End of Project Report

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1 Executive Summary

Prospect has aimed to realise and validate the end-to-end management of broadband multimedia services in an open service market. This report summarises the achievements of the project. It presents the architecture of the systems used in the various end-user trials and demonstrations conducted by Prospect. It also presents the conclusions reached through the experiences gained in developing and trialling these systems.

The development and integration systems, components, and subsystems by different project partners reflected the software development scenario of the open service market. Therefore, a common methodology for analysing, designing, implementing, testing, and integrating management systems was required to provide guidance to Prospect developers and industry in general. Prospect therefore evolved and used a software development methodology for multi-domain service management systems based on an iterative, incremental development process using the UML notation.

In order to demonstrate and evaluate the many different aspects of integrated, multi-domain service management, the project performed several trials; each one concentrating on a specific problem area. Trial 2.1a, for instance, demonstrated the management of the Tele-Education Service by the customer administrator. Trial 2.2b, on the other hand, showed the provider-to-provider interactions needed to perform end-to-end configuration and control of broadband communication services. For each of the trials the business model and a set of use cases is presented, in accordance with the development methodology.

Faced with the problem of integrating multiple service management systems over several business scenarios, the project opted for a component-based system architecture. Reusable components, defined with open interfaces, facilitated the composition of the trial systems. The project developed both functional units, for instance a subscription management component, and generic technology gateways, for example a CORBA/CMIP gateway component.

Management services implemented by the project comprised of management systems for composite services such as the Tele-Education Service, for information services such as the WebStore service, and for communication services such as the Virtual Private Network service. While the systems for the composite service and the information services were implemented using CORBA technology, the management systems for the communication services used both CORBA and TMN platforms. This reflects the situation in the expected open service market, where enterprises must collaborate across heterogeneous technological domains.

Integration and testing of the complex service management systems require a rigorous testing process. Testing, however, only ensures correct operation of the systems. Whether the systems satisfy the requirements of end-users and administrators, must be analysed through additional evaluation.

The project’s conclusions are related to the different stakeholders of the open service market, to the different technologies used, and to the various standards adopted. The main benefit of the Prospect system, for instance, to the service provider stakeholder is the automation of service management processes, which directly leads to reduced costs in operating the service. The service customer also benefits from the automation of service management processes, and, additionally, from on-line access to all service management functions, which speeds up the customer-provider interactions and makes them more accurate.

Prospect’s system architecture is largely drawn from the TINA Service Architecture and was implemented using commercially available CORBA platforms. TINA, however, is not yet widely accepted, mainly because it is regarded as a complex solution which in addition requires a high level of conformance in order to benefit from its realisation. The project’s experience, on the other hand, has shown that TINA components can be integrated into a less rigid framework, for instance one for integrating IP services. CORBA was applied successfully in the project.
2 Project Objectives

The growth in advanced communication services will lead to a future communications environment with a variety of advanced services being offered by different organisations in an open market fuelled by deregulation and cheaper broadband network access. We term this the Open Services Market.

The main objective of the Prospect project was as follows:

‘To realise and validate, via a commercial/business end-user trial, the integrated end-to-end management of IBC services, in a multi-service provider and broadband network environment. The focus will be on the design and implementation of solutions for interconnecting management systems for competing and co-operating service providers of pan-European services.’

In support of the main objective, the objectives for the final period of the project have been to:

- provide a specification of the Prospect System Model for Trial 2, which was separated into two parts and two phases; a Customer Management trial (T2.1a, T2.2a) and an Integrated Network and Service Management trial (T2.1b, T2.2b).
- develop enhanced service and service management systems for Trial 2 in line with user requirements, particularly Performance Reporting and Fault Management related to Service Level Agreements.
- develop the service and network management systems for Prospect’s Trial 2 incorporating the necessary features to support management of Personal Communication Support (PCS).
- specify, design, and implement a dynamic CORBA/TMN gateway to enable interworking between the CORBA-based management systems and the TMN based network infrastructure.
- specify, design, and implement a CORBA/SMTP gateway supporting interoperability between the CORBA-based management systems and the SNMP based LAN management infrastructure.
- develop the necessary educational material required to support the provision and operation of the tele-education service during Trial 2.
- provide a guide to service management system development methodology.
- conduct Prospect Trial 2.
- evaluate the operation of the Prospect Trial 2 and assess the tele-education and management services.
- disseminate results from and experience of designing and operating the Prospect trials to the wider technical community.
- disseminate technical results from Prospect and collaborate with other projects within the ACTS community, and in particular integrate, Prospect’s management systems with systems of other Communications Management Cluster projects.

In order to meet these objectives, Prospect designed and implemented a management system for the expected open services market.

The TINA Consortium has specified an architecture which takes into account the business roles applicable for tomorrow’s telecommunications market place. The TINA Service Architecture and Network Resource Architecture are based on distributed computing principles and specify end-to-end management systems designed to meet the increasingly more complex requirements of telecommunication management capabilities. Rather than trying to implement a system based solely on TINA’s evolving architecture, Prospect opted for a hybrid solution based on TINA, TMN and the Internet technologies. This approach has several advantages: (1) it is unlikely that any one architecture will dominate the market so Prospect can have a good knowledge of how all can co-exist, (2) as we are not locking into one architecture, we are unlikely to develop a blinkered opinion of this architecture, but
remain in a strong position to give an objective critical analysis of all the architectures, (3) the Internet has many applications with little or no management capability - a requirement for commercial exploitation; while TINA has plenty of management functionality, but few applications. Prospect provides a good opportunity for synergy of TINA, TMN and the Internet. We demonstrated the vertical integration of Internet-based IP applications with TINA-based service management and TMN-based network management of both IP and ATM networks.

In Prospect we assume an open services market with multiple providers operating as multiple administrative domains which are both competing and co-operating at the same time. The design of multi-domain management services is problematic as the development process needs to cater for: (1) multi-domain management services (i.e. management services which span across a chain of several service providers), (2) inter-domain management services (i.e. management services which cross a single administrative boundary between two service providers), and (3) intra-domain management services (i.e. management services used within a service providers domain, but which may be reusable/customisable in more than one domain e.g. subscription and accounting). The design process used in Prospect outlines how such management services could be realised and what modelling techniques are most appropriate.

If such a vision of multiple services and multiple service providers is to be realised, solid practical experiences with inter-domain management interfaces must be gained through real operational trials. Prospect has provided an integrated end-to-end IBC service management system supporting multiple co-existing IBC services. The aim was to demonstrate the following:

- Multimedia tele-service offerings from several different providers including service management functions.
- Inter-domain management interfaces between service providers and network operators to negotiate resource and bandwidth allocations.
- Inter-domain management interfaces between service providers and customers to agree on service profiles and to monitor service usage and quality of service contracts.
- Multi-domain subscription management services across user organisations, service providers and network operators.
- Recording and processing accounting information to support one-stop shopping and billing.

The main focus of Prospect was to achieve the objectives described above in the context of a pan-European trial. This trial envisaged a broadband network infrastructure consisting of an international ATM backbone and access networks run by the national hosts. Various IBC services, such as Virtual Private Network (VPN), multimedia conferencing, interactive hypermedia systems, multimedia WebStore, etc. are made available on this network infrastructure by different service providers. In the trial, these IBC services are used as supporting services for a Tele-Education Service (TES). The management of the Tele-Educational Services and of the general purpose teleservices which support them, form the basis of the end-user service management systems provided by the Prospect project. These services, with integrated management services such as subscription and accounting were provided to the relevant user roles in the customer and service provider domains via appropriate interfaces.

An essential component of the trial was the active participation of a commercial educational service provider and end-users. This involvement provided a sound basis for trial execution and evaluation. The integrated end-to-end management system developed for the trial aimed to ensure the correct functioning, usability, efficiency and high availability of the IBC environment.
3 Relationship to Programme Objectives/Consensus Management Activities

Prospect is concerned with ACTS Domain 5: Intelligence in Networks and Service Engineering. The primary goals of this project in supporting the ACTS programme objectives are as follows:

- To bring together the different actors within a multi-service provider IBC environment, namely end-users and (possibly competing) service providers.
- In addressing Experimental Service Development (subarea 1), Prospect demonstrates, via a series of trials, the integrated end-to-end management of an advanced set of services in a multiple service provider and heterogeneous network environment.
- To address the issues of User Control and Management Services (subarea 4), Prospect provides an insight into the future multi-service provider environment by focusing on inter-domain management aspects in its trials. Also Prospect develops and demonstrates aspects of user control that have been derived from analysis of end-user requirements in a realistic end-user/multi-service provider environment.

Prospect has also participated actively in the NI Chain Group. In the NIM Chain, Prospect has led the work in gaining consensus in design methodologies for telecommunications service management systems. Prospect has been responsible for the editing of NIM Guideline #1 on this subject and for its presentation at several workshops, conferences and international fora. A Prospect partner also hosted the joint NIM Chain / NMF Workshop on designing management systems and provided input for NMF modelling work.

Prospect has also contributed heavily to NIM Guideline #4 which addresses the coexistence of TINA and TMN. More specifically this guideline reflected aspects of Prospect’s CORBA/TMN gateway. Prospect also supported the NI Accounting Chain by presenting aspects of its accounting management system of information services.

Within Domain 5, Prospect was very active in organising the IS&N’98 conference. A Prospect partner was responsible for the organising and mentoring of all service management papers for the conference.

Prospect is a frequent contributor to the IS&N Newsletter and project representatives have given presentations at several Domain 5 plenary meetings and workshops. Prospect has been an active member in the Communications Management Cluster of Domain 5 which has resulted in collaborations with MISA and TRUMPET and has also participated in Service Engineering Cluster meetings.
4 Main Achievements

4.1 Overview

Prospect completed the development and execution of Trial 2. The development of the Trial 2 systems was divided into two phases; Trial 2.1, which was completed in January 1998, and Trial 2.2, which was completed in stages in June 1998. The trials were conducted through a series of integration events, demonstrations and user trials. The work and achievements in the current reporting period are presented here in terms of their impact on the stakeholders identified as having an interest in the development, delivery and management of multi-domain services.

The primary beneficiaries of integrated, inter-domain management of networks and services are the Customer and Provider organisations involved in the operation of the services and the responsible Management Administration Personnel within these organisations. The End-Users of the services also benefit from the integrated delivery and management of the services that they use. The trial configurations implemented and operated in Prospect aim to exercise these human roles and to evaluate their experiences with the systems. An equally important beneficiary of the architectures, technologies and methodologies used in Prospect are the Developers of management system software. These may be the providers of services who develop their own management systems, or System Integrators who may undertake the development and assembly of the systems on behalf of the providers. The relationships between the human roles and the organisation types examined in Prospect are summarised in Figure 1.

As shown in Figure 1, several subtypes of service provider may be distinguished according to the specific service types they offer. In the Prospect business model, four different types of providers have been identified. A Network Operator offers plain connectivity services, e.g. ISDN or ATM connections. A Communications Service Provider extends and enhances basic connectivity services to provide managed, end-to-end communications services over several network administration domains, e.g. Extranet services. A Tele-service Provider offers value-added, distributed application-based tele-services, e.g. a multimedia conferencing service or an information retrieval service. Finally, the Composite Service Provider uses several existing tele-services in order to compose its own service offerings.

The business situation adopted for the Prospect trials consists of a Composite Service Provider delivering a Tele-Education Service (TES) to users using an array of different tele-services. These services are:

- A Hyper-Media (HM) service, providing secure, accounted access to WWW servers.
- A Multimedia Conferencing (MMC) service, providing a secure, accounted IP multicast based, desktop conferencing service.
- A Web-Store (WS) service, providing upload services to WWW servers.
These services are composed into a one-stop-shop TES in two ways, either from different services operated by separate Tele-service Providers subcontracted to the TES provider, or from different services provided directly by the TES Provider. The former approach, adopted previously in Trial 1, was used in Trial 2.1a, while the latter approach was that adopted in Trial 2.2a.

In addition, a Virtual Private Network (VPN) Communication Service is used to provide an end-to-end Intranet service connecting the TES Service Provider and its Customers. This is provided to the TES Provider by a Communication Service Provider, termed the VPN Provider. The VPN Provider in turn uses an ATM Network Operator’s Virtual Path (VP) management service for links between Customer Premises Networks (CPNs) and those of other parties involved in the delivery of the Tele-Education Service. This vertical integration of Network Operator, VPN Provider and TES Provider has previously been the subject of Trial 2.1b and in the reporting period was enhanced in Trial T2.2b.

Figure 2 summarises the relationships between these providers and the related user roles, as developed in the different trial systems active in the reporting period. The following paragraphs detail the work and achievements of the current reporting period in the context of their impact on the different stakeholder types.

### 4.2 Prospect Stakeholders

#### 4.2.1 Service Customer

The chief aim of the Customer stakeholder in an open services market is in obtaining cost-effective telecommunications services for its end-users. In addition to the charged cost of the service, the major factors contributing to the overall cost-effectiveness of a service are: the internal cost of administering the service and the ease of use for service end-users. Prospect has addressed these factors in the following ways.

An on-line management application for the TES Customer, enhanced from Trial 1, was used and evaluated in Trial 2.1a. The application accesses a Subscription Management component that operates in the TES Provider domain and which is based on designs from the TINA Service Architecture. The application allows the Customer Administrator to check details of subscription contracts, of services subscribed to and of tariffs related to those subscriptions. Its principal use in Trial 2.1a was for the
management of customer user groups. The Customer Administrator is able to use the application to authorise or bar users as students on different TES courses. In Trial 2.2b the same application was used to add and remove customer network sites from the network. Accessing such management information on-line reduces the cost to the Customer of administering the service.

**Trial 2.1a: Customer Management of Multi-domain Composite Service**

**Trial 2.2a: Management of Composite Service with PCS**

**Trial 2.2b: Integration of Service and Network Management**

The usability of the Customer and End-User applications was supported by implementing the applications as CORBA-capable applets run in a commercial WWW-browser. These applets provided a common framework for delivering both composite services and management services to the users in Trial 2.1a and Trial 2.2a. This framework consisted of service independent applets used for user
authentication and session control for all services, together with a set of TES- and tele-service-specific applets that integrated the presentation of the specific tele-services, i.e. the HM, MMC and WS services, to the user using a suitable pedagogical metaphor.

For Trial 2.2a this user application framework was further enhanced with service independent applet support for the location of remote users and for inviting them to participate in a service session. Users can be located either by specifying a user specific identification, or by specifying a user role. In the latter case the calling user will be put in contact with someone designated to be currently fulfilling this role.

### 4.2.2 Service Provider

As an abstract stakeholder in an open services market, the chief aims of the Service Provider are to reduce the cost of providing services, to achieve excellence in customer service and to quickly introduce new services. A major cost of service provision is that of Service Management. This cost can be reduced by the automation of service management processes and by the automation of the interactions between such processes.

The Prospect trials demonstrate such automation in several different service management functional areas. Trial 2.1a, 2.2a and 2.2b all contained the TINA-based component for automating Subscription Management. In addition, service providers in Trial 2.1a also operated a TINA-based Accounting Management component. This interacted with the Subscription Management component to determine tariffs that applied to different customers and services. In all user service interactions, the Subscription Management component was responsible for ensuring that only suitably authorised users could use specific services, while the Accounting Management component was used to record the usage of a specific service by a user and to generate from this suitable billing information.

Further management functional areas were also addressed by automated components. An extension to the Subscription Management component for Trial 2.2b allowed it to record information on Service Level Agreements (SLAs) and performance reporting requirements, based on NMF information models. This allowed SLA threshold information and SLA violation-related accounting information to be associated with individual customer subscriptions. This therefore supported automated interactions between the Subscription Management, Accounting Management and Performance Reporting components when dealing with SLA violation detection, and its impact on customers’ bills. In Trial 2.2b, the Performance Reporting component interacted with yet another management component which handled trouble tickets. This is based on a commercial trouble ticketing system, which in this application enables the service provider to record and track instances of SLA violations reported by the Performance Management component. The immediate availability of such information to the Service Provider’s customer care personnel greatly improves the provider’s ability to provide customer satisfaction, while automation of activities such as trouble ticketing reduces the cost of delivering this level of customer satisfaction.

Any interactions between the Customer Administrator and management components in the Service Provider’s domain requires appropriate access control for the security of the interactions. This has been supported in Prospect by reusing the same TINA-based session control component that was also used for user service interactions. This provided authentication of management users using dual key cryptography authorisation and the Subscription Management component for access control checks. Access control was then applied by instantiating a management-specific User Service Session Management component, which mediated any inter-domain interactions.

A Service Provider also requires some management capabilities over the behaviour of services used by users. Such management is categorised as either service dependent or service independent depending on whether the service behaviour it is managing is service dependent or service independent. Examples of service dependent service management capabilities are the specific management functions available for the WebStore service. Service independent service management includes the accounting of different
types of service sessions and the ability to control users’ access to specific service profiles via the subscription management component. Personal Communication Support (PCS) is a service independent extension to service functionality introduced in Prospect for Trial 2.2a. This extension supports the location and calling of users via a user identifier. In addition to the PCS capabilities, a Role Management component has been developed to allow users to be located and called using a role identifier. Additional service management applications have therefore been developed to allow the Service Provider administrator to create and manage roles used for role location, associate particular users with specific roles and activate or deactivate role holders.

4.2.3 Composite Service Provider

The Composite Service Provider provides services to its customer that are constructed through combining several distinct services. In Prospect the TES Provider acts as the Composite Service Provider. These constituent services may be provided by separate providers subcontracted to the Composite Service Provider, as demonstrated in Trial 1 and Trial 2.1a, or they may be separate services provided by the Composite Service Provider, as demonstrated in Trial 2.2a. Both approaches benefit from the use of reusable components with open interfaces. In the case of subcontracted services the availability of open interfaces between the Composite Service Provider and the subcontracting Service Providers greatly eases the interaction of the Composite Service Provider with its subcontractors, in particular, the co-ordination of consistent service management information between them. In Trial 2.1a the use of open interfaces in different providers was implemented by the reuse of components that supported the open inter-domain interfaces based on TINA Service Architecture models. This greatly simplified the migration to the case in Trial 2.2a, where the Composite Service Provider operated all the constituent services itself. By using the same service independent components as the subcontractors had, the Trial 2.2a Composite Service Provider was able to integrate the services into its system with virtually no code modification. The same applied to the end user application software, which used the same open interfaces to the provider in both cases.

4.2.4 Communication Service Provider

The aim of the Communication Service Provider is to provide end-to-end connectivity in a multi-owner, multi-vendor, and multi-technology environment. This is all visible in the management of a Virtual Private Network (VPN). The VPN is an important example of a service which cannot be realised without multi-domain management solutions. Given the huge interest in commercial applications of the Internet, the VPN is also an important enabler for Internet-based business communications, with the ever increasing needs for Quality of Service guarantees across multiple network domains.

The network technology independent parts of the VPN management system were completed at the beginning of the reporting period. These have been integrated with the Session Control and Subscription Management components used in the other Service Providers, in order to offer the TES Provider a similar open inter-domain management interface. VPN configuration visualisation tools have also been developed to support the clear demonstration of VPN management.

The management of different network domains has involved integration with the Network Operator systems via the CORBA/CMIP Gateway and the development of VPN system components for managing Customer Premises Network components, i.e. private ATM switches, hosts and IP routers.

The design of the VPN management system has been enhanced in the reporting period to include Performance Reporting and Fault Management components. Based on the SLA defined in the subscription information model, the Performance Management component in the VPN is able to create a SLA violation when performance information received from the either ATM Provider or Customer Premises Network Provider does not satisfy the defined SLA. This SLA violation is reported to the TES Management System by the VPN. The Performance Reporting and Fault Management component is
integrated with the Trouble Ticketing component in the TES Provider domain, the Network Operator systems via the CORBA/CMIP Gateway, and Customer Premises Network system. VPN fault/performance visualisation tools have also been developed to support the clear demonstration of faults and SLA violations. The information received by the VPN is transformed into a displayable format (charts and figures) that is accessible from the VPN Provider Administrator interface.

An Inter-Domain routing algorithm has been introduced in the VPN to determine the route that should be used in order to satisfy the customer’s connection request. The routing algorithm supports the needs of the customer (offering lowest cost, best QoS connections, smallest hop count, shortest connection setup time, etc.). The VPN management system has also been enhanced to enable it to manage ATM/SDH-based networks via the MISA GBCM Xuser interface, accessed via the CORBA/CMIP Gateway.

A gateway between CORBA and SNMP has also been developed. The CORBA/SNMP Gateway allows for interaction between the VPN service and the CPN network elements in a generic way. Interactions include configuration of LAN equipment and notification of faults and SLA violations. The CORBA/SNMP Gateway is generic as it allows for the use of any MIB in an SNMP agent, and is dynamic as these MIBs can be loaded without restarting the gateway. The design of the CORBA/SNMP Gateway conforms to the JIDM specifications.

4.2.5 Network Operator

The chief aim of the Network Operator stakeholder is to provide network connections between its customers in a flexible, efficient and economical way. Apart from providing network connections the Network Operator provides management functionality to support the needs of its customers in terms of communication quality of service and behaviour in response to network faults. The ATM VP management service offered by the Network Operator is provided through a TMN Operations System (OS) giving a top level view of the different VP layer network administrative domains within the Network Operator’s domain.

The network model applied within the public network OS is based on the ETSI NA43316 Generic Object Model Library (GOM), which has been specialised to ATM technology. The fundamental idea behind the GOM network model is the breakdown of networks into subnetworks interconnected by links. This decomposition process stops at the lowest level where a subnetwork is equivalent to a cross connect. The network elements are managed through Q3 interfaces complying to the ITU-T standard I.751 for managing ATM network elements. Prospect has also aimed to promote a more decentralised use of network management models such as GOM. An issue when implementing a decentralised network management application is to allow for a distributed route determination process, and to allow for subnetworks at higher partitioning levels to make qualified route decisions concerning routes through an opaque subnetwork at a lower partitioning level. The concept of opaque subnetworks and associated concepts for the handling of these within a network OS provides the means to distribute the implementation of the network service at will. In order to facilitate opaque subnetworks Prospect has added route managed objects to the network model. Within the partitioning hierarchy the route management object allows subnetworks at higher partitioning levels to query route information from subnetworks at a lower partitioning level in order to make qualified decisions about which subnetworks a requested connection should be routed through.

Surveillance of faults in end-to-end connections is achieved by the introduction of a generic fault correlation function. If any of the managed objects that are involved in an end-to-end ATM connection changes to a faulty state, the managed objects which represents the end-to-end ATM connection will be put into a fault state by the correlation function. This concept has been developed in an entirely generic way, which allows the implementation to be reused in many similar situations without special programming effort.
The network management systems have also been extended to include X.738 scanning objects and the network elements emulate certain behaviour in order to readily demonstrate performance and fault management capabilities of the higher layers in Trial 2.2b.

A CORBA/CMIP gateway is used to bridge between the CORBA and the CMIS/CMIP technology domains and allows the VPN provider to access and control the service provided by the public CMIP based ATM VP service provider. By using the gateway the ATM VP service can be seen by the VPN as a CORBA based service offering. The gateway represents this service in the CORBA domain, by translating the GDMO model into equivalent IDL definitions and offering these IDL interfaces at its CORBA server interface. CORBA invocations on the IDL interfaces are translated into equivalent CMIS requests by the gateway and forwarded to the underlying ATM VP Network Management OS. The rules for mapping the GDMO specifications into equivalent IDL definitions are defined by the Joint Inter-Domain Management (JIDM) working group.

4.2.6 System Developer and Integrator

Competitive pressures in the open services market will mean that service and management software systems will have to be developed and integrated for less cost and at an increased pace. The software engineering process involved in developing such software is therefore key to the developers of service and management systems, and has been explicitly examined in Prospect. Methodological Guidelines have been provided for the designers and implementers of software systems used in the Prospect trials. These guidelines have been published as the NIM Chain Guideline #1 and recorded in more detail on Deliverable D22B. The guidelines specify an incremental, use case-based approach to system design, with particular emphasis on the separation of inter-domain and intra-domain interactions and the integration of common, reusable components into designs. The Unified Modelling Language has been adopted as a notation at all stages of the development cycle, with CASE tools used to support its use. The design documents for the systems and components composing the Trial 2 system model, which provide input to deliverable D4B (Trial 2 System Model) reflect the adoption of the guidelines in the project. In the reporting period the methodological experiences of the designers and implementers of the Trial 2.1 and Trial 2.2 systems were analysed and the results recorded in deliverable D53B.

The reuse of components developed for the Trial 2 systems has provided valuable experience to system integrators in the use of third party components, and in how to manage the evolution of these components in the face of changing requirements. This reduces development costs and shortens development cycles for new services. Also the effort needed for the integration and testing of the composite service is dramatically reduced by reuse.

4.3 Establishment of Practical Experiments and Demonstrations

The project has spent considerable effort in assembling service and management infrastructure to support practical experiments and demonstrations in this reporting period.

The experience from the earlier part of the project, culminating in Trial 1, showed that several aspects of the management systems being developed in Prospect could not be readily observed and therefore assessed through user trials. The structure of Trial 2 was therefore designed to allow the systems that were suitable for user trials to be developed in parallel with those systems that were not and were therefore presented to interested industrial parties through public demonstrations. Additionally, the systems that were involved in user trials were also included in some public demonstrations.

Trial 2.1a concentrated on the Customer Management of the Tele-Education Service operating over the different trial sites. Successful integration events have demonstrated the integration of the various
provider systems and user applications. A full international user trial was performed in January 1998 consisting of TES Customer Administrators managing the authorisation of students to different TES courses run over a week-long period. A key aspect of this part of the trial therefore was the co-ordination of the management interactions between the TES Customer and the TES Provider with those between the TES Provider and the various Teleservice Providers that were involved in providing the TES service. It was through this co-ordination that both the TES end user and the customer administrator were able to use the TES service and accompanying management services without any knowledge of the roles of the other Teleservice Providers involved in the provision of these services.

Trial 2.2 consisted of a series of internal integration events to demonstrate the integration of the PCS component and the Trouble Ticketing component. This has been split into two parts:

Trial 2.2a was from the end users point of view very similar to Trial 2.1a but provided the opportunity to thoroughly test two major changes to the underlying service and management systems. Firstly the provider systems had been reconfigured from the multi-provider scenario of Trial 2.1a to the single provider one of Trial 2.2b, with all servers now operating locally at DELTA. Secondly modification had been made to some of the DSI components to provide Personal Communication Support. Though the PCS features were not exercised by the users in the trial, the components were successfully tested.

Trial 2.2b concentrated on the vertical integration of fault and performance management, in particular on how an alarm generated by the network element propagates up to the TES Customer which receives trouble tickets reporting SLA violations. The operation of these systems was also shown at IS&N’98 conference. In Trial 2.2b Prospect successfully demonstrated two scenarios: fault and performance management, and configuration management across multiple administrative and technological domains.

Both the ATM and the CPN provider management systems reported fault and performance data to the VPN Provider. Based on this information, their management system then reported to the TES provider, if the SLA between these organisations is violated. In the TES Provider domain, trouble tickets were created for each customer affected by the performance degradation. Discounts were granted for these customers and the TES Provider Administrator informed the customers of all resolution activities until the problem was fixed.

In Prospect, a multimedia service is built on top of a VPN Service, which in turn was using an ATM VP Service. By using the Xuser interface from MISA, the Prospect VPN Service was able to use the MISA GBCM service in parallel to its own ATM VP service. The set-up was a typical example of the future open services market where a service provider (Prospect’s VPN) can base its service offerings on resources purchased from other organisations (Prospect’s VP Service and MISA’s GBCM). This scenario was also demonstrated at IS&N’98.

Network Infrastructure:

Reflecting contemporary trends in multimedia and information services, the services in Prospect are IP-based. All management system traffic, for both CORBA and CMIP, is also over IP. The network infrastructure requirements for Prospect are therefore for an IP network. The user trials and demonstrations of the Trial 2.1a system involved users at DELTA and TDK in Copenhagen, UCL in London, GMD-Fokus in Berlin and Broadcom and TCD in Dublin. The network infrastructure constructed for this consisted of IP unicast and multicast routers at each site, JAMES ATM VBR VP of up to 2Mbps between TDK, GMD, UCL and Broadcom and 2Mbps local leased lines to TCD and Delta. This international network infrastructure was also used heavily for the distributed integration and testing of trial software.

Trials 2.2a and 2.2b were conducted at just a single site due to the termination of JAMES services. Integration work and some demonstration was performed nationally in Denmark using the leased line between Delta and TDK, and internationally via N-ISDN. This latter work demonstrated the feasibility of accessing provider management and data services over a single 64kbps line. In demonstrations of the
trial systems involving integrated network management, the IP network had local ATM links providing the connections between routers.

**Service Infrastructure:**

The services used in Trial 2 run on both Win32 and Solaris operating systems. All user services are accessed via Netscape Communicator 4.0 and consist of a combination of applets and accompanying applications controlled from applets. The Multimedia Conferencing service uses the rat audio conferencing tool and the vic video conferencing tools from the MERCI project, controlled from Java applets. Up to fifteen PC and SPARC workstations have been equipped with audio and video devices for use with these tools. The Web-based HyperMedia and WebStore services use augmented Apache and Jigsaw Web-servers respectively. Access to all services uses SECUSE 5.0c for dual key encryption, with keys being held either in software Personal Security Environments or on chip-cards. Figure 3 shows the full computing network infrastructure used for T2.1a.

Management Infrastructure:

The Network Operator management systems are based on UHC’s Q3ADE TMN platform, while the management systems of all the other stakeholders use Iona’s Orbix and OrbixWeb CORBA implementations. For Trial 2.2 the different providers’ management systems use IIOP for the CORBA communication. Each Teleservice Provider system consists of around fifteen to twenty CORBA servers that are started statically and which locate each other through a common naming context scheme in the CORBA Naming Service. Certain components support data persistency through integration with simple databases as well as commercially available data-bases (e.g. Oracle RDBMS). The core management systems have been operated over periods of several weeks in support of integration events.
The vertical integration of Fault and Performance Management was a major task in this reporting period. The purpose of Fault and Performance Management in Prospect is to show a complete workflow initiated by the network element up to the TES Customer which receives trouble tickets reporting SLA violations. Figure 4 shows the infrastructure assembled for Trial 2.2b.

The TES Customer management application consists of Java applets running in Netscape Communicator 4.0 and uses OrbixWeb to access the TES Provider management system. The TES Customer also uses a separate commercial application, Remedy ARS, to view trouble tickets created by the TES management system in the event of network failures. The TES Provider management system is based on Orbix for AIX and is integrated with the Remedy ARS system.

The VPN Service Management system is based on Orbix for Windows NT. Java applets are used for visualisation tools for configuration and fault/performance information. A Java implementation of the Subscription Management component was reused and integrated with the VPN management application.

The management system for the public ATM network is based on UHC's Q3ADE platform for Windows NT, while the CORBA/CMIP gateway uses Orbix (also for NT) to provide the CORBA interfaces. Several web-based graphical user interfaces for visualisation of the ATM network topology and monitoring of the gateway have also been developed and integrated with the system.

The CPN management system uses Java and OrbixWeb and runs on the Solaris platform. A CORBA/SNMP gateway is used in order to control the ATM LAN switches. A graphical user interface has been developed which runs on Windows NT.
The CORBA IIOP protocol is used universally for communication between the different management systems; except for the Q-Adapters, Network OS and CORBA/CMIP gateway in the TMN system for the public network, which use the CMIP protocol.
5 Main Conclusions

The experience of developing the different trial systems in Prospect has resulted in a wide range of conclusions about the development of service and network management systems in an Open Service Market environment. These conclusions are summarised here in terms of their benefits to the different stakeholders identified in building the Prospect system.

The Customer Stakeholder:

The principles benefits for the Customer are in the provision of on-line customer management applications. This allows the customer administrators to access, and in some cases manipulate, certain management information on-line, thus making such customer-provider interactions cheaper and more efficient. Specifically, customer administrators in the Prospect trials were able to manage subscription information, viewing details of subscription contracts, services subscribed to and tariffs, as well as being able to authorise or bar users from services and add or remove customer sites from those connected to a providers network. By implementing these applications using CORBA-client applets Prospect has demonstrated how such sophisticated on-line management services can be made easily available to any size of customer.

The Tele-Education Service (TES) provider domain structure used in Prospect also benefited the customer by providing one-stop-shopping for all the services and management services provided to the customer. For management services, management interactions were propagated from the customer to sub-providers by the TES provider without the knowledge of the customer. For user services, the propagation and co-ordination of management services between the TES and its sub-providers ensured that users were able to access all the TES’s constituent services seamlessly, without being concerned with their multi-provider origins. For customers such one-stop-shopping enables access to a much wider range of service providers without a concomitant increase in service administration costs.

Another area addressed by Prospect was the configuration of the customer premises network for inclusion in the provider’s service network. The Customer was relieved of this activity by the Virtual Private Network (VPN) architecture, which integrated the management of wide area communication with that of the Customer Premises Network (CPN). In particular, the Prospect VPN-CPN management system benefits customers operating internal IP networks that they wish to connect securely over a broadband backbone to the IP networks of other organisations.

The Service Provider Stakeholder:

The Service Provider stakeholder benefits in general from the automation of service management business processes that are provided by the Prospect system, in particular those dealing with inter-domain interactions. The Prospect trial systems support several instances of inter-domain management information flows:

- Subscription management information between the TES Provider and its sub-providers and customers.
- Accounting management information from sub-providers to the TES Provider.
- Service Level Agreement violation information from the VPN Provider to the TES Provider.
- Configuration management information from the VPN Provider to the Network Operator.
- Performance and fault information from the Network Operator to the VPN Provider.

Automating these inter-domain interactions reduces the operating costs of the service providers concerned, and widens the opportunity for co-operation between providers.

Inter-domain information flows naturally needs to be secure. The Prospect system achieves this in most cases by enhancing a TINA based access and service session control mechanism, which incorporates mutual authentication and support for symmetric key distribution. This same mechanisms was also used
for all user interactions with the TES Provider systems. Such secure access is needed if companies are to be confident enough able to apply TINA technology and inter-domain management automation in critical commercial situations.

**The Composite Service Provider:**

The Composite Service Provider has an additional burden compared to those of a general service provider as it has to deal with many other provider organisations. In the Prospect system this problem has been reduced by using *open interfaces for inter-domain management interactions*. The availability of open, inter-domain interface definition encourages different providers to support these interfaces in their systems, and thus eases the task of a Composite Service Provider, e.g. the TES Provider in the Prospect scenarios, in interfacing with several different providers’ systems.

The presence of open interfaces also encourages the development of *commercial off-the-shelf components* that implement these interfaces. For a service provider, this can reduce the cost of supporting these interfaces and providing the functionality the interface supports. Prospect has developed reusable management components based on TINA subscription and accounting specifications, different implementations of which have been interchangeably reused in different service provider systems.

Such use of open management interfaces supports the combination of specialised or niche services in broader service offerings, or allows more specialised services to be offered by combining existing services in new ways. This opens up opportunities for service provision to a much wider range of companies, including SMEs, while the use of commercial off-the-shelf components minimises the cost of management and development for such organisations.

**The Communications Service Provider and Network Operator:**

A Communication Service Provider aims to provide *a seamless, end-to-end communications management service* for its customers. This means mapping different management services from a number of underlying Network Operators onto what appears to its customers as a single service. In Prospect this is performed by the VPN Provider through the use of an internal, distributed communication control model implemented with CORBA. This model satisfies the VPN customer’s need for a single network view, while being easily mapped onto different network technologies at either the network or network element level. This mapping is implemented on a per-case basis, with a new mapping gateways required for each new network or element interface with which the VPN must interact. The VPN also extends to the CPN, interacting with the data communications equipment typically found there through custom and generic CORBA/SNMP gateways. The latter enables the extension of this approach to a huge range of network devices.

The use of standard information models for these interfaces obviously eases the size of this task over a number of Network Operators.

When interacting with Network Operators, open telecommunications MIBS are used. The VPN system has been demonstrated to inter-work with both the Prospect Network Operator via the ETSI GOM interface and with the MISA GBCM system via its X-User interface. An automated CORBA/CMIP gateway has been used to perform technology inter-working in these situations. This is important to the Communication Service Provider which operates between the domain of advanced service providers where CORBA may dominate, and network operators where CMIP represents a large existing investment.

**The System Developer and Integrator:**

All the above stakeholders require systems to be developed and integrated with existing or off-the-shelf components. Even where open interfaces are involved, this task is complicated by the variety of sources from which interface definitions can be drawn. Prospect has used the development cycles of the various trials to exercise and refine a development methodology that can be applied in development situations involving many parties, e.g. system integrators, component developers, standardisers. The methodology
discards many existing telecommunication and distributed systems approaches, e.g. ODP viewpoints, in favour of approaches from the software engineering world, e.g. use cases and UML, that are more mature and have better tools support. The resulting guidelines will help system developers and integrators entering the Open Service Market.
6 Input to Standards and ACTS Guidelines

Prospect was Guideline Editor of NIM Guideline #1, “Methodology for the Development of Multi-Domain Management Systems”. Prospect has also made significant contributions to the NIM guideline #4 (TINA-TMN Coexistence), principally in the area of CORBA/CMIP inter-working.

The project liaised with relevant standards bodies. Representatives from Prospect are members of the NMF SMART Peer-to-Peer Service Configuration team which started its work in March 1996. The Prospect representatives have been able to contribute their experience in the area of multi-domain service management and the requirements on inter-domain management interfaces as a basis for the team's work.

The Prospect Methodology was presented at a joint NMF/NIM chain workshop in Dublin. The methodology was well received and included as background information in the NMF submission to ITU-SG 4 representing results from ACTS.

The detailed work on Accounting Management in Prospect was passed onto VITAL where it influenced their further modelling of TINA Accounting Management. This VITAL work was fed back to TINA-C and now appears in the TINA Service Component Specification.
7 Overall Impact, Exploitation and Dissemination of Results

7.1 Impact related to standards

TINA:
The project has drawn heavily on TINA specifications in its designs. Unfortunately, these specifications have taken a long time to evolve, and many are still incomplete. This together with the very closed mode of operation taken by TINA-C made it difficult for Prospect to track developments in the TINA architecture closely. Therefore, TINA specifications have been used to provide some architectural and structural ideas, but no attempt has been made to adhere to later TINA specifications as they emerged - indeed the mechanisms for achieving TINA conformance is still not clearly defined.

A major departure from TINA was in the mechanism used for controlling and managing the network. A pragmatic decision was made to use IP applications for user services, principally Web-based applications and multicast-based conferencing. This required the management of an IP network infrastructure, in the form of customer routers connected by an ATM VP backbone, forming a VPN functioning as a multi-domain Intranet, or Extranet. As there was no resource allocation capabilities available to applications at the IP level, there was no need for a link between service sessions and network connection control via communication session, as there is for resource management in TINA. Therefore, apart from being informed by some general concepts in the VPN design, the TINA Network Architecture was not used in Prospect. Furthermore a general analysis of the TINA Network Architecture reveals that its hierarchical and centralised nature would make any mapping onto the distributed routing approach of the Internet a clumsy one. The immaturity of current TINA-Internet integration work, especially in addressing scaleable, performance and deployment issues makes integration at the network level a major challenge.

In Prospect, the main source of input from TINA was version 2.0 of the Service Architecture (TINA-SA). This provided fairly detailed specifications for subscription and accounting management components, as well as for the access and service session control components with which they inter-worked. These were augmented to support IP-based services. The subscription management component was simplified to the extent needed to support simple IP services, as well as being augmented to handle SLA information, needed to interact with performance monitoring components. The accounting model component was also modified, to improve implementation efficiency and to support extensibility for new services. Some of these modifications were passed back to the TINA consortium via collaboration with the VITAL project. The service session control was greatly simplified by the removal of the service session manager. This was possible due to the absence of a need to control the communication session, and the delegation of group control semantics to IP multicast-based services. Therefore only a user service session manager was required. This reported service session usage to the accounting component, and enabled the user to use the session through the distribution of service specific usage tokens, e.g. WWW cookies, multicast addresses or encryption keys. The access session was also modified to provide user authentication, support for user location and invitation and use of personal profiles.

The separation of service independent and service dependent parts of the session control model, again inspired by the TINA model, proved a very valuable concept. As the interactions between the session control logic and subscription and accounting management were largely service independent, then using these components for different services required very little modification. Clearly identifying where a component is service independent and where it is service dependent is seen therefore as an important part of managing its reuse in different service management applications.

In a typical telecom service the main capability provided to users is that of being able to set up connections, between humans, humans and machines and between machines. As the TINA-SA is meant
to cover all information and telecom services it obviously must be able to accommodate such typical telecom services as VPN. To test this, and to achieve insight into the principles of the TINA-SA, this architecture was applied to the Prospect VPN service. The main effort was centred around application of the session and concepts, in particular in the information and computational VPN models, and the subscription model. In order to apply the subscription model to the VPN, the subscription management component implementation has been integrated with the VPN service system. This demanded little extra effort as the subscription model concepts to a certain extent can be mapped directly to corresponding VPN resources.

Following the principles of the VPN integration architecture particular attention was paid to modelling inter-domain administrative gateway functions, such as authentication, authorisation, accounting and access control, by means of TINA’s session management components (e.g., USM, SSM). For these aspects, the TINA-SA did provide useful structuring and separation principles, thereby supporting the underlying assumption that such functions can be encapsulated and to a large extent separated from the core service functionality. It was however found that the application of the TINA-SA to what is basically a connectivity service, was not straightforward. The TINA-SA contains aspects of connectivity management (the communication session) but represented as kind of “platform service” (particularly relevant in case of “information services”), rather than as end-user service (which is the essence of the VPN service). With the VPN service we have thus experienced significant overlap of service core and service substance, and both of these and communication session concept.

The TINA development methodology was attempted, but not found to be successfully, partially due to lack of effective tool support and partly to do with the problems encountered with ODP discussed below. However, the component model of the TINA Service Architecture was found to be very flexible, supporting different stakeholder models in different trials with the need for very little reconfiguration.

TINA has not yet been widely accepted outside of the telecommunication research community. This may be partly due to its perceived overall complexity and confusion about whether TINA provides a component model or a set of reference points. In addition TINA tends to be regarded as a complete solution, and that a high level of conformance to a TINA framework is required to gain benefit from individual components. Prospect has shown that this is not necessarily the case and that TINA components can be integrated into less rigid solution frameworks.

IETF:

Internet standards based applications have been used widely in Prospect, from WWW and M-BONE related applications used in the TES services, to IIOP and CMIP over TCP being used for management traffic. Audio and video streams using IP transport over ATM was used very successfully in Prospect international Trials, based on the rat and vic conferencing tools. SNMP MIBs have been successfully used for managing ATM switches and IP routing configurations for integrated customer premises network management.

Prospect has, however, worked more closely in adapting some Internet specification to a DPE based environment. An IDL interfaces for accessing a server supporting conference announcements conforming to the Session Description Protocol has been developed, and could be used as part of a TINA to Session Initiation Protocol gateway in future. Some initial studies have been presented in extending TINA subscription and accounting management to interact with RSVP admission control via a gateway with the Common Object Policy Service.

OMG:

CORBA was applied widely in the project, and on the whole with success. The major problems with the OMA were found in using CORBA services. The services used, such as the naming service and the event service, did not seem well suited to inter-domain applications since they did not provide any form of fine grained access control. For example in the naming service it would be desirable to make name bindings related to inter-domain interfaces openly available, while those related to intra-domain interfaces should only be available within that domain. Prospect addressed this problem by placing inter
and intra-domain interface name binding on different servers and assuming that the intra-domain servers were behind fire-walls and not federated to the inter-domain name server. Similarly with the event service being used for inter-domain interactions, access to different event channels should be only available to specific clients. The recently defined notification service may address some of these problems with the event service.

The lifecycle service was not used partly because no suitable implementation was available, but also because suitable access control was not present, resulting in the use of specific factory objects as used in TINA.

NMF:
The Business Process model defined by the NMF has been used by Prospect as a broad reference, but has not been adhered to in specific detail. Some other NMF results have been used by Prospect for Performance Management (NMF701) and Trouble Ticketing (NMF501, NMF601). These documents provide valuable input in the form of requirements specification and information agreements.

In particular, the Trouble Ticketing component developed in Prospect is based on the NMF standard. However, the information model presented in NMF601 had to be adapted to the specific requirements of information service providers. Another result of this exercise has been that trouble tickets should only been created for reporting malfunctions and failures to the end-user of a service. For provider to provider interactions, a special reporting mechanism, based on the CORBA Event Service specification, was developed in order to accelerate fault propagation along the service chain. A commercially available system, Remedy ARS [Remedy], was easily integrated with the Trouble Ticketing component and was used to present the trouble tickets to the end-user.

JIDM:
The JIDM task-force (joint NMF and OpenGroup) has specified mapping rules covering the gateway processes between CORBA, CMIP and SNMP. These have been implemented in Prospect and the experiences so far proves their applicability. The existence of commercial needs for such gateway functionality has been experienced by the significant interest and number of inquirers from organisations outside the Prospect project.

ODP:

ODP was introduced into the project principally because TINA specifications were structured in ODP viewpoints. The Enterprise viewpoint, used to represent stakeholder, roles and high level scenarios, and the Technology viewpoint, both represented useful views of the system during development. The Information and Computational viewpoint, though useful representations in themselves, posed a problem in that they separated otherwise tightly coupled aspects of design. Changes in one of these two viewpoints usually led to changes in the other, and their relationship had to be analysed using additional dynamic models, e.g. sequence diagrams, before any implementation could be attempted. The lack of tool support for the representations in these viewpoints therefore made maintaining consistency between the viewpoints difficult. The Engineering viewpoint was also found not to be very suitable in this problem domain. Engineering viewpoint issues were dealt with in sufficient detail by the different platform used, e.g. CORBA, CMIP, WWW, and their inter-working requirements were either already address explicitly by bodies such as JIDM, or were straightforward enough, that recasting the platform description in a common engineering viewpoint language offered little benefit.

ITU-T and ETSI:

Some of the ETSI recommendations and papers around the Information Society and EII (European Information Infrastructure) has been used by Prospect for the analysis requirements of the OSM. GOM from ETSI has been used at the network level. The ETSI Generic Object Model consists of a library of objects which has been specialised to ATM technology. Through the implementation work it has become apparent the GOM model is feasible with respect to both connection management and fault
management. However, it takes large scale trials with a much larger network before it can be checked how well the concept scales.

**UML:**

UML was adopted in Prospect since it provided a unified notation for the different forms of expression already found necessary in the project development cycle, i.e. use cases, object diagrams, sequence diagrams and component diagrams. The fact that this was a unification of existing popular notations, that it was likely to become the de facto standard for graphical representations for software engineering and that it was being adopted by the OMG also favoured its adoption by the project.

Some shortfalls were encountered, however, in using UML. In particular it was not easy to represent multi-interface objects other than in component diagrams, where they were required to be components. The use of these multi-interface components in other diagrams, especially sequence diagrams was found cumbersome.

**7.2 Impact related to technologies**

**CORBA:**

The CORBA platforms used in Prospect were Orbix and OrbixWeb from Iona Technologies. This was found to work fairly satisfactorily. However several problems were encountered due to the complexity of configuring the platform, both for first time users and for applications requiring large numbers of servers. Interoperability with another CORBA platform, i.e. DSOM from IBM, was attempted, but was found, despite vendor claims, to present problems, therefore a single vendor solution was adopted. Performance for some applications of CORBA was found to be slow, but no detailed investigations were performed to determine whether the platform or the application code was the source of the poor performance.

Another issue that emerged in the project, and would make deployment of the Prospect system problematic, was ORB licensing. The Prospect UAP was co-resident on the user’s workstation with a local server representing the user (the ISM). This required the user to operate an ORB daemon, which typically requires the purchase of a license. Requiring the customer to bear this cost directly would not be acceptable in a typical service provision scenario.

**Java/WWW:**

The use of Netscape and applets for developing the user applications was found to be very effective. By ensuring the providers supplied appropriate CORBA-client classes for their remote service interfaces, the integration of the user application was greatly simplified. By providing the CORBA client classes with simple, open APIs, the user application development task was mostly concerned with constructing the presentation of the application to the user rather than with testing client server interactions. This was a definite benefit for the Prospect partner involved in developing the TES application for the trials.

This is a fast moving area of technology, so we are fairly confident that current problems, largely related to system access and communication restrictions imposed on applets by the browser, will be overcome in the near future.

**CASE Tools:**

Both Rational Rose and Paradigm Plus CASE tools were used in Prospect, mostly for UML-based modelling. Both were found adequate, with Rational Rose used more heavily for design and code generation, while Paradigm plus used more for analysis and design, reflecting their relative strengths. Paradigm Plus benefited from the ability to import models between different projects, thus supporting distributed usage well. Paradigm Plus was found inadequate in repository support for operation parameter types, which was supported in Rational Rose. The inability of Rational Rose to export models in an interchangeable format was seen as a major drawback.
7.3 Impact of Emerging Technologies and Architectures

During the project several areas of technology have emerged or improved. Though some of them have been incorporated into the Prospect system, the project did not have the opportunity to use other promising developments. Such developments are:

- Java: Improvements in applet technology, such as signed applets. Complimenting component model using JavaBeans. Using Java multimedia classes in the user application.

- CORBA Services: Commercial offerings of the Lifecycle and Persistency service would have been of use in the Prospect System.

7.4 Exploitation of Results

Internal exploitation of the following results will take place by the Prospect consortium:

The CORBA/CMIP Gateway complies to the rules for mapping GDMO specifications into equivalent IDL definitions as defined by the Joint Inter-Domain Management working group (JIDM).

The CORBA/SNMP Gateway is based on the specifications from JIDM which allows dynamic translation of CORBA requests coming from the VPN to SNMP PDUs.

An ATM network element management solution compliant to the ITU-T standard I.751 for management of ATM network element equipment has been developed in Prospect. The network level management component developed in Prospect is based on the ETSI GOM model for network level management. The work within Prospect has shown that this model can successfully be applied to networks of ATM switches.

The Prospect Virtual Private Network (VPN) is a service management system which provides end-to-end connectivity management services for a heterogeneous network infrastructure.

The Customer Premises Network Operations System (CPN OS) is a management system for a private CPN and is capable of working as both standalone system or as a client for the VPN OS.

Prospect defined three composite objects which in line with the NMF-MSF architecture to simplify and ease the use of the service provided by the underlying adapter objects defined by JIDM.

In order to demonstrate and validate the management solutions, a complex and highly demanding tele-education service has been constructed. This service is composed of many different components: Video-conferencing, web-browsers, shared whiteboards, animations, simulations etc. Two tele-educational environments have been constructed in Prospect, offering two different courses. The two environments are DELTA’s Virtual College, offering an introductory course in Asynchronous Transfer Mode (ATM) and TCD’s tele-education environment offering a RDBMS/SQL course.

This Prospect Design Methodology describes a rigorous design process for developing multi domain service management systems. The design process caters for: (i) multi domain management services (i.e. management services which span a chain of several service providers), (ii) inter domain management services (i.e. management services which cross a single administrative boundary between two service providers), and (iii) intra domain management services (i.e. management services used within a service providers domain, but which may be reusable/customisable in more than one domain e.g. subscription, accounting).
8 Self Assessment

Prospect has demonstrated, through a series of trial systems, the development of component-based service control and management systems across administrative, technological and architectural domains - a capability essential to success in an open services market. An intensive progression of integration events, user trials and public demonstrations have proven the operation and usability of these systems. Though this success has required appropriate expertise, flexible planning and good working relationships within the consortium, it has also required the development of suitable methodological approaches using state of the art object-oriented techniques. These approaches have already been captured and widely disseminated as guidelines.

Architectural and technological heterogeneity has been successfully tackled by the project in several areas, notably:

- The construction of integrated service delivery and management systems from reusable components.
- The integration of CORBA and TMN management through the CORBA/CMIP Gateway.
- The integration of CORBA and SNMP based management through the CORBA/SNMP Gateway.
- The integration of WWW and CORBA technology using Java in user applications.
- The augmentation of TINA Service Architecture models to support IP-based services and personal communications support.
- The integration of the management of IP and ATM networks in the VPN system.
- The integration of management components based on different standard models, e.g. TINA subscription and accounting management, NMF performance and trouble ticketing and ITU-T X.700.

Towards the end of the project has placed particular emphasis on the dissemination of its results through a number of publications and demonstrations. Prospect continued its liaisons with other ACTS projects. In particular, the integration with MISA’s management system which was demonstrated at the IS&N’98 conference in Antwerp was a good additional technical achievement for the project.
9 Annexes

9.1 List of Deliverables produced

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9.2 List of published papers

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