The EuroBridge Methodology for Telecommunications Service Specification

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Abstract In designing and specifying a system that will be used to provide telecommunications services to a user population, it is important to identify all major actors involved, and their individual concerns at an early stage and to carry this knowledge through to the design and implementation of the service. Within the RACE EuroBridge project efforts are underway to provide a a toolkit and a unified system architecture to support designers and providers of advanced multi-media network services. In this paper, we examine the approaches taken to service specification by the Intelligent Network (IN) community and the RACE Open Services Architecture (ROSA) project . We investigate the applicability of these techniques to the specification and design of multi-media services to be hosted on the EuroBridge Service platform and apply the ROSA approach to a simple video-conference specification. We further outline how it can result in a complete design that can be implemented on the EuroBridge Service Platform.

The EuroBridge Project

EuroBridge is a research project funded under the European Commission RACE (Research and Development in Advanced Communications Technologies in Europe) programme [CEC92]. The overall goal of the programme is to progress the introduction of Integrated Broadband Communication's (IBC) services within the community countries with the aim of achieving widespead availability of these services by 1995. A major part of the programme is devoted to the development of practical pilot services and is referred to as the Advanced Communications Experiments (ACE) project line. Within this area, multi-media is seen as a key technology.

In order to avoid unnecessary duplication of effort, a number of support projects were embarked upon to provide infra-structural support to ACE developers. EuroBridge is one such project, and it is tasked with the development of a common service platform, together with support methodologies and tools that will provide a communications infrastructure offering multi-point and multi-media capability. It should operate on a wide range of networks (e.g. ISDN, DQDB, FDDI, ATM), and hide heterogeneity from applications which use its services. The system architecture of the EuroBridge service platform is based on the OSI reference model, using the ISO Development Environment (ISODE) as a starting point.

The design of a new IBC service is complex in that it must operate with very high availability, across many different network types, and may involve many different organizations. To tackle this problem effectively, it is essential that IBC service designers have effective methodologies available to them to ensure completeness in requirements gathering, functional design and implementation. In EuroBridge, we have studied methodologies conventionally used in telecommunications service design, and applied them to the specification of multi-point, multi-media services. The following sections will describe the methodologies employed by the Intelligent Network (IN) community and the RACE Open Services Architecture (ROSA) project, and employ the latter in the design of a typical EuroBridge service - interactive video-conferencing.

The Intelligent Network Architecture

The concept of the *Intelligent Network* originated in the late 1980's arising from the development of more sophisticated mechanisms for carrying signalling information between switches [Jab91] in the public switched telephone network. Implementation work has begun in France [CK92], Germany [KSH92] and the U.S. [BB92] among others, and the CCITT has developed the Q.1200 [CCI91a] series of recommendations for release in their *White Book* to be issued at the end of the 1988-1992 study period.

The Q.1200 series of recommendations is structured into a number of groups: Q.120X defines the *Intelligent Network Conceptual Model* and each recommendation, Q.1201 up to Q.1209 defines sections of this model in a general manner. The evolution of the intelligent network is seen as a controlled transition from today's public network systems by the introduction of Capability Sets which represent a range of network services that would be introduced in a single phase. The first of these is Capability Set 1 (CS-1) [CCI91b] and each aspect of this is defined in Q.121X series. The scope of CS-1 encompasses new services that can be used to enhance the various switched networks during the call setup [DV92,CCI91b] phase, little (if any) impact will be made on the *active* phase of the call.

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Examples of the services envisaged are Conference Calling, Televoting, Virtual Private Network etc.

In the evolution towards the ultimate goal (referred to as the Long Term Capability Set), the intelligent network will introduce CS-2, CS-3 etc. in sequence. It is envisaged [DV92] that CS-2, on which work will start sometime in 1992, will address new services within the *active* phase of the call, and will include *Multi-Point* and *Multi-Media* services.

The IN Conceptual Model

The Intelligent Network conceptual model looks at the network and its associated services as a set of four *planes* where each plane represents a different abstract view of the functionality. The ability to take a restricted view of the system as a whole means that a designer can focus in on a limited number of concerns which will assist in achieving an optimal design and associated implementation of the service.

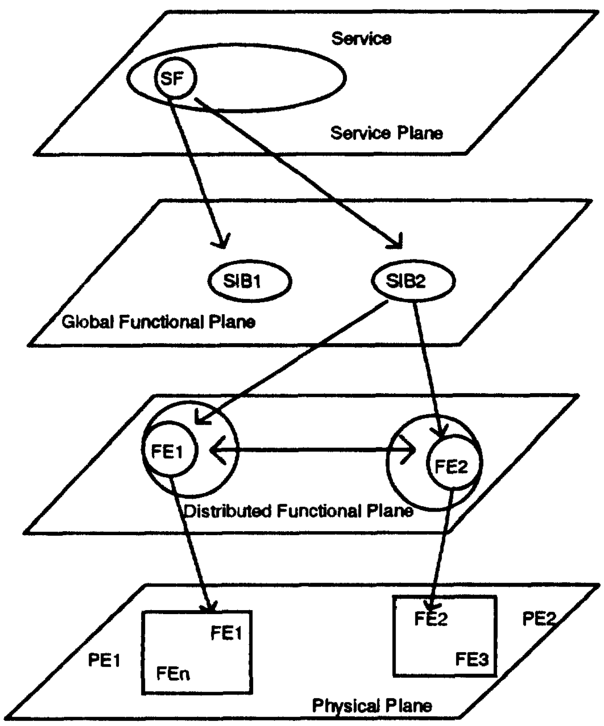

Figure 1 The Intelligent Network (IN) Conceptual Model

The scope of each of the four planes is as follows:

Service Plane: This plane contains *no implementation information*. Rather it attempts to subdivide the overall service into *Service Features* each of which represents a set of interactions with the user of the service.

Global Functional Plane: Here, the functionality involved in a service is modelled from a network-wide point of view. It is assumed that a library of general purpose re-usable components known as *Service Independent Building-blocks* (SIBs) are available or will be constructed as required. Each service feature identified in the Service Plane can be refined into a collection of SIBs glued together with some combination logic known as *Global Service Logic*. Backwards compatibility is maintained with the existing network by modelling the current call-processing functionality as a *Basic Call Processing* (BCP) SIB.

Distributed Functional Plane: In this plane, the concept of distribution is introduced. The network is modelled as a collection of *Functional Entities* which implement *Functional Entity Actions*. These FE's are indivisible, and all of an FE must be located on a single node in the physical realisation of the network. What was identified as a single SIB in the plane above must be mapped into a set of FEAs implemented in a number of different FEs at this level. As yet, no details of links used, or protocols involved in communications have been specified. The concept of the functional entity, as well as the nature of those FEs identified in the IN standards is clearly an attempt to allow new IN services to be integrated as modules into the existing switch fabric with the minimum amount of disruption.

Physical Plane: At this point, the functional entities are assigned to particular nodes (Physical Entities) in the network, and protocols and physical links are associated with the interactions between the FEs.

The main goal of the 4 planes in the IN Conceptual Model is to define 4 different levels of abstraction at which the service can be viewed, in the hope of achieving an optimal design with the maximum possible amount of reuse. One of its disadvantage is that in striving for a phased transition from the existing technology base to the desired intelligent network, it contains many concepts that are not applicable to and may hinder the deployment of new (non-voice) services.

The ROSA Architecture

The RACE (R1093) Open Services Architecture project [WPQ91] adopted some principles of the Intelligent Network approach, and was also influenced by work within OSI, ANSA and ISO's ODP. The ROSA methodology which provides an approach to service specification in IBC has also adopted a 4-plane model. It differs from the IN model in two major respects: firstly, the elements of IN that were introduced to deliberately reflect current practice in handling voice traffic have been largely removed, and secondly, the notion of Object Orientation is introduced.

The planes in the ROSA conceptual model are described individually below:

Service Description: This corresponds to the Service Plane in the IN model. Since this is a *description* rather than a *specification* it is expressed informally. The purpose of deriving this description is to identify the major actors in the system, and to look at the service from each distinct point of view. The behaviour of human users is modelled by *activator* objects [WPQ91]. The technique of *stake-holder analysis* taken from ISO's ODP is used to ensure completeness. This will be described in more detail later.

Service Level Specification: At this level, the objects identified in the service description are expanded and the interactions between them fully refined. The information can be captured using object interaction, decomposition and description diagrams.

Logical Level Specification: Each object identified at the service level can be structured into component object types that can be distributed on different nodes of the network. This corresponds to the Distributed Functional Plane of the IN conceptual Model, but there is no concept of named Functional Entities into which the different services must be incorporated.

Realisation Level Specification: This final plane defines how the various objects at the logical level can be mapped into a physical network composed of heterogeneous systems.

ODP Viewpoints

One of the strengths of the service description methodology in ROSA is the use of the *viewpoint* concept taken from the ISOs Reference Model for Open Distributed Processing (RM/ODP). Any service will involve participation by a number of different actors e.g. service users, network providers etc. RM/ODP attempts to recognise these different interests by defining five viewpoints [Pro92]. These viewpoints are pragmatic tools, each leading to a representation of the system with emphasis on a specific concern.

The viewpoints identified by RM/ODP are as follows:

The **Enterprise Viewpoint** defines how the service will interact with users and clarifies business policies and the environment in which the service interacts.

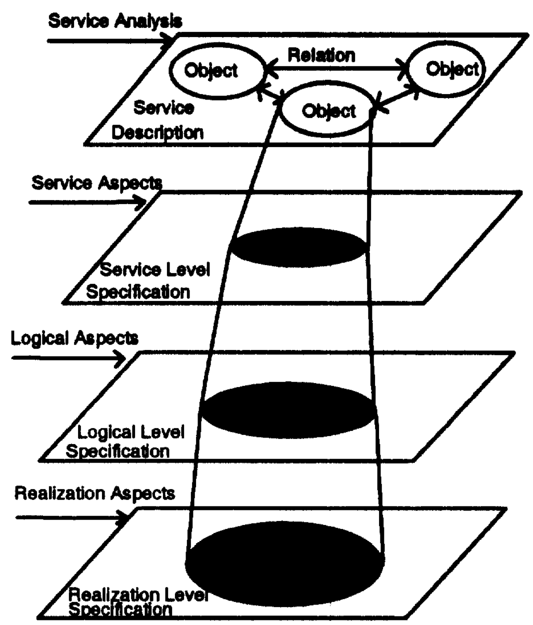

Figure 2 The ROSA Conceptual Model

The **Information Viewpoint** looks at the information sources, sinks and repositories, as well as the information flows between them.

The **Computational Viewpoint** examines the programming environments, tools and services used to automate the service.

The **Engineering Viewpoint** examines the engineering mechanisms used to enable the distribution of programs and data.

The **Technology Viewpoint** deals with real world artefacts from which the system is constructed.

Each of the viewpoints has an issues list called "*Aspects*" which includes: Security, Management, User Access, Identification, Storage, Process and Communication.

Many of these viewpoints and aspects are incorporated into the ROSA methodology in the different planes. At the Service and Logical level, we are primarily interested in the Enterprise and Information viewpoints.

Towards a EuroBridge Methodology

The EuroBridge Project is charged with developing the *EuroBridge Service Platform* which will facilitate the fast development and deployment of advanced services in the IBCN. Within the prototyping work involved in the platform development, there is considerable emphasis on the use of layered network architectures including RM/OSI and TCP/IP.

Within the project, there is a need to adopt a consistent methodology for service description and specification that will take into account the differing views of network operators, service users and service providers. The ROSA methodology offers a sound basis for this, but as it originated in the domain of telecommunications, it does not recognise the contribution that can be made by existing application level services in OSI.

Since many of the Application Service Elements in OSI were developed in the absence of object oriented techniques, it is important that the use of ROSA does not impede the incorporation of ideas from within the OSI domain: specifically, it should not impose an object-oriented implementation style on the services that are specified. While it is appropriate to use techniques such as *inheritance* at the higher levels of service specification, this may prove to be an obstacle if used at the lower levels.

The object-oriented notations used within the ROSA project have been designed with a view to developing a total support environment that would allow implementations to be generated from specifications. This provides the primary motivation for the design of such notations as ZOO and COOLish. Such support environments and tools will not be available for use within the time-frame of the EuroBridge Project. This means the notations used within the project will serve as a means for clarifying design features, and for communication purposes between partners. Accordingly, it is appropriate that the project confine itself, in the main, to informal textual and graphical specifications.

The use of the ROSA methodology will have a number of important impacts on the work of the EuroBridge project. By describing services at a very high level in the first instance, the service designer should be able to:

- Avoid imposing implementation details too early in the process.
- Gain a complete view of all aspects of the service from the point-of-view of each of the actors involved.
- Develop Service Level objects that can be reused in subsequent service designs, and form an fundamental part of the EuroBridge Service Platform.

The use of Logical Level specifications can take place in conjunction with a library of *objects* representing existing OSI and TCP/IP application service elements. It will allow:

- The easy reuse of existing technology e.g. RDA, FTAM, FTP, etc.
- The development of a wide range of Logical Level object types that can form part of the EuroBridge Service Platform.
- The realisation of the different logical objects using appropriate technology in either a computing or telecommunications context e.g. a given logical object could be realised over an OSI protocol stack, or CCITT SS7 TCAP.
- Better engineering of the distribution aspects of the service

Finally, the realisation level specification can be used to ensure that services developed using the EuroBridge service platform will be easily portable over a wide range of computing and networking environments.

Using ROSA in the EuroBridge Context

In order to illustrate the utility of the ROSA approach in the EuroBridge context, we have applied the methodology to the specification of a key EuroBridge service: interactive video-conferencing. This example illustrates how the methodology can be used to specify new multi-point, multi-media IBC services, while making maximum use of existing OSI Application Service Elements.

Outline Videoconference Specification

This example exercises the ROSA design methodology in the definition of a simple video-conferencing service. The intent is to show what issues are dealt with at each level in the specification process, rather than to attempt to produce a complete design.

A brief commentary now follows for each of the four planes (Service Description, Service Specification, Logical Specification and Realisation Specification) of the ROSA method.

The Service Description

At this early stage, all of the actors involved and their interactions with the service are identified. A distinction is made between the provider of the network service, and the entity providing the conferencing service, but in reality, these may coincide. Service customer and service user are also shown separately. This is done to isolate the technical concerns of service provision from the administrative relationships that may exist between a provider and his customer.

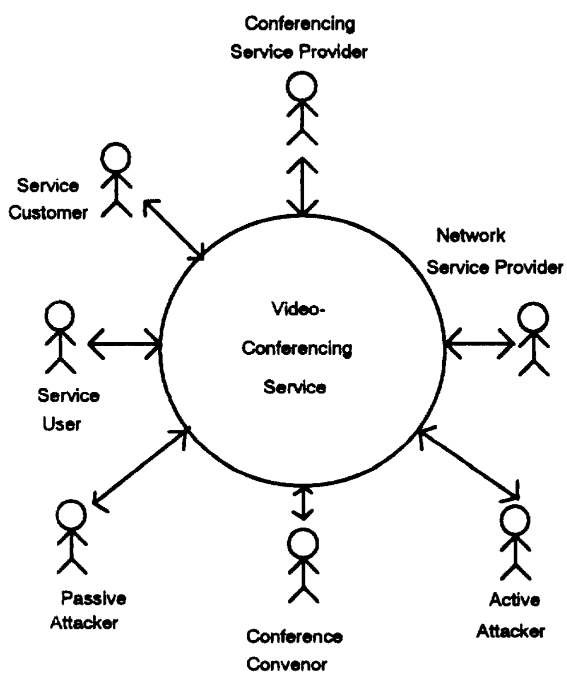

Figure 3 Video Conference Service Description

The conference convenor has the ultimate responsibility for which parties may take part in the video-conference. In so far as he may wish to take part himself, he will do so as a *Service User*. To highlight the security concerns, two forms of attacker are shown, the first of these is *passive* and will engage purely in *eavesdropping*, whereas the active attacker may attempt *masquerade* or other more intrusive forms of attack. The actions of these actors will not be refined further in this outline model.

The Service Specification

At this level, the service is broken into distinct objects, and detail is added (including naming the operations and their parameters) to their interactions. Humans in the system are modelled as *Activator* objects. No distribution aspects are addressed yet.

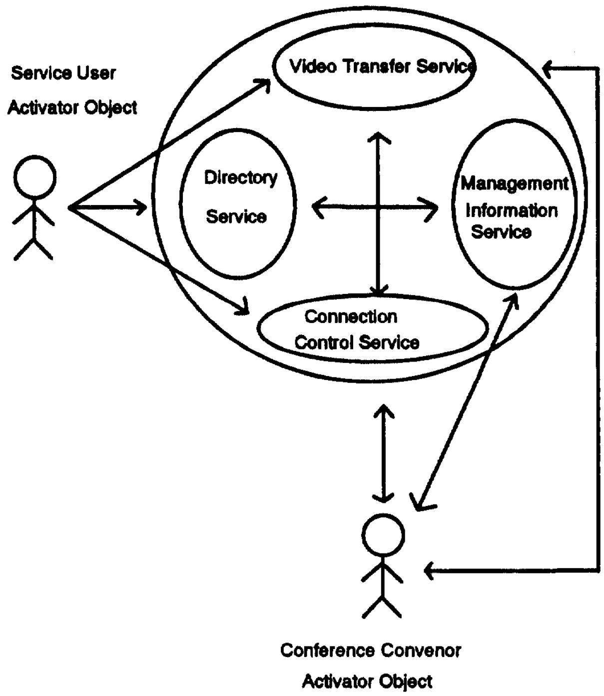

Figure 4 Video Conference Service Specification

Logical Level Specification

At the logical level, the objects are refined to a degree where they can be distributed on distinct nodes. Since there can be many different types of hardware used, these aspects are still modelled as the generic *Video Source/Sink*. Protocols to implement the interactions between objects have not yet been specified.

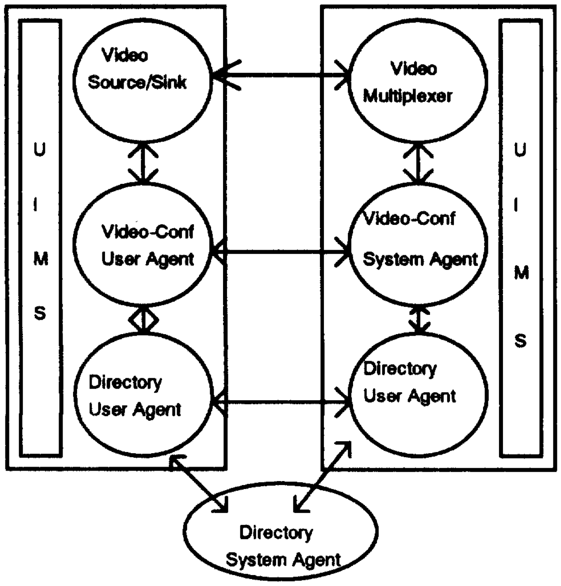

Figure 5 Video Conference Logical Specification

The Realisation Level Specification

Finally, the objects identified in the level above are assigned to specific nodes, and all protocols used for communication must be identified. This specification shows the equipment used at a user site, and that of the conference convenor. Standardised OSI application service elements are used for setting up associations (ACSE), invoking remote operations (ROSE), and supporting directory services (DASE) for user authentication and contact support. A new ASE has been defined to support video-conference related operations (e.g. join_conference,leave_conference etc).

All of the OSI ASEs run over a complete OSI protocol stack, whilst the video information is encoded as a H.261 (Nx64K) data stream, passed through a conversational stack, and carried using per-arbitrated slots on a DQDB (IEEE 802.6) MAN which serves as the user network interface of the IBCN.

Video streams from all participants are sent to the conference convenor's node, where (at the discretion of the convenor), they are combined in a video multiplexer and the resulting video stream returned to all sites. For simplicity, the convenor is located at the same physical node as the video multiplexer hardware, but a remote interface could be easily defined.

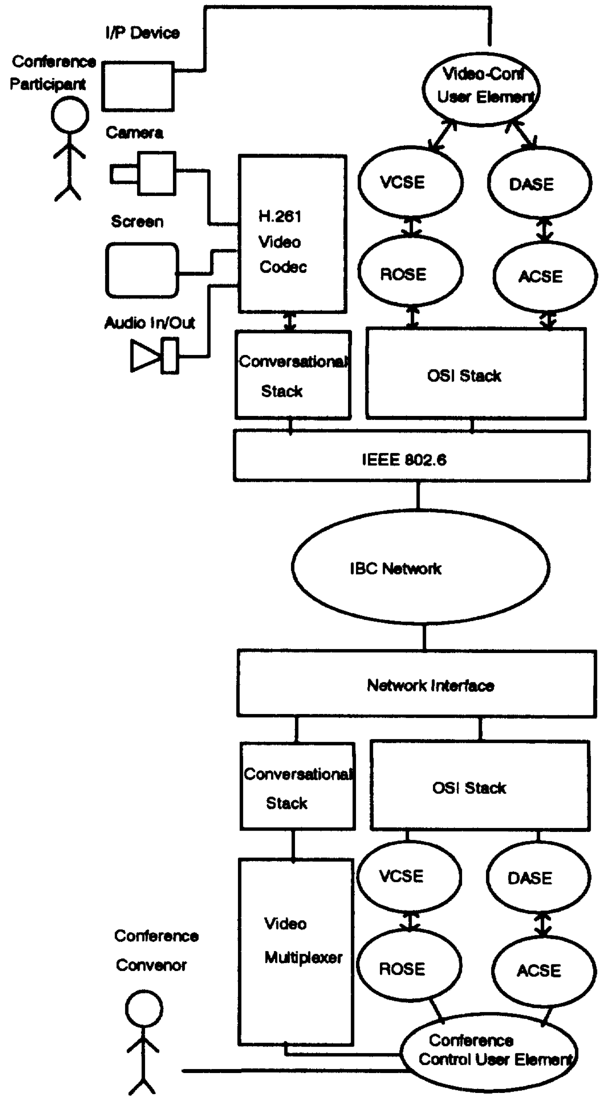

Figure 6 Video-Conference Realization Specification

Concluding Remarks

Many of the issues identified at higher levels, e.g. the administration, management and security elements of the scenario have not been carried downward through each of the planes. Because of this, the realisation level contains purely functional aspects of the service being described.

Imperative Implementation of Object Oriented Designs

The ROSA methodology is based on the use of Object-Oriented design principles, even to the point of modelling human users that interact with a system as *activator objects* with associated operations. The EuroBridge project, on the other hand, is committed to developing prototype applications and services by building on the OSI reference model, and more specifically, the ISO development Environment (ISODE). The OSI reference model was developed prior to the widespread adoption of object oriented techniques, while the ISODE is implemented in C using conventional imperative programming techniques. These two factors combined mean that prototyping in EuroBridge will inevitably have to rely on the imperative paradigm for implementation work.

The uppermost 3 planes of the ROSA methodology isolate the designer from implementation concerns. At these levels, the full power of object-oriented specification can be used. Lower down at the realisation level, the resulting class hierarchies will need to be flattened before they can be implemented and integrated with the underlying software infrastructure (ISODE).

Conclusions

In this document we have examined the different views adopted by the telecommunication and computing communities on the nature of a *network service*. We have concluded that there is a need to reconcile these two views, and to accommodate the concerns of both communities to allow for the use of existing technology from the OSI domain, and to offer flexible strategies for the deployment of these services both inside and outside the global telecommunications network.

We have examined the architectural work taking place in the *Intelligent Network* standards community, and found that while it achieves a useful separation of concerns in the design process, it has been tailored to fit-in with current technology in the area of switched networks to the detriment of its universal applicability. The work within the ROSA project has a more general applicability, and can easily accommodate OSI level-7 technology within the logical layer specification. This makes it ideally suited as a service specification methodology for the EuroBridge project.

The sample service that have been specified have shown how the ROSA method can be applied to a video-conferencing service, allowing the recognition of the different concerns of all of the actors involved in service provision and usage. It has also been possible to make use of all relevant OSI level-7 ASEs, without placing any undue restrictions on the ultimate realisation of the service.

In the specification of new services using the ROSA methodology, a library of objects and their refinements will be built up describing a wide variety of service components at each of the service-, logical- and realization-levels. These objects will form a repository of reusable design expertise that can be used to form a major part of the EuroBridge service platform.

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