EURESCOM Services Platform

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Abstract - This paper presents the results of the EURESCOM Project 715. In February 1999, a large team of researchers from six European Public Network Operators has completed a two year period of co-operative experiments on a TINA based environment, called the EURESCOM Services Platform (ESP). This platform consists of a variety of CORBA implementations, hardware platforms, and Operating System configurations. The team has developed various multimedia services based on a subset of TINA's Service Architecture. P715 has also investigated stream management to realize the binding of audio-visual systems on the ESP. The interface uses a subset of the OMG stream service specification. The binding objects are integrated into the ESP, taking into account the TINA and OMG models for stream management to set up point-to-point bindings (H.320 & H.323) as well as multi-party binding (H.323). At present, P715 is probably one of the most important TINA test beds running between several Public Network Operators. P715 has proposed some modification of TINA's Ret Reference Point. A set of basic IDL interfaces for components in the User domain was defined and proposed for standardization within the TINA consortium. Furthermore, the experiences with the Rtr/3Pty specification and implementation have been inputted into the appropriate TINA work group. Finally, P715 has suggested a simplified implementation of the communications session management based on the "Control and Management of Audio/Video Streams", recently adopted by OMG.

I. INTRODUCTION

This paper gives an overview of the results from the EURESCOM Project 715, *EURESCOM Services Platform*. The main objective for this project is to validate the claim that Public Network Operators (PNOs) and Service Providers can benefit from distributed object technologies and middleware platforms. The EURESCOM Project 715 has built a Pan-European platform based on OMG's CORBA to show the capabilities of these technologies. The project has developed an experimental infrastructure for telecommunications service provisioning based on TINA's Service Architecture. The major aim of the project is technology assessment based on true hands-on experience gained through actual experiments. The objective is to show

to what extent TINA like systems can be built and interoperate using today's technology. The project has searched for TINA compliant products and off the shelf commercially available CORBA products. Where needed, the project has designed its own solutions and components, preferably according to emerging OMG standards.

The EURESCOM Project 715 has been carried out from February 1997 to February 1999. The partners in this project were BT - British Telecommunications plc, Deutsche Telekom AG, France Télécom, FINNET Group, KPN - Royal Dutch Telecom N.V., and Telecom Éireann. Besides management and dissemination of results, the project consists of four main tasks focusing on: *platform building, service architecture, stream management, and end-user services*. The vast majority of the budget of 325 Man Months has been used to run more than 52 experiments. Most of these experiments have produced results in the form of demonstrators. The project has organized six workshops, during which the demonstrators have been presented.

This paper is structured as follows. Section 2, gives an overview of the basic ingredients of the technical infrastructure of the EURESCOM Services Platform. The project has built a kernel Transport Network in which each partner is using its favorite hardware and CORBA implementations, i.e., a true heterogeneous, multivendor environment for experiments. Section 3 presents the results of work on Service Management. The project has performed a market scan on for commercially available Service Management products. We briefly present the results of interoperability experiments based on TINA's Ret and 3Pty/Rtr reference points. Section 4 presents the results of experiments with management of audio and video streams. The stream management experiments range from simple point-to-point connections to more complex multi-party stream bindings and an integration with the Service Management platform. In Section 5, we shortly describe a set of end-user services, which integrate the results of experiments on the basic platform infrastructure, service management and stream management. Finally, section 6 summarizes the achievements of the project, including down streaming of results into standardization organizations such as TINA.

II. THE EURESCOM SERVICES PLATFORM

A. Introduction

In order to achieve its objectives, the P715 project has created a distributed environment for experiments. The platform spans all the sites of the participating organizations. For object communication, the CORBA technology is used. A precondition for the project was to use the existing hardware and software infrastructure available at the sites of the partners. This has resulted in the interconnection of a number of different hardware- and operating systems, in particular different flavors of Unix systems and PCs running Windows 95 and Windows NT. These systems interoperate with a number of different ORB implementations. Additional heterogeneity was introduced because miscellaneous programming languages such as C++, Java and Smalltalk were used at the different sites (see Table I).

Name	Language
CoolORB	C++
NEO	C++
OmniBroker	C++
ORBacus	C++
Orbix	C++
Visibroker for C++	C++
Visibroker for Java	Java
OrbixWeb	Java
Distributed Smalltalk	Smalltalk

Table I ORB implementations used in P715

B. The ISDN kTN

The kernel Transport Network (kTN) is star shaped with a central router located at EURESCOM headquarters in Heidelberg, Germany. Single B channel ISDN connections are used between the different routers. Higher bandwidth could have been achieved by channel bundling, however the anticipated interoperability problems of the different ISDN routers prevented the project from implementing this.

The overview in Fig. 1 shows EURESCOM in the center, surrounded by the other six P715 partners. Every partner has access to the public Internet, but in addition a number of hosts are interconnected via an ISDN based network. For these hosts, IP traffic is transported over ISDN. The ISDN kTN has a star topology, with EURESCOM as its central hub. Connections between any two partners lead through this node. The dial-up connections are established only when IP traffic must be routed between partners. When there is no IP traffic for a while, connections are released.

Measurements were made to compare the behavior of the public Internet with the ISDN kTN. The most important result is that the response time for the ISDN kTN with two

Fig. 1. Integration of the partner sites with public Internet and ISDN kTN

hops (site X - EURESCOM - site Y) is nearly constant for a certain connection. The round-trip delay is about 100 ms. For the public Internet, these times vary greatly. Response times span from 100 ms up to 4000 ms. The disadvantages of the ISDN kTN are the relatively small (but constant) throughput of 64 kb/second and the long set up times (up to 9 seconds). Load tests with a number of simultaneous CORBA applications have shown that the kTN is very reliable. In more detail, the connection set-up times have been investigated in an extra experiment, which analyzed the performance of the P715-ISDN-Router Platform. For the ESP it was decided to rely on the ISDN solution and not to migrate to other networks because of the simplicity of the solution and the middleware focus of the project. For the proposed end-user applications, the available bandwidth was sufficient.

Besides the current kTN, which is based on IP over ISDN, the P715 project evaluated alternative technologies within two experiments. The first experiment aimed to evaluate the capabilities within the ISDN network for the interconnection of CORBA nodes. We used ORBacus [1] to implement GIOP directly over N-ISDN using the Open Communication Interface (OCI) [2]. It was relatively easy to achieve connectivity using a direct GIOP-over-N-ISDN plug-in for ORBacus compared to TCP/IP, PPP and router configuration problems. The connection establishment time reduces from 9 seconds to a few milliseconds. The plug-in technology and the selected transport protocol are transparent to CORBA applications, there is no specific code required at application level (same application code as with IIOP, except one initialization line). The second experiment aimed at using the information elements of signaling messages or further D-channel facilities for the exchange General Inter-ORB Protocol (GIOP) messages. These options have been explored but not used, because the required D-channel facilities are not offered in all countries participating in P715.

C. Federated Naming Service

The ESP includes a CORBA Naming Service for publishing and obtaining object references [3], [4].

Obtaining an object reference is an essential step for object interactions to take place. Fig. 2 depicts the top level of the naming tree as agreed by the project. In a WAN-ORB, such as the ESP, it is very important to decide on the location of the NamingContext objects. A single Naming Server, at a central location, could easily become a performance bottleneck. Therefore, the naming tree is distributed over several hosts. The distribution of the naming tree is facilitated by a wrapper, which ensures that local object references can be resolved locally, eliminating the need for a WAN IIOP call. Remote object references can still be retrieved, through the use of a central NamingServer. An additional benefit of the wrapper approach is that the overall system becomes more resilient against partial failures. If there is a temporary breakdown in the ISDN connections, or the machine running the global NamingServer has a breakdown, local objects can still be resolved through the local NamingServer.

D. CORBA services

The P715 project has investigated various other CORBA Services, i.e., the Object Transaction Service (OTS), Trading Service and ORB security. Within the scope of this overview paper, we cannot present the details of all these experiments. We restrict ourselves to a short description of the activities and the main conclusions.

As specified by the OMG, the Object Transaction Service (OTS), despite what is suggested by its name, is simply a 2-Phase Commit (2PC) protocol engine for distributed transactions and will require the help of the Concurrency Control and Persistence Services in order to properly insure isolation and durability. From the perspective of PNOs, the OTS has also some weaknesses, e.g., vulnerability of the 2-PC protocol, lack of support for the advanced transaction models, lack of real-time guarantees, and lack of an asynchronous transaction model. Except for the first one, these weaknesses are under consideration in various OMG's Special Interest Groups and Task Forces (such as ORBOS, Telecom TF and Real-Time SIG). We have investigated commercially available OTS products that may be of interest for telecommunication services. We have also setup a test environment to run interoperability tests. The main conclusion is that many OTS products do not conform to standards set by OMG. The OTS interoperability issues along with those involving other CORBA Services, emphasize the urgent need for public CORBA conformance and certification tests in order to keep CORBA products really open as stated in the OMG specifications.

Fig. 2. Naming Tree

P715 investigated available Trader Service implementations along with building up a trader federation. Three partners used the ORBacus Trading Service implementation and installed the trader successfully. Links were set up between the traders at the different sites. The test scenario dealt with real estates, where every partner could export real estate offers to their own trader using a set of GUI based applications, which were also used to link and query the traders. The experiment has shown that a trader federation proved a universal method to manage and advertise service offers to customers and third party providers. Problems occurred when traders were linked in a loop: offers were returned twice.

We have also investigated ORB security. The OMG's CORBA standard currently specifies two levels of security. Level 1 addresses the basic requirements, which enable the construction of secure systems. Level 2 security extends this capability with a variety of interfaces for specifying and managing security policies and domains. Level 0 (this is not an approved OMG term) corresponds to the provisioning of authentication and session encryption. This level (when it is achieved via the Secure Sockets Layer (SSL)) is currently being standardized by the OMG. The security experiment included an assessment of available products that support CORBA level 0 security. Two suitable products OrbixSSL and ORBacus SSL were found. Support for security is considered a mandatory requirement for a TINA Service Management platform, however at this point in time we have not integrated these products in our ESP.

III. SERVICE MANAGEMENT

A. Introduction

TINA (Telecommunications Information Networking Architecture) has been designed to support heterogeneity in hardware and software, multiple service types, consumer

Fig. 3. TINA Service Management related inter domain Reference Points

mobility (personal and terminal), and complex enterprise relationships in service delivery. The TINA Consortium has defined a business model for telecommunications in which a number of roles are identified, and a set of Reference Points which specify the interactions between these roles using OMG's Interface Definition Language (IDL), and informal semantic descriptions. Fig. 3 shows the TINA business model related to the Service Management Platform implemented within P715.

Here, the most important roles are the Consumer (end-user of services), Retailer (managing individual relationships with Consumers) and 3rd Party Providers (offering one or more services to a Retailer for resale). A single business enterprise may play one or more roles at any particular time.

The approach adopted by P715 is to take the TINA Reference Point specifications as a starting point and evaluate them by implementing a set of heterogeneous prototype service management platforms. The main focus is on interoperability between these platforms. The P715 activities on building a Service Management platform include a survey of actual commercial products, the implementation of a subset of the Ret Reference Point, the definition of the 3Pty/RtR reference Point, and an implementation of the 3Pty/RtR Reference Point to assess more complex interoperations.

B. Survey of commercial products

It is preferable, wherever possible, to build our service management platform using commercial components rather than be required to develop our own. During the course of this project two Requests for Information (RFIs) were issued on TINA-based and other service management products to all vendor members of the TINA consortium and several other suppliers. The first RFI was issued early in the project to identify possible products for use in building the service management platform. The most positive response was received from Alcatel (who have been strong contributors to the TINA Consortium and auxiliary projects for a number of years). A pre-commercial system was potentially available but the fact that it was built to an early version of the Ret specification limited its value to P715 in validating the TINA specifications. Alcatel are maintaining a

significant involvement in TINA, and intend to produce systems compliant to the latest versions of the specifications.

The second RFI was issued towards the end of the project to gain an update of the market situation on service management and related products. Although some time was spent in trying to identify the right contacts in the target companies, the response from this RFI was more disappointing than the first. Of those that did respond, only Alcatel and IONA could offer products which were of potential use to the P715 or subsequent platforms.

The lack of stable specifications explains the shortage of compliant commercial products. In addition, there will be some reluctance on the part of vendors to commit to standards-based products until there is a clear indication of a commercially interesting market.

C. Implementing a TINA Service Management platform

The main goal of the P715 activities on the TINA Service Management specification, is to achieve interoperability between multiple service management platforms based on TINA Reference Point specifications [5]. Each partner has implemented a service management platform (TINA Retailer) and a client (TINA Consumer). The computational objects implemented are Provider Agent (PA) in the Consumer domain and Initial Agent (IA) and User Agent (UA) in the Provider domain. We have adopted a pragmatic approach, implementing subsets of functionality required to validate specific usage scenarios, rather than attempting a complete implementation of the available specifications. The Ret Reference Point is divided into two parts, access and usage. The purpose of the usage part is to support interactions between consumer domain and provider domain components of a particular service instance, e.g., invite a third party to join a video conference session, and explicitly supports the TINA session model. The access part is considered mandatory for TINA compliance, the usage part is optional. In P715, we have concentrated on interoperability based on the access part, assuming for the

Fig. 4. Service Management Objects

moment that consumer and provider domain components of any particular service come from the same source and use proprietary communications within a service instance. The consumer domain service-specific component (ssUAP) must support interactions with PA's from different sources. For this reason, we have defined an intra-domain reference point between the PA and the ssUAP [6]. Fig. 4 shows the relevant computational objects that each partner has implemented in their own environment.

Key to our approach is that the service management objects were developed by each partner, independent of each other. This has led to a truly heterogeneous multi-provider test-bed for assessing the TINA reference point specification. A detailed description of experiences with the Ret reference point and the intra-domain reference point can be found in [7]. Experiences with the RtR/3Pty reference point and how the interworking between the partner implementation was tested, can be found in [8].

D. Benefits of a TINA Service Management platform

Our experiences with prototyping a set of TINA Service Management platforms and demonstrating the interoperability between these platforms, have helped us identify a number of benefits, both for consumers and providers. Our observation is that the applied technologies, such as CORBA and Java, are generally adequate for a real liberalised, open telecommunications market, which introduces benefits to all players.

For consumers, the implication of a service platform is that they get a choice between many Telecom operator (Providers) without changing their terminal equipment. This allows consumers to quickly switch between providers, for example to change to the cheapest provider, without

investing in new or additional equipment.

For 3rd party providers, the standardized interfaces between them and the retailer enables them to get services to many consumers. This means that 3rd party providers can offer their services to a potentially larger market.

Providers can not only provide their own services, but can also sell services provided by others. The implication is that a service can be provided through various channels. Providers can package service that fit the needs of their customers, thus attracting more customers.

IV. STREAM MANAGEMENT

A. Introduction

P715 has investigated stream management to realize the binding of audio-visual systems in the ESP. Stream management is used by the services on the ESP to bind audio-visual devices with a specified Quality of Service. To guarantee a clear distinction between service control and network control, there should be a clear interface between the service management architecture and the stream management architecture. In P715, this interface is provided by a so-called binding object, which can be accessed easily by the services on the ESP. This binding object takes care of the setting up of the streams, according to the required QoS.

In general, there are three methods to set-up audio-visual streams:

1. **First party control**, where one of the audio-visual devices sets up and controls the stream. First party control is the usual way to set up streams.
2. **Centralized control**, where the stream is set up and

Fig. 5. Setting up streams using hybrid control

controlled by a centralized party. The TINA Network Resource Architecture [9] suggests centralized control.

3. **Hybrid control**, where centralized and first party control are combined. A centralized party instructs one of the audio-visual devices to set up the stream. Interfaces for hybrid control are defined by the OMG.

P715 has chosen the hybrid approach (see Fig. 5). The hybrid approach has the advantage that existing products can be used, while still providing an easy interface to the service management architecture.

The interface that we have implemented uses a subset of the OMG A/V stream service specification[10]. We have implemented binding objects to set up point-to-point bindings (H.320 & H.323) as well as multi-party bindings (H.323) with a Multipoint Control Unit (MCU). The binding objects are integrated into the ESP, taking into account the TINA and OMG models for stream management. In the next section we describe our practical experiences with the implementation of the binding objects, as well as our experiences with the integration of these objects in the ESP.

The initial activities on stream binding include a point-to-

point binding object, which encapsulates H.320 and H.323. Section B describes this work. In section C this binding object is extended to support multi-party bindings. Finally, the stream binding object is integrated with the TINA Service Management platform in section D.

B. Point-to-point binding (H.320 & H.323)

Early stream binding work in P715 involved the implementation of stand-alone demonstrators, initially based on proprietary interfaces but later on based on the OMG A/V Streams specification. The selection of the OMG specification for stream binding was brought about by the need for a service layer view of streams allowing end-to-end connectivity rather than the network-centric view provided by TINA. Also the OMG specification is standards-based, which provides the potential for interoperability with future streams-based products. The first P715 demonstrator was built using the OMG specification utilizing traditional H.320 products (Proshare and Zydacron) to establish videoconference connections over basic rate ISDN. IP-based H.323 connectivity has been added in follow-on demonstrators.

The computational model of the stream-binding architecture is shown in Fig. 7. Computational model for multi-party

Fig. 6. Computational model of the stream-control architecture

stream binding. The figure also shows the sequence of operations used to establish a stream connection. The interfaces shown in the figure, StreamCtrl, MMDev, VDev and StreamEndPoint, are all OMG specified interfaces. A further interface, the StreamCtrlFactory, is not specified by the OMG, but is a legal addition as the OMG specification allows flexibility in the way the StreamCtrl is created.

For these stand-alone demonstrators, a means for requesting the stream binding was required. This requirement was fulfilled by a GUI to allow a user to request a connection between two terminals, one of which was usually (although not necessarily) his own. In the case of an H.323 connection, the bandwidth (i.e. QoS) of the connection could also be selected. A naming service (NS) was used to hold the Interoperable Object References, (IORs) of the MMDevs to enable the GUI to pass this information to the StreamCtrl when requesting a binding between them.

C. Multi-party binding (H.323)

The configuration shown in Fig. 6 restricts the stream binding to point-to-point, which is severely limiting for a video-conferencing service. A means to extend this to allow multi-point conferencing was therefore sought. In the case of H.320 conferencing over ISDN2, the use of a hardware multi-point control unit (MCU) would be required, which would be prohibitively expensive and difficult to manage. The alternative for H.323 conferencing over IP networks (LAN or ISDN2) is to use a software MCU, which are not only more realistically priced, but enable the conference to be managed through a remote user interface. P715 spent some time investigating the options for multi-point conferencing, and concluded that the most suitable solution was a software MCU from White Pine called Meeting Point.

The configuration for multi-party stream binding is shown in Fig. 7. In this case there are effectively a number of point-to-point bindings made between StreamEndPoints in the user terminals and the MCU. The MCU receives audio and video information from each client, performs a mixing function, and sends the resulting information to all the other clients in the conference. During initial tests of the H.323 client and server (MCU) software, it was found that whilst acceptable results in terms of video and audio quality were achieved over LAN connections, there were severe problems with the quality of IP over ISDN2 connections.

D. Integration of stream binding with TINA Service Management

The work on stand-alone demonstrators allowed P715 to develop a standards-based stream-binding capability using CORBA technology for point-to-point and multi-party connectivity. The next step was to integrate that capability into the service management platform. The overall

Fig. 7. Computational model for multi-party stream binding

architecture for this is shown in Fig. 8, and requires that the TINA components can communicate with the OMG interfaces to set up the stream connections.

It was found that currently defined TINA inter-domain reference points were unsuitable for this purpose, as they were situated at too low a level in the hierarchy. However, TINA has identified an intra-domain reference point (EE-Com RP) which is ideally situated between the SSM and CSM. This reference point mapped perfectly to the OMG StreamCtrl interface, which allowed the use of the OMG IDL for operations on that interface.

Thus the stream-binding demonstrators already developed could be integrated with the existing TINA-compliant platform by substituting operation requests from the GUI with those from the SSM. Other modifications had to be implemented to allow the client terminal to notify the Retailer whether the terminal could support streams-based services, and to allow the stream-binding information (e.g. object references) to be passed to the StreamCtrl interface. Following the integration of point-to-point video-conferencing into the services platform, a multi-party capability was added later.

TINA
OMG
P715

Fig. 8. Computational view on stream control in P715

V. END USER SERVICES

A. Introduction

One of the main reasons for adopting a TINA oriented distributed computing approach has been the promise of ease of development for new applications. To put this idea to the test one task was dedicated to the development of end-user applications. These applications would run on top of the EURESCOM Service Platform, ESP, developed within the other tasks of the project. In building end-user services there were a number of important aspects which had to be considered in relation to the platform developed within the project:

1. How easy was it to integrate the services developed with the TINA service management components developed within other tasks
2. The use of stream objects
3. Using object oriented design approaches to enable re-use and future extension of services
4. Having multimedia services running on the platform

All the final end user services implemented by the partners were installed at the partners' sites and tested across the platform. Each of the services addressed at least one of the issues above. All the services were developed with their usefulness in mind as well as testing the underlying platform.

From the outset it was important for the project to have realistic services available on the platform as this would be

the visible part of the output of the project. It is very difficult to demonstrate the components that make up the platform, however, it is possible to show the platform's usefulness if there are interesting and viable services running on it. The range of possibilities for the TINA based services platform is reflected by the diversity of services developed within the project

B. Surveillance Camera Application

This application was one of the multimedia applications accessible through the services platform. The Surveillance Camera Application was developed externally. It contains a server side comprising of the software and a motorised camera, DSP-board, and a frame grabber card, and the client software. The GUIs of the client and the server applications were developed by the Technical Research Centre of Finland (VTT).

The application software rights are external to P715, but the P715 members have the right to use and distribute the client binaries within the project members for research, experimentation, and demonstrations. The surveillance camera application was integrated with the service platform components, a step that was obviously required for each of the proposed services. Users of this application were required to install the surveillance camera application client software at the client PC.

C. Visualization of CORBA Systems

In keeping with the concept of having many diverse services

available for demonstrations this service was developed in order to aid visualization of the underlying components of the distributed services platform. Program visualization is an attractive way for understanding collaboration structures of complex distributed systems. It can help gaining insight in to how distributed systems work.

This particular tool visualizes the interactions of the CORBA objects that are operated on the EURESCOM Service platform. Such a tool can be used, for example, to explain how the Service Architecture works. In designing such a tool it was important to take into account specific approaches to visualize an open distributed system. Further details of the visualization tool can be found in [11]. It was decided to adopt a four-step process.

1. Event Collection
2. Event Processing
3. Storage
4. Display

Once a set of events are chosen, which give a full description of the actions performed in the system, they could be applied to the phases above giving an output which is displayed in a Java applet.

D. Distributed Scheduler

There are many schedulers in the market place today such as Microsoft Outlook and Netscape Calendar. These tools offer basic scheduling functionality at the desktop. However, few of these offer the ability to operate in a distributed environment. This was the prime focus of the *Distributed Scheduler* application. The aim was to develop a scheduler that would have all the normal functionality of one of the tools mentioned above, but the advantage of this application is that it could work across platform boundaries since it would be available on the EURESCOM Services Platform.

The objective of the Distributed Scheduler was to allow a user to enter their day-to-day activities onto a calendar and to schedule meetings/appointments whenever the need arises. The basic functionality is analogous to a traditional diary or calendar planner. When a user decides to hold a meeting/appointment, they enter the specific details. They must decide who they wish to attend this meeting, after which each of the invitees are automatically notified with the details. When a user schedules a meeting, each of the invitees own schedules are automatically updated with the day and time of the meeting. The Distributed Scheduler is a CORBA based application and uses a JavaBean as a GUI component.

E. Virtual World and Audio-Conferencing

These two applications were developed to fill the need for easy-to-use interactive end-user services. With the virtual world application several users can navigate a virtual world at the same time. Users can see each other and can interact with each other by means of a text chat as well as through various objects in the world that provide shared behavior. The shared space is a 3D virtual world. The VRML (Virtual Reality Modeling Language) was used to design 3D scenes, which can easily be downloaded from a server to the client machine and shown within a VRML-compliant browser. The VRML enabling browser used for this application was the CP (Community Place) Browser from Sony. Users of the application are required to download and pre-install the browser plus the VRML files associated with the virtual world.

The audio conference application aims to enable users attached to the ESP to set up an audio conference over the PSTN. The actual audio conference platform existed within BT from a previous project. It can dial several phone numbers on the PSTN and simulate an audio conference by mixing the speech channels. To access this platform from the TINA components developed in this project a gateway was developed by BT through which the two environments can communicate transparently.

F. Value Added Web in the ESP

Value Added Web (VAW) is a service that offers end-users the ability to access WWW-pages, which have been provided for by a Content-Provider, through a Retailer. The value added is mainly concerned with charging for multimedia content and potentially the ability to set-up dedicated end-to-end connections between Content Provider and end-user.

The VAW service combines technologies from the WorldWide Web, TINA and the OMG. The service demonstrates how IIOP and HTTP can be combined to provide more advanced services [12]

The VAW business model provides several benefits to the involved parties. Content providers can charge for valuable content, without dealing with complex billing processes and customer care. End-users can still use the traditional web, with its best-effort services, but in addition they can buy value-added services when required. This includes retrieval of valuable content, which is currently not on the web because there is no convenient way to charge for that. Furthermore, end-users can define QoS requirements on the content, such as delivery speed or audio/video quality in the case of multimedia content.

G. Supplementary Service Features

To demonstrate the full usage of the platform, more advanced features were added. These features include everyday applications like customer management, billing as well as the platform software administration applications. For these extensions it was decided that a database interface was required. The following is a complete list of the supplementary services:

- Online customer subscription management, this would be used by a consumer and an administrator
- Online service subscription management, to be used by the customer
- Service usage authorization
- Billing and accounting information handling

The service usage is divided in two main interfaces: subscriber/subscription and accounting interfaces. The first interface includes methods for user and service subscription management, the second interface includes methods for accounting information management.

H. Media on Demand T-Mod

The Media on Demand service T-MoD allows users the interactive retrieval and presentation of MHEG5 coded multimedia information such as movies, audio, still images, text and even games. The utilisation of MHEG5 impacts the functional architecture of the service. The service is separated into a Java based graphical user interface (GUI), the MHEG engine, the access to data storage and the transfer of multimedia data. The GUI and MHEG engine are downloaded and run in the user domain

The service has been completely integrated in the DT service platform, as one of the services offered by the DT retailer. The service platform also allows accounting for the used services and to display accounting information to the user.

5 CONCLUSIONS

The main achievements of the project are both the existence of a European platform, which to a large extent is based on distributed object technology, and the validation of the TINA Service Architecture concepts. At present, P 715 is probably one of the most important TINA test beds running between several Public Network Operators. This project demonstrates the possibility for different teams to develop a consistent set of service components thanks to strict interface specifications. The project has provided some concrete feedback to TINA-C (especially about the Ret and 3Pty Reference Points, see below). It suggests a simplified implementation of the communications session management based on the "Control and Management of

Audio/Video Streams", recently adopted by OMG.

The experiments on platform building have shown that it is possible to use a CORBA infrastructure for distributed telecommunication applications. The Naming Service is extensively used in the ESP to locate the initial agent for TINA applications. Other services such as the CORBA Trader and the Object Transaction Service have been examined. In particular the interworking between different products has turned out to be still a problem. These services as well as the security investigations have not been used in the ESP but the experiments delivered valuable results for other forthcoming projects. The ESP used an ISDN based kTN, which has turned out to be a good decision because it was quite stable and reliable, once it was configured. The performance of the public Internet can be much higher, but is not guaranteed. Using ISDN had the big advantage of constant test conditions with an acceptable response behavior. However, for downloading big applications a higher throughput would be necessary. The set-up of the ISDN communication was not always trivial due to difficult configuration at some of the partner's sites and differences between router products. Also, the IP configurations need to be performed very carefully because otherwise malfunction and asymmetric routing can occur. These situations were quite hard to detect. Better tool support would have been very helpful for the kTN administration.

The experiments on service architectures have shown that interoperability between providers in the delivery of telecommunications services to consumers through open interfaces is beneficial to both providers and consumers. P715 has constructed a set of service management platforms based on the TINA Service Architecture and compliant to TINA inter-domain Reference Points, to validate and assess these specifications. Commercial availability of components is limited as a result of the immaturity of detailed specifications. A stepwise approach to implementation has been adopted to validate essential components of the Ret Reference Point and interoperability has been demonstrated between five of the six partners. The project has already successfully provided input to TINA-C following the implementation work carried out so far. Partial specification of 3Pty/RtR Reference Points, as required by P715, has been undertaken and submitted to the TINA SARP Workgroup. This allows a Consumer to access services offered by a 3rd party, through a chosen Retailer

The project has demonstrated the feasibility of connection establishment using stream-binding techniques as specified by the OMG, in conjunction with a TINA-compliant service management platform (the P715 ESP). H.320 and H.323 A/V stream technology could be integrated into the P715 ESP by means of APIs of existing products. We have established point-to-point bindings (based on H.320 and

H.323) as well as multi-party bindings (based on H.323). During our work we encountered some interoperability problems between different CORBA platforms, due to the fact that we were often working on the edge of the technical capabilities of CORBA implementations. The platform suppliers however could generally solve these problems. Future work should focus on management issues such as fault and performance management. Performance management could be achieved by using such protocols as the Reservation Protocol (RSVP) or using a network layer such as ATM, which provides the ability to reserve a predefined bandwidth.

A total of ten end user services have been run on the platform which range from simple games, distributed scheduler, audio and video conferencing. Some legacy applications have been successfully integrated into the platform.

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