End-to-end Multimedia Services using the Telecommunications Management Network

David Lewis
Department of Computer Science
University College London
dlewis@cs.ucl.ac.uk

Introduction

Though the progress toward European IBC continues apace, the piloting of advanced multimedia applications over ATM and experience with the European PNO Pilot has revealed many of the short-comings of existing broadband equipment and services in satisfying user requirements. Some of these short-comings are due to difficulties arising from the many administrative domains involved in providing pan-European broadband communication services coupled with the demanding and varied requirements of the distributed multimedia applications that will use these services. The RACE II PREPARE project has been addressing this area by examining inter-domain service management issues. This work has been performed in the assumed context of the future, open telecommunications market in Europe which will involve not only organisations operating different network domains (both public and private), but also organisations providing value added services over these networks. The central case study of this project was the development of a Virtual Private Network (VPN) management service that supported the requirements of customers wishing to operate end-to-end multimedia teleservices over heterogeneous broadband networks. This paper describes the requirements that were imposed on this management service and how these requirements were met by an implementation based on existing management platforms and demonstrated over a broadband testbed. The experience of this implementation and the input this has had into a more complex implementation using the European PNO ATM Pilot currently being developed is also discussed.

Requirements for End-to-end Multimedia Services

The requirements capture process for the VPN management service was guided by the aim to implement and demonstrate the service over a real network consisting of different broadband Public Network (PN) and Customer Premises Network (CPN) technologies in support of existing distributed multimedia applications. The process was performed by developing a set of scenarios based on the known functionalities and limitations of the networks and applications involved. The salient requirements resulting from this process were:

- Any configuration of network resources in support of distributed multimedia applications should be in response to requests from the VPN service customer, and in particular the end users of the applications that operate over the VPN.
- The quality of service (QoS) provided by a multimedia application to the end users is a function of the resources allocated both across the PNs and across the CPNs to which the end users' terminal equipment is attached and therefore requires co-ordinated allocation of resources in both domains.
- Analysing the requirements of some distributed multimedia applications revealed a wide range of network QoS and configuration requirements (e.g. point to point, point to multi-point and multi-point to multi-point communication paths were all basic requirements for a multimedia conferencing service).
- Modification of the connection graphs and QoS parameters of operational communication paths in response to end user application requests was required.
- In addition to the control of the configuration of end-to-end communication paths the customer and end user also requires information on network faults and performance variations affecting these paths, and therefore the operation of the teleservice.

Inter-domain Management and TMN

Though progress is being made in standardising signalling at the UNI and NNI interfaces it was clear that this area was not fully mature and that commercial implementations would not be available within the

time frame of the project. It was also clear that the scope of this signalling functionality would not cover the requirements for heterogeneous (i.e. non-ATM) network operation or for the feedback of network performance and fault information. The approach taken, therefore, was to adopt an architecture based on the ITU-T's Telecommunication Management Network recommendation [TMN]. This recommendation provides a reference model of how complex networks can be managed by a hierarchy of layered management operations systems (OS). These layers consisted of a network element layer for managing individual network nodes, a network layer for managing full networks and a service layer for managing services over these networks. In PREPARE we assumed that the network element and network layers were limited to single organisation domains and only at the service layer did different domains interact. It was at the service management layer, therefore, that a common abstraction of resource management of end-to-end communication paths was required to implement the end-to-end VPN service.

Management of End-to-end Resources

As the end-to-end communication path to be abstracted and managed covered both the CPN and the PN domains, the TMN based architecture shown in figure 1 was adopted. This consisted of a central VPN service level management operations system (OS) that managed the various heterogeneous PN domains and which communicated directly with service level management OSs in each CPN. A common management information model available as an inter-domain management interface (the TMN x-interface) to the service level OSs was developed. This provided the required level of abstraction for:

- VPN node identification, i.e. end point of communication paths and interface points between PN and CPN domains,
- long term reservation of network resources in each domain for potential use by the VPN service,
- allocation of network resources in each domain for end-to-end communication paths.

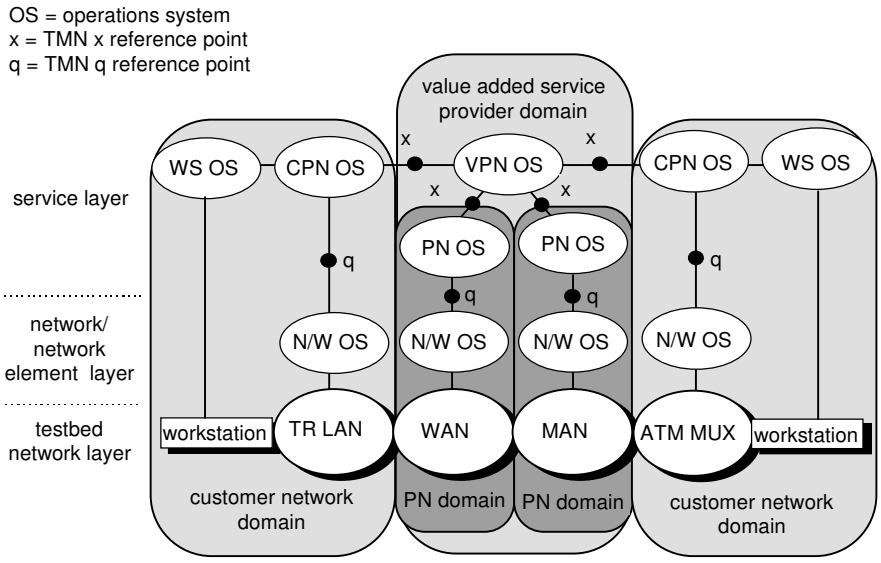

Figure 1.: PREPARE TMN Architecture

The latter abstraction was provided by a single managed object class, called a user stream. This was simply defined by two or more end-points (i.e. multimedia terminal equipment), the topology of end-point inter-connection (i.e. uni-directional point to point, bi-directional point to point, uni-directional point-to-multipoint and multipoint to multipoint) and the QoS to be provided for communication traffic transmitted by each end-point. To enable an end-to-end communication path with QoS guaranteed across all domains, linked user stream objects specifying the required set of end-points and QoS required are created in the service level OS of each domain traversed by the required communication path. This provides each service level OS with sufficient information to instruct the network layer OS in its domain to allocate the required network resources between the end-points and/or inter-network access points, e.g. through the set up of ATM Permanent Virtual Circuits, for the individual domains' portion of the end-to-end communication path.

Results and Further Work

The different OSs were implemented on heterogeneous management platforms, namely HP's Openview, IBM's NetView/6000, Ericsson's TMOS and the OSIMIS platform developed under the RACE program, all of which supported the CMIP based interfaces required by the TMN recommendation. The operation of the VPN management system was successfully tested and demonstrated publicly on the 8 December 1995. The testbed networks used for this demonstration consisted of Token Ring CPNs connected by DQDB MANs running SMDS and ATM multiplexer based CPNs connected by a MAN and the Danish national ATM WAN pilot, BATMAN. The scenarios demonstrated showed the use of user streams for allocating, modifying and releasing end-to-end resources allocation for a multi-media conferencing application operated by end users, and for notifying the end user, of network faults or performance problems that effected the application's communication path. At the same time operator consoles for both the VPN service administrator and the CPN administrator allowed these functions to be monitored through a graphical abstraction of the VPN inter-domain information model.

The user stream and the rest of the VPN service management functionality have been further used by the PREPARE project for a second phase of implementation and demonstration to be completed in 1995. Here the VPN service is used in support of multimedia teleservices that are operated by a separate teleservice provider. In this context the user stream is used as the basis for the accounting of usage of network resources. The teleservice provider sets up user streams, using the VPN provider's inter-domain management interface, in response to customer requests for end-to-end teleservices. The teleservice provider then receives information on the actual usage of the user stream by end users as an itemised bill from the VPN provider which it passes on as part of its itemised bill to the teleservice customer. These management services will operate over an broadband testbed that connects Fore Systems ATM LANs in Copenhagen, London and Berlin via NKT and IBM PN switches and links provided by the European PNO pilot [Lewis].

Conclusion

The PREPARE project has demonstrated that end-to-end management of network resources can be implemented using TMN based inter-domain management to support the complex requirements placed on broadband networks by today's multimedia teleservices. Though in the medium to long term the connectivity functionality provided by the user stream will be performed by UNI and NNI signalling rather than the management of Permanent Virtual Circuits, this model gives us a route to providing end-to-end services over today's multi-domain ATM networks. More significantly it provides a model for dealing with network heterogeneity by hiding technological differences under a common end-to-end information model. Furthermore this common model provides the basis for rich end-to-end fault, performance and accounting management services.

References

[TMN] ITU-T Recommendation M.3010 (1992), *Principles for a TMN*.

[X700] ITU-T, X.700, *OSI Systems Management*, X.700- Series Recommendations, OSI Systems Management.

[Lewis] Lewis, D., Kirstein, P. (1994), *A Testbed for the Investigation of Multimedia Services and Teleservice Management*, Proceedings of the 3rd International Conference on Broadband Islands.