge, had demonstrated early in the 18th century the possibility of transmissing and receiving Hertzian waves bearing useful information over short distances. It was however G. Marconi who systematically set about to achieve a practical system of wireless telegraphy capable of functioning over considerable distances and providing a commercial service. G. Marconi was honored with a nobel prize in 1909 for this achievement.

Telecommunication systems have come a long way since Marconi and the progress will continue for the forseeable future. It is the intention to build an infrastructure capable of providing Universal Telecommunication Services at the begining of the 21st century. Asynchroneous Transfer Mode (ATM) will be at the heart of the technologies required to build this infrastructure. ATM is a mature technology as was Hertzian waves at the begining of the 18th century. What is required at the moment however is a Marconi to tell us how to use ATM to provide a commercial service. This, we think, is the current challenge.

Early in 1995, we formed in Europe a co-operation between industry, knowledge institutes, universities and user groups for the purpose of getting closer to the solution of the abovementioned challenge. This initiative, known under the name of PLATINUM, is partially supported by the Dutch Ministry of Economic Affairs. The objectives of this project are twofold:

1. Provide the proper ATM infrastructure and mechanisms to support switched advanced multimedia multi-

party services. Bring ATM and its benefits such as QoS to the desktop;

2. Provide the appropriate application Building Blocks on top of the ATM infrastructure to allow a flexible composition of services.

The philosophy of providing on the PLATINUM platform Building Blocks as opposed to monolithic applications stems from our belief that the "killer application for ATM" is pure utopia and that a modular approach to service composition is part of the solution sought. This modular approach is embodied in the so-called Computer Supported Co-operative Work "CSCW"[1]. At the end of this project which is planned for June of this year, a complete implementation of an innovative broadband network architecture supporting multimedia multiparty services will be operational. On top of this ATM infrastructure, we implement and integrate four application Building Blocks: video conferencing, co-authoring, shared whiteboard, and information retrieval.

In this paper, we introduce the results achieved in this consortium. In section 1, we introduce the ATM network and system requirements and configuration where the core switching complex in this network is the Lucent Technologies Network system's Globeview 2000. The call/connection control system implemented on this platform to support multiconnection and multiparty calls is also discussed in this section. In section 2, the PLATINUM distributed functional architecture is introduced where both TCP/IP based applications as well as native ATM applications (composed from the basic building blocks) are supported. In section 3, the 155Mb/s ATM desktop is described from both the hardware and software point of view. An Application Programming Interface "API" allowing applications to directly access ATM via a middleware layer is also introduced. The results are conclusive that native ATM running in the client machine brings the promised performance boost all the way to the users. Finally, in section 4 some conclusions are drawn from this experience and the next phase of the project is introduced.

1. system requirements and configuration

The PLATINUM project - **Pl**atform providing **I**ntegrated services to **N**ew **U**sers of **M**ultimedia- aims to develop innovative multimedia applications, combined with the underlying advanced B-ISDN infrastructure and a signalling system based on the so-called ITU-T Capability set 3.

The PLATINUM network configuration is made up of several subsystems. At the heart of this network is Lucent Technologies Network system's Globeview 2000 ATM switch. This service node has been configured for PLATINUM with a capacity of 20 Gbit/s including several priorities for cell loss and delay. The service node used within PLATINUM can support multiple circuit packs and various types of functions, interfaces and protocols including ATM User-Network Interface and Network-Node Interface, high speed interfaces, video servers and data servers. The system includes an integrated Network Managemnt Module for operations, administration, maintenance, and provisioning. In the PLATINUM platform, the SDH optical interfaces at STM-1 (155 Mbit/s transmission rate) are used to connect the multimedia terminals and the rest of the equipment such the ATM Network Termination 2 (NT-2). This NT-2 provides a PABX type functionality with call completion capabilities.

The signalling system as implemented in PLATINUM is based on a specification developed within RACE (Research and development in Advanced Communications in Europe)[2]. The protocols are based on the ITU-T specification Q.2931[3] with extensions (Q.2931 Ext.) for the multiconnection multiparty aspects. The capabilities of this protocol can be summarized as follows:

1. Call Establishment

- The user can establish a point to point call and expand it during the active phase to include two or more parties
- The user may set up a multiparty call in one shot
- The user can establish a call with a single connection and add one or more connections
- the user can set up a call including multiple connections in "one shot"
- the user can set up a call with multiple parties and multiple connections in one shot

2. Call Release

- The initiator of the call can clear the call in one shot; users which were invited into the call can clear only their part of the call.

3. Addition

- a user can add one or more parties to an active call
- a user can add one or more connections between any parties involved in an active call

- a user is also able to add multiple parties and multiple connections to an active call simultaneously

4. Deletion

- a user can delete one or more parties from an active call
- a user can delete one or more connections between any parties involved in an active call
- a user is also able to delete multiple parties and multiple connections from an active call simultaneously

5. Information

- users involved in a call can be informed of changes in the call with an “Information” message.

For the purposes of this project, a rapid prototyping environment has been used to generate C++ code for the signalling system using SDLs combined with ASN.1 specifications [4].

The complexity of the signalling protocols specified for multiparty multiconnection calls translates in a complex network functionality and more specifically in a complex Call Processing and a complex Network Management[5]. In a multiparty call, multiple endpoints are involved, which makes the protocol state machines extremely complex. It has become clear to us that these call configurations will require a master-slave(s) architecture where the originating local exchange is the master and the different endpoints involved in a call are the slaves. The trigger for acceptance/non-acceptance of a call is generated by the master based on service logic which depends on the responses of the different endpoints.

To guarantee reusability and scalability, the Call Processing was designed in a modular way, See Figure 1. This modularity allows for instance the call processing to be used in different network nodes with or without Intelligent Network (IN) features.

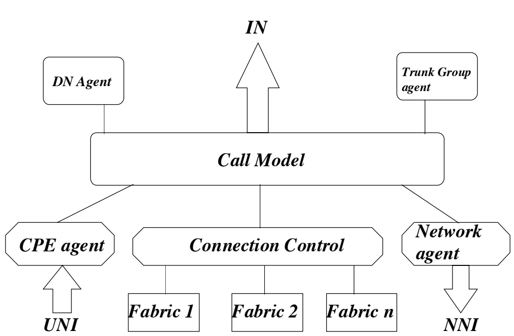

Figure 1 : Call Processing Architecture

At the heart of the Call Processing is the Call Model which is composed of three entities: an entity associated with the incoming side (A customer Premises Equipment in this case), an entity with the outgoing side (a Network Node in this case), and an entity associated with Switch path. This Call Model supports four interfaces:

1. Signalling channel to/from the originating CPE;
2. Signalling channel to/from the network;
3. Control Channel to the Switch Fabric;
4. Interface to the IN World.

At the incoming side of the Call Model we have an Access Agent entity per customer. The Access Agent is to represent the customer who sits on the end of the line coming into the switch by maintaining information associated with its Dial Number (DN). It maintains the list of features assigned to this DN as well as the status of these features. It also maintains the knowledge of which calls are originating from this DN and which calls are being delivered to this DN.

At the outgoing side of the call Model we have a trunk group agent that, as its name implies, is responsible for the information associated with a particular trunk group.

The switch path agent is responsible for maintaining the state information related to the connection from one side of the switch to the other. A switch path agent instance is created dynamically for each call. It is deleted when the call is released.

It is clear that in our heterogeneous world, Consumer Electronics such as PCs and Telephones are the most prone to rapid changes. Telecommunication Equipment residing in Public or Private Networks which require huge investments, need therefore to be able to support a whole range of UNI protocols. To design the Call Model in a cost effective way and to shield it from any protocol dependency, a Customer Premises Equipment (CPE) agent module is introduced. This CPE agent is responsible for translating the internal protocol spoken by the Access Agent into the protocol specific to a CPE in addition to keeping a customer profile. It understands the capabilities of its assigned CPE and knows what resources are required to support the CPE’s protocols.

The switch path entity represents the switch resources used to connect one edge of the switch to the other. The physical connection might use several switching elements in getting from one side of the switch to the other side but this fact is not visible at this layer (A routing algoritm is used to determine the in and out ports). The path can have directionality (one way or two way), and the bandwidth in each direction can vary. The switch path component uses the Connection Control layer to accomplish its task. The connection is aware of the underlying switching fabric and knows the fabric type (circuits, ATM,..). A generic protocol was designed for the communication between the Call Model and the Connection Control which is completely independent of the switching techno logy.

Although the Network Node Interface (NNI) is not discussed in this paper, it should be mentioned that the PLATINUM NNI comprises the standard B-ISUP as a Bearer Control with the addition of two extra layers, namely Resource Control and Call Control.

The PLATINUM platform supports as stated above multiparty call configuartions. This requires, in addition to special signalling protocols and call processing, a combining and multicast function. Although many possibilities were investigated, we finally implemented in this project the combining function in the terminal and the multicast function in the network. A multicast function is provided within the network to optimize multiple connections (point-to-multipoint and multipoint-to-multipoint) without consuming a large number of virtual circuits in the ATM network. The delay due to this functionality is minimal in the PLATINUM platform as its current function is simply to replicate and transfer the cells through logical connections in one-to-many or many-to-many configurations.

2. PLATINUM distributed functional architecture

This section concentrates on the functional scope of the problem domain area. A layered architecture is used where at the bottom a Network layer is introduced providing a bearer service up to the AAL layer (refer to the Broadband ISDN protocol architecture). Note that AAL type 5 is used in this project for both control plane as well as user plane information. For the Control Plane information, S-AAL is used as a data link layer protocol. On top of this network service, a middleware layer known as "MediaBuilder" provides some extra functionality for the applications using Native ATM on the client side (See Figure 2). On top of the MediaBuilder are the applications. An Application Programming Interface called Telecommunication Services API is used by the Middleware to access ATM services[6]. This, in essence, is putting the ATM network under direct control of the applications. Furthermore the architecture caters also for the support of both LAN emulation and classical IP over ATM.

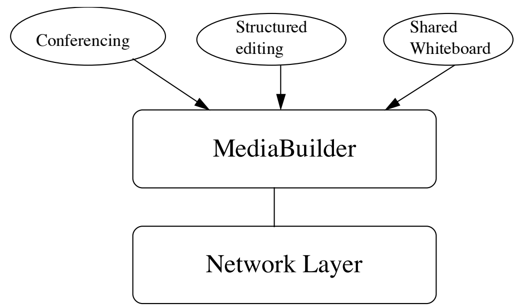

Fig. 2 Functional Architecture

As stated above, MediaBuilder sits between the Application Layer and the Network Layer. It has thus the role of shielding the application from the characteristics of the network and the specifics of the multimedia terminal. It embodies the philosophy of making applications completely oblivious and the underlying network. This MediaBuilder offers some key and generic functionality used by several applications. In particular, we identify:

Session Management handles the control of a multiparty multimedia communication session, e.g. establishment and release of a session, addition or deletion of a party or medium to or from an active session

Floor Control Handles rights, roles, and/or priviledges of users

Stream Support enables the exchange of user streams like audio and video, e.g. reliable transport of user data, combining of different incoming audio streams, and encoding and decoding or compression and decompression of audio and video streams

Remote Data Access allows access to directory servers or access to a remote file

Shared Object Collection enables the sharing of objects among users such as in a distributed file system or shared object database

Four basic building blocks have been developed on top of the Mediabuilder:

- Multimedia Conferencing which provides support for the exchange of audio, video, and data. This includes a user interface to configure the call as desired by the caller
- Shared whiteboard provides an electronic whiteboard to facilitate a joint editing session
- Collaborative structured editing provides co-authoring facilities. This application is based on the compound document editing paradigm, which means that a document is hierarchically composed of “parts” that are viewed/edited by applications which we might call “part handlers”.

Information retrieval has been implemented as a TCP/IP application.

At the top level of our scope, we have a service provided by multimedia CSCW applications to a user environment. These multimedia applications (e.g. teleconferencing, tele-education, tele-consultation) are simply different compositions of the basic application Building Blocks (conferencing, collaborative editing, shared whiteboard,...).

3. ATM to the desktop

As a migration path to ATM, most current desktops provide either LAN Emulation or the IETF’s classical IP-over ATM. Although this is a good way of protecting user’s investments in application software, it will however not deliver all the benefits of ATM. In PLATINUM , work is done to bring ATM signalling and QoS features through to applications, see Figure 3.

In PLATINUM , the multimedia desktop is an NCR Globalyst 630 PC running Windows NT. It is a fast Pentium based PC (120 Mhz clock) with a PCI bus. It connects directly to the ATM network with a standard 155Mb/s ATM interface. The ATM card which can operate in both SDH and SONET mode handles the Physical layer, the ATM layer, and the Segmentation and Reassembly (SAR) layer. A video/audio board developed at Lucent Technologies Bell Laboratories is used in this project. The video part of the board consists of three components, the encoder, the decoder, and the interface to the ATM card. The decoder decompresses and displays multiple Moving JPEG video streams and the encoder is capable of compressing in real time full size entertainment quality video and simultaneously producing three other reduced resolution compressed streams. The resulting four resolution streams are full size , 1/4 size, 1/16 size and 1/64 size. The audio part can also handle full-duplex multiple audio streams.

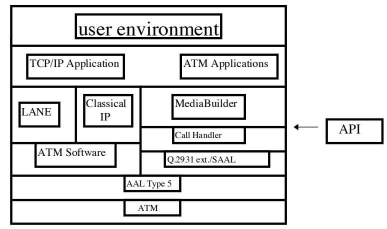

Fig 3. ATM Desktop Architecture

4. conclusion

Within PLATINUM , a service platform on top of an ATM infrastructure has been built. The experience gained in this process is very valuable for the introduction of real time, interactive services on the Information Superhighway. Although it is claimed that ATM as a switching technology is maturing quite fast, this cannot be claimed for what comes along with ATM. Control and management aspects of a network providing true multimedia multiparty services are still being debated. The added value of these networks is still to be demonstrated. The user needs to be convinced of the benefits of ATM , and this can be accomplished only by bringing these promised benefits to his/her desk. It has become clear to us that we still have a long way to go before we can talk about ATM to the home or to the office. A migration path from today’s technologies will have to be carefully thought out.

In Phase 2 of this project, the network platform, applications,and experiment settings are validated in an extended pilot, where among others we fully replace two traditional courses by an electronic, distributed classroom application involving four universities.

5. References

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