MOBILITY CONSIDERATIONS FOR INTEGRATED TELECOMMUNICATIONS SERVICE ENVIRONMENTS

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INTRODUCTION

The 1990s have witnessed significant growth in both the use and capabilities of mobile telecommunications technologies. Furthermore, technological convergence is now beginning to occur in terms of integrating mobile and fixed technologies into a unified architecture for telecommunications services. The design of such a service architecture has been the focus of a number of initiatives in recent years, including TINA-C (1) and projects under the ACTS (Advanced Communications Technologies and Services) programme of the European Commission (2).

The paper begins by presenting a general overview of the types of architecture that are being developed to facilitate this integrated approach. The focus then moves to consider the specific issue of how mobility may be incorporated within the framework. The discussion draws upon the work of the ACTS DOLMEN (Service Machine for an Open Long-term Mobile and Fixed Network Environment) project as a means of illustrating the Service Architecture concept and demonstrating a way of implementing a solution to the mobility considerations. DOLMEN is responsible for the definition and validation of OSAM (Open Service Architecture for fixed and Mobile environments) and is contributing to the definitions within TINA and, via its partners, to the ITU specifications.

THE SERVICE ARCHITECTURE CONCEPT

The notion of a Service Architecture is an advance on the Intelligent Network principle of separating physical-connection-oriented call processing from service-oriented call processing. Furthermore, the concept of a 'call' ceases to be the central focus and is replaced by the notion of a 'service instance'. The purpose of a Service Architecture is to guide the design of advanced telecommunications services and the systems supporting their provision.

Within the architecture, the service processing layer is provided by a Service Machine. This service processing is carried out in an open distributed way:

-by structuring services into objects;
-by relying on a distributed processing platform for open interaction and co-operation among objects;

-by having a technology-independent view of the network resources through an adaptation mechanism which encapsulates implementation details and allows them to be seen by the service machine as objects;

-by having a technology-independent view of the applications through an adaptation mechanism which encapsulates deployment details and allows them to be seen by the service machine as objects.

A Service Architecture dictates concepts, rules, guidelines and prescriptive models for the Service Machine, which is an abstract execution environment for services. The Service Machine is concerned with the provision of computational and engineering support for service definition and provision.

From an RM-ODP Computational viewpoint (3) the Service Machine addresses a number of areas, as described below :

-Management aspects, which mainly refer to software modules implementing (i) Fault, Configuration, (ii) Accounting, Performance and (iii) Security management of the services and the resources they need;

-Session Control aspects, which provide software modules and their relationships or associations, whose goal is to control service provisioning to the end-user;

-Connection Control aspects, which model transport network connection establishment;

-Provision Support aspects, which mainly refer to a services that are commonly needed in the support of service provision (accounting, call logging, event notification, etc.);

-Resource aspects, which mainly refer to services of the resource infrastructure together with their service metrics. Resources in this context may be anything from network elements to databases.

From an RM-ODP Engineering viewpoint (3) the Service Machine (which is often referred to as the Service Network) addresses:

-Distribution Support Services, which comprise a software platform providing distribution transparencies (hiding software object location and functionality from the end user);

-Service Nodes which are the actual hosts of the Service Machine software modules and of the Distribution Support Services;

-Core Transport Network, which enables the interconnection of, and communication between, Service Nodes;

-Resource Adaptation, which enables access to and usage of the services of the Resource Infrastructure. The concept of Resource Infrastructure refers to whatever is available from a system which is not part of the Service Network but can be used, controlled and managed by it.

An overall view of a Service Network is shown in Figure 1.

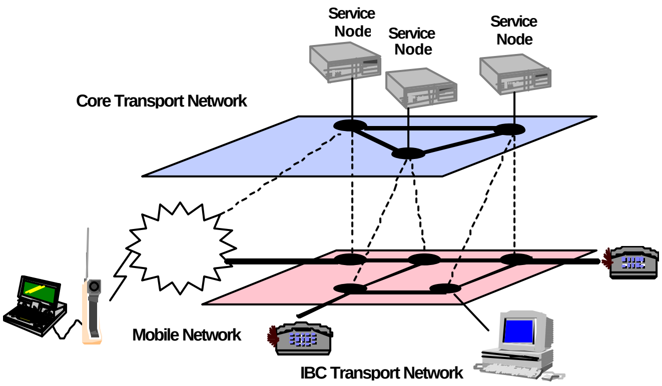

Figure 1 : Engineering View of a Service Machine

It is possible to identify a number of core elements that are generally accepted as representing the essence of any long-term telecommunications architecture. These are described below and illustrated in Figure 2:

-An Application layer including all elements specific to applications fully in the realm of end-users (clients and servers) and totally transparent to Telecommunication Actors [A];

-A Service Machine including:
Communicating Service Components of general use and scope in telecommunications that can be invoked in support of, and adaptation to, the selected application. [C];
A service execution environment based on an open distributed processing platform [P], and objects providing adaptation to the network resource infrastructure [N].

-A Network Resource Infrastructure comprising broadband transfer capabilities, resulting from the provision and interconnection of resources from transport network providers [I].

Conformance to the Service Architecture should result in the flexible design of open-ended systems, offering a multiplicity of (customised) quality services.

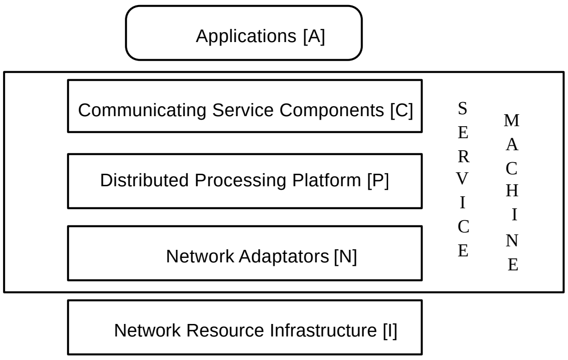

Figure 2 : Service Architecture Elements

ADDRESSING MOBILITY WITHIN THE SERVICE ARCHITECTURE

Overview

It has been identified by Palazzo et al (4) that there are two basic approaches for supporting mobility in a Service Architecture. In the first approach mobile communication services are viewed as any other telecommunication service. The underlying Network Resource Infrastructure involves both mobile and fixed transport networks, but without the intelligence to control and manage resources. Such intelligence is considered to be part of the Service Machine. This approach is termed *Service Engineering*.

In the second approach, intelligence for the support of mobile communication services is considered as an inherent part of the Network Resource Infrastructure. In this sense the existing mobile systems and evolving ones are assumed to provide the functions needed in mobility and the Service Machine will include an interface to these systems as it does to other basic telecommunication services. This is termed *System Engineering*.

A "Trade-Off" between the Service and System Engineering approaches

The Service Engineering approach assumes that all Personal Mobility and most of the Terminal Mobility functions should be included in the Service Machine.

The consequence of this is easy and flexible reuse of the functions in the definition of new services.

The System Engineering approach shows the mobility environment as an already available set of services provided by a system supporting mobility, for example IMT-2000 and GSM.

The implications of each of the two approaches on a Service Architecture can be summarised as shown in Figure 3. While the control of the mobility functions resides in the Service Machine in both cases, their support is up to the Service Machine in the Service Engineering approach alone. In other words, the two approaches can be regarded as opposite solutions in which mobility functions are supported by either the Service Machine or the Network Infrastructure.

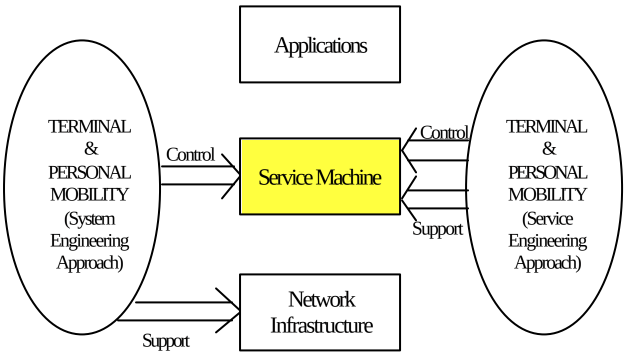

Figure 3 : Mobility impact of service/system approaches

Both approaches have drawbacks. Choice of the Service Engineering approach could require a full redesign of already defined mobility services. Choice of the System Engineering approach has the disadvantage of being strongly dependent on the progress of the developing third-generation mobile systems.

As a consequence, there is benefit in looking at "trade-off" solutions which reside somewhere between the two poles. In these solutions the Service Machine is defined in a form that lends itself to implementation with currently available technology and constitutes a significant input for designers of trials and demonstrators of the Service Architecture.

One "trade-off is presented in Figure 4. All the Personal Mobility functions are placed in the Service Machine. Conversely, most of the Terminal Mobility functions are allocated in the Network Infrastructure, because it is part of the existing environment, while only appropriate resource adapters have to be designed inside the Service Machine to interface them.

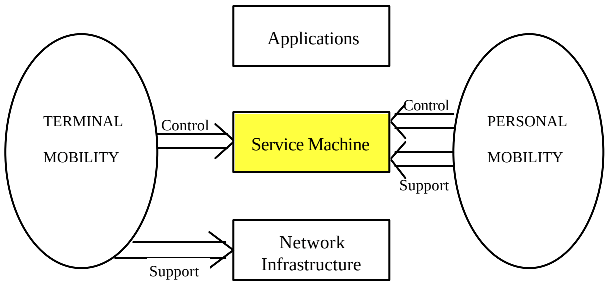

Figure 4 : Architectural impact in the "trade-off"

This solution guarantees that Terminal Mobility functions already available in existing systems can be reused, whereas Personal Mobility ones can be designed according to the Service Architecture, thus guaranteeing principles of generality and reusability and allowing easy development of support for new applications. In addition this trade-off does not prevent objects providing Personal Mobility from being reused to (re)design Terminal Mobility functions.

The resource adapters will be the main elements that will need modification dependent upon which of the above approaches is adopted.

Implementing Mobility Considerations

The ACTS project DOLMEN, in developing, validating and promoting the OSAM architecture, implements the mobility considerations in a number of ways:

-Extensions to TINA to encapsulate mobility functions for both *personal* mobility (the division of user agency into a user agent for both the home and visited domain) and *terminal* mobility (mobile and fixed domain *bridging*). Both of these concepts are discussed in greater detail below;

-the definition, specification and implementation of components to deal with mobility in the access, service and communications sessions;

-the definition of resource adapters for mobile and fixed network elements. In the trialing of the architecture, adaptation will be to ATM, GSM and WLAN elements. Further discussion of resource adaptation in the mobile domain is included below.

Personal Mobility. The TINA concept of the User Agent (UA) provides a user representation in the provider domain, to deal with user-specific information requirements. The TINA UA provides a gateway for the user to the services in the provider domain.

However, if we consider personal mobility, it is possible that the user is roaming in a area far removed from their user agent location, and it would be inefficient to access the provider domain through the "remote" agent.

DOLMEN introduces the concept of having two domains: *home* (the users' subscribed domain) and *visited* (the provider domain in which the user currently resides). The *User Agent visited* provides access through the visited provider domain. It is created when the user is in a visited domain and knows about the user by getting information from the *User Agent home* object. Therefore, the *User Agent visited* is aware of the user's profile and the user has the same familiarity to the agent, without having to rely on long distance communications to achieve it.

Terminal Mobility. We now consider terminal mobility - the use of a mobile terminal and a low bandwidth, unreliable communications link. If the user's terminal is to be mobile, is it possible to use the standard communications mechanisms that function in the fixed domain when we are using an unreliable communications medium?

As the OSAM architecture should integrate both fixed and mobile domains, it is necessary to make terminal mobility transparent by providing mechanisms in the service environment which will enable transparent computational object communication across the mobile link.

The DOLMEN implementation is based on the CORBA 2.0 distributed object standard (5) as its distributed processing environment (DPE). The mechanism implemented is based on the Internet Inter-ORB Protocol (IIOP) specification for providing interoperability between different Object Request Brokers (ORBs). In the DOLMEN case, the ORBs reside at either side of the mobile link, and the concept of *bridging* the fixed and mobile domains, and ORBs, is used, with a half-bridge in either domain which has the required functionality to deconstruct and reconstruct communications across the mobile link. Communication across the bridge is carried out using a specially defined Light-Weight Inter-ORB Protocol (LW-IOP). This has been developed from the IIOP specification to encompass the same functionality, but with the low bandwidth and unreliability aspects taken into consideration.

Resource Adaptation and Mobility. In principle, every part of mobile system functionality could be the focus of adaptation to fit into the overall Service Architecture framework. Not only switching elements and terminals, but also resources like large databases could be re-used. Even more, software modules, like IN Service Independent Building-blocks (SIBs) or generic procedures (6), could be adapted. For example, the resource adapter is an entity which is the interface between the Personal Mobility environment and the network. In this sense any interaction between the Personal Mobility environment and the network is filtered by the resource adapter. Its scope is to solve any problem deriving from heterogeneous underlying networks in order to guarantee connectivity to the Personal Mobility service user

From the above it can be seen that resource adaptation is the way to incorporate legacy resources into a Service Architecture environment. This is done in such a way that, from a Service Architecture point of view, the resource fits into the architecture.

Service control, execution and management will be provided by the Service Machine, logically abstracted from the underlying transport networks. In doing this, the architecture distinguishes session control from connection control. Session control comprises functionality needed to establish a service session between two users (e.g. handling requests, inviting parties, check constraints of each party, etc.), whilst connection control comprises functionality to control the transport network resources that are required to support the service session.

Further details of the resource adaptation concept can be found in (7).

Trialing the Architecture

As part of the DOLMEN project is concerned with the demonstration of the OSAM architecture, it is necessary to trial the implementation of the architecture, focusing on the mobility aspects.

The DOLMEN will test and demonstrate the OSAM architecture using two application areas: Hypermedia Information Browsing (HIB) and Audio Conferencing. Each application area will develop custom client applications, which will reside on mobile terminals, and custom servers, which will be implemented as part of the user and service session components of the distributed architecture.

The use of two application areas allows the demonstration of different aspects of the architecture. The HIB application looks at providing an architectural foundation to World Wide Web (WWW) browsing to enable effective Internet browsing on a mobile client and also exploit stream communication as a way of downloading large media types (e.g., video downloads). A side issue of the HIB application is the integration of an existing application into a TINA environment, in the case of the DOLMEN application, a 'DOLMEN wrapper' is placed around a Netscape Navigator client.

The audio conferencing application focuses far more on the communication of real-time information over a mobile link, in this case using real-time audio streams for both two-party and multi-party conferencing. It also demonstrates the development of an entirely new client, differing from the HIB client, which is a wrapper around an existing application.

CONCLUSIONS

The decoupling of intelligence from underlying network technologies represents a significant trend in the design and development of long-term telecommunications systems. It is anticipated that this Service Architecture oriented approach will lead to much more flexible service provision. At the same time, it can be seen that the issue of mobility is likely to be of increasing importance.

The incorporation of mobility influences the Service Architecture in terms of the Service Machine and the Network Resource Infrastructure (the former being further subdivided into Communicating Service Objects, Distributed Processing Platform and Resource Adapters). Two alternatives are offered by way of Service and System Engineering.

The Service Engineering approach is more flexible, but requires great effort to redesign already available mobility services. System Engineering is easier to realise in a short term, but is strongly dependent on the progress of the evolving mobile systems and offers less opportunity in terms of direct control and management.

Work on these integrated telecommunications environments is still ongoing. Efforts such as the DOLMEN technology trial will provide an indication of both the functionality and performance that the use of Service Architectures can be expected to deliver in practice.

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