Service Provisioning in the Virtual Home Environment

Jani Suomalainen
Helsinki University of Technology
Telecommunications Software and Multimedia Laboratory
Jani.Suomalainen@vtt.fi

Abstract

The virtual home environment enables the use of same personalised services with familiar interfaces in any location regardless of access networks or terminal devices. The realisation of the virtual home environment requires advanced intelligence to be incorporated to networks for handling the diversity of the terminal and network landscape. In order to fulfil these requirements and to hide the complexity, enabling technologies, usage and development interfaces and service architectures have emerged.

This paper explores the concept of virtual home environment and presents existing solutions for service development, deployment and usage. Standards for service control and execution as well as for network and terminal adaptation are discussed. Furthermore, a complete end-to-end architectural solution for providing services is described.

1 Introduction

The emergence of next generation wireless networks is changing the models and value chains of the mobile communication. A wide range of value-added services, previously feasible only in high-speed fixed networks, are coming accessible also to roaming users. To provide a large service category for users, previously closed networks are opened to third parties providing content and value-added services.

The ability to use personalised services with various terminals regardless of the access network or location is a vision promoted by the cellular industry and standardisation bodies, including Third Generation Partnership Project (3GPP) [1], Universal Mobile Telecommunications System (UMTS) Forum [2] and International Telecommunication Union [3]. This vision is realised in virtual home environment (VHE), which is a concept enabling users to access same value-added services from everywhere with a same look and feel experience. In consequence, users can be provided a complete range of customised and easily accessible services to any location.

This paper explores solutions proposed to implement a VHE and describes a high-level architecture defining how to deploy existing solutions to realise the service provisioning. In more detail, the paper follows the work done by 3GPP defining the VHE concept and specifying solutions for separating the service and network layers, as well as the IST/VESPER project, proposing an architecture for the realisation of VHE. Additionally, related work

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

from other industry initiatives is also briefly discussed. In particularly, the paper focuses on the service layer and service provisioning related issues.

Section 2 describes the virtual home environment concept as introduced by 3GPP. In the section, personal service environment and profiles, which are essential elements of the VHE, are presented and the roles of value-added service providers and home environments are discussed. Furthermore, some VHE service examples are listed.

Section 3 presents some enabling technologies that have been proposed to support the VHE principles. In particularly, toolkits for adaptation and controlling of services over heterogeneous networks and for terminal adaptation are handled in the section and their applicability for VHE service provisioning is discussed.

Section 4 presents a complete approach for the VHE service provisioning. In the section, a VHE business model, defining different entities, i.e. companies and users involved with the VHE, and their relationships, is described. Furthermore, an architectural framework, specifying how VHE services can be instantiated, executed and used, is presented.

2 The Virtual Home Environment

2.1 The Concept of VHE

The Third Generation Partnership Project, a joint initiative of several standardisation bodies, has defined the virtual home environment [1]. The VHE is a concept for the personal service environment portability across network boundaries and between terminals. In the VHE, users are consistently presented same personalised features, customised user interfaces and services in whatever network, terminal or geographical location within the capabilities of the terminal and the network.

Individual user's information how personalised services are provided and presented are contained in a personal service environment, which can be presented as a set of user profiles. Each user profile consists of general user interface related information as well as subscribed services related information. Because users can have multiple roles for different situations or needs, for instance, being at work, in the car or at home, a single user can have multiple profiles.

User's profiles are provided and controlled by the home environment, which has agreements with value-added service providers (HE-VASPs) to make services available. In addition to home services, a user can utilise other services provided by value-added service providers within a visited network. Figure 1 shows the logical components of 3GPP's VHE vision and their relationships' from user's point of view.

2.2 VHE Services

VHE enables the access to different kinds of services within the capabilities of networks and terminals. Some examples these of services are [4, 5]:

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

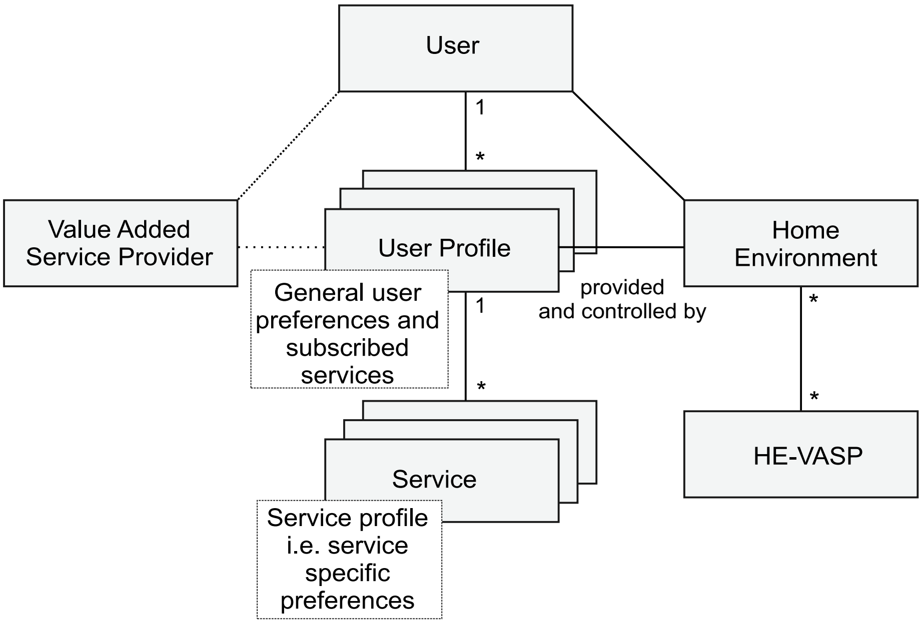

Figure 1: The Logical Components of the VHE from User's Point of View [1]

- ability to use common URL bookmarks between all browsing devices when mobile or wireline,
- in-network rules for call and email forwarding, handling and filtering while roaming,
- access to the same calendar from any location and
- multimedia (e.g. movies, multimedia news) delivery to diverse terminals (e.g. PC or PDA).

3 Enabling Technologies

Users' VHE services are enabled by supporting user profiles and their portability. Furthermore, technologies supporting the service management, control and execution are needed to deliver VHE services to users. To ease the realisation of a VHE, 3GPP has defined a set of toolkits for different VHE requirements. Additionally, mechanisms both from the telecommunication area and from the internet community can be used to realise and enhance VHE services.

This section presents technologies and standards that enable different aspects of the VHE concept to be realised. First, network-domain solutions and architectures, enabling services to be delivered and controlled in different networks, are shortly presented in Section 3.1. Then in Section 3.2, client-domain solutions, making services adaptable into different terminal devices, are discussed. Finally, server-domain solutions, particularly network interfaces that hide the network dependent mechanisms from applications, are presented in Section 3.3.

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

3.1 Service Delivery in Heterogeneous Networks

In order to support the VHE requirements, service control and mobility management mechanisms must be able to operate on diverse networks. In general, two different approaches for controlling services can be taken. In mobile and fixed telecommunication field, signalling based intelligent networks (INs) have traditionally been seen as a key to provide services. On the other hand, the Internet community has proposed mechanisms for delivering services with Internet based protocols.

CAMEL (Customised Applications for Mobile network Enhanced Logic) [6] extends the scope of IN service provisioning for roaming users. It allows the provisioning of certain IN services in mobile networks, in addition to wired telephony networks. However, the CAMEL standard supports only operator specific services and does not support the provision of third-party services.

Some solutions have emerged to combine the services from both the telecommunication and the internet fields. In particularly, the goal of these solutions has been the integration of intelligent network and Internet services. For instance, IETF (Internet Engineering Task Force) has two working groups specifying IN/IP co-operation. **SPIRITS** (Service in the Public switched telephone network/IN Requesting InTernet Service) [7] working group has proposed mechanisms, which enable telephone network to request Internet services. **PINT** (Public switched telephone network/Internet INTernetworking) [8] is somewhat the reverse of SPIRITS. It provides Internet servers capability to access telephony network services. In both approaches, the request is relayed to a server in another domain by using a special gateway solution.

One current trend within the telecom field seems to be the convergence towards **All-IP networks**. Hence, all wireless and fixed end-to-end traffic can in the future be based to the Internet protocol. In consequence, IP based technologies, such as SIP (Session Initiation Protocol) for service control and Mobile IP for mobility management, can be suitable candidates for the realisation of the VHE concept. To demonstrate this vision, the Eurescom P920 project [9] has defined and trialed VHE services, which were based to core IP technologies, such as Mobile IP and HTTP, and to portal based solutions.

3.2 Service Execution Environments

In the terminal-side, standardised environments and interpreted languages can be used to enable application execution hardware and operating system independently. 3GPP has defined two execution environments for mobile terminals. Mobile station Execution Environment (MExE) provides a secure standardised platform for wireless application protocol (WAP) and Java-based applications. Whereas, USIM application toolkit (USAT) is a mechanism for developing and controlling capability limited applications residing in Universal Subscriber Identity Module (USIM) cards.

MExE [10] enables value-added services to be offered through a client/server relationship between the MExE server and the client terminal. The MExE standard categorises terminals to be based on WAP, to personal Java with telephony extensions or to Java 2 Micro Edition, with CLDC and MIDP environments. In addition to service execution platform, the MExE provides a mechanism for servers to resolve capabilities of the terminals. The specification standardises a capability negotiation mechanism, where terminals' capabilities are described using XML-based data representation schema.

USAT [11] is a toolset that can be used to implement simple and secure applications on smart cards. It can be used for storing security related information and for authenticating the user as well as to hold some applications such as a calendar or an electronic wallet. Furthermore, by using a USAT server an operator can control existing applications on an USIM card and deliver new applications.

3.3 Open Network APIs

Standardisation work within VHE has promoted the view that the third generation service architecture should adopt a layered approach. According to this vision, a standardised interface is used between the network layer, consisting of network elements under an operator's control, and the service layer, consisting of third-party servers running service logic. The separation of service layer from network characteristics enables the services to be adapted to diverse networks. Furthermore, the use of standardised network interfaces makes possible for operators to open their networks and provide network resources to applications in consistent manner and, hence, allows operator independent value-added service providers to efficiently implement new services.

3GPP has proposed the **Open Service Access** (OSA) framework [12] to be a solution separating the network and service layers and to be the underlying architecture for VHE. Corresponding interfaces have also been defined by the Parlay group [13] and the JAIN (Java APIs for Integrated Networks) community [14]. Currently, 3GPP, Parlay group and JAIN community member companies have actively worked together on producing their specifications through liaison in European Telecommunication Standards Institute (ETSI). In consequence, the jointly defined OSA application programming interfaces have been recently published in an ETSI standard [15].

Figure 2 shows an overview of the OSA framework. Applications, providing content and end-user services, reside in application servers and access network services via the OSA interface. Key component of OSA is the framework server, which is used by applications to access and discover network functionalities. Framework provides also methods for authenticating and for balancing the load to multiple machines. Actual network resources are provided by the network service capability features (SCFs), which can provide anything from the call control to the user location functionality. In order to be accessible, SCFs must register themselves to the framework.

To hide the network complexity and different characteristics as well as the vendor dependency from applications, abstract SCF classes group service capability server (SCS) classes, which are distributed across one or more physical nodes. These SCSs interact with network entities, which implement the actual network protocols and services.

The service capability features specified in ETSI/OSA API include:

- **Call control** and **data session control** SCFs, which provide capabilities to manage calls and data sessions, e.g., to route and disconnect calls/sessions and to enable noti-

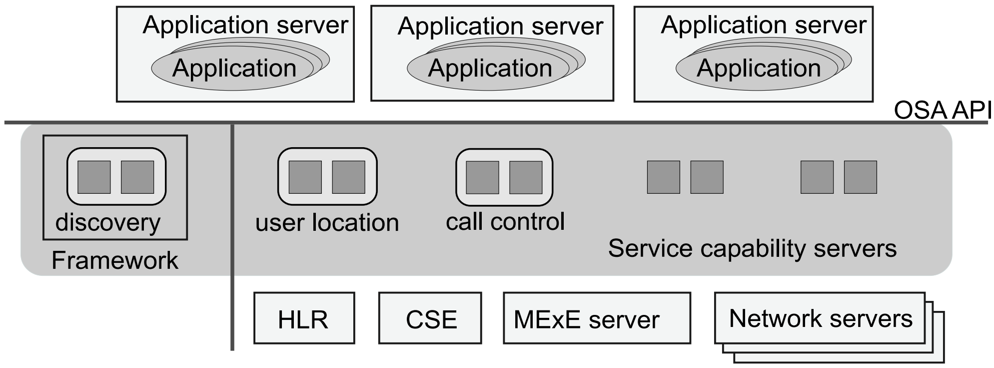

Figure 2: Overview of Open Service Access [12]

fications. Service capability server implementing these features could, for example, utilise the CAMEL service environment (CSE) for controlling the call.

- **Connectivity manager** SCF, which provides applications the capability to establish QoS parameters for packets travelling through the provider network.

- **Mobility** SCF, which provides terminal location (geographical or network related), general terminal status monitoring and network capabilities information. For instance, the terminal location can be resolved using a home location register (HLR).

- **Terminal capabilities** SCF, which provides on request information about capabilities of MExE or WAP compatible terminals. The terminal capabilities can be provided by the MExE service environment after a capability negotiation has taken place.

- **User interaction** SCF, which supports the information transfer, used by applications to interact with end-users or with end-users participating to a call. An example scenario could be an application requesting a PIN code before permitting user to proceed.

- **Generic messaging** SCF, which provides applications capability to send, store and receive messages. For instance, SMS or e-mail services could be used to realise this feature.

- **Account management** SCF, which provides features to interact with users account. In particularly, transaction histories can be retrieved, account balance can be queried and notification on certain criteria can be requested.

- **Charging** SCF, which provides applications the capability to charge for the use of the applications. The charged may or may not be the same user that uses services.

Additionally, the 3GPP's OSA proposal also discusses of the user profile management as a network capability feature. However, the models and mechanisms for profile management are out of the scope of OSA release 5.

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

4 Service Provision in VESPER

VESPER (Virtual Home Environment for Service Personalization and Roaming Users) is a European IST (Information Society Technology) project whose objective has been the precise definition, development and validation of a VHE system. The project has specified an architectural framework, enabling the realisation of a VHE for service provision and use. VESPER concentrates on VHE aspects not covered by 3GPP's solutions, while at the same time proposing improvements to other aspects, and, in this way, achieving a specification of a complete VHE architecture [16].

This section presents VESPER's approach for providing services within the virtual home environment. Section 4.1 describes the VESPER business model, defining the roles of people and companies involved in the VHE system and Section 4.2 gives an overview of the VESPER architecture.

4.1 VHE Business Model

To analyse a distributed system enabling the VHE concept, the VESPER project defined a business model, which is illustrated in Figure 3. The model distributes the identified responsibilities among a number of roles, which are relevant for grouping functionalities. Reference points between the roles describe interactions, between different parts of the system, where standardised APIs might be required.

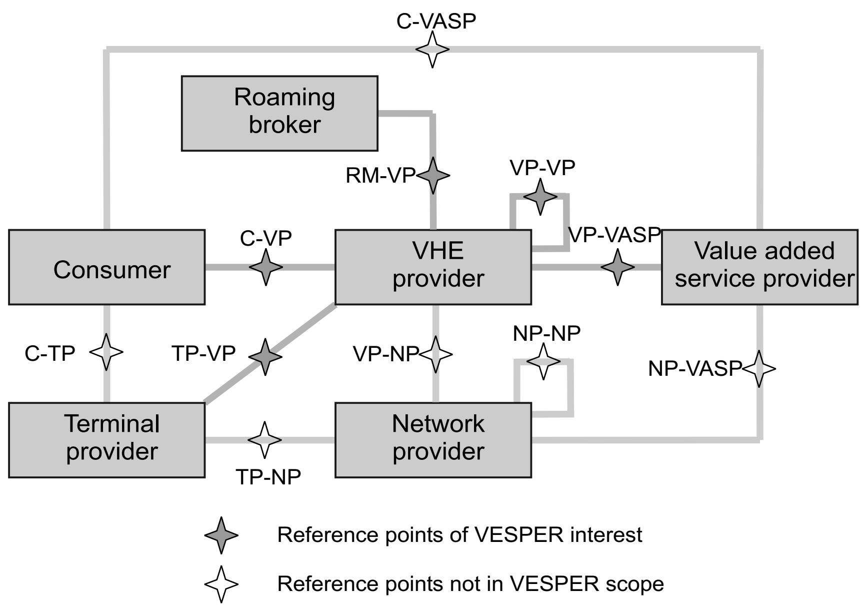

Figure 3: VESPER Business Model [16]

The roles involved in the business model are:

- **Consumer** is a subscriber or an end-user that consumes services. For instance, a consumer can be person, household or company.

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

- **VHE provider (VP)** enables users to access VHE services. It controls and manages users' subscriptions, service registrations, profiles, accounting and service sessions. The VP is a long-term business role to which the legacy role of operator will evolve.
- **Network provider (NP)** provides to VHE providers the necessary transport capabilities and network services enabling consumers to access and use the services. The NP can act either as home network provider or as a visited network provider.
- **Value-added service provider (VASP)** offers services such as content or interactive applications. These services are not provided directly to consumers, instead VASPs have contracts with VHE provider for service delivery.
- **Roaming broker (RB)** is responsible of providing the information of user's home services to the visited domain, taking care of the dynamical setting of relationship among the involved entities as well as determining signalling inter-working and accounting procedures.
- **Terminal provider (TP)** provides a capability for consumer to access and exploit services. Terminals have technological interrelation with the NP. Additionally, characteristics of terminals may be interest to the VP, as it is in the case when service logic is loaded from the VP or the VASP or if the content must be adapted for a terminal.

The business model contains two kinds of reference points, illustrating relationships between roles. For connections out of the VESPER's scope (marked with a transparent star in Figure 3) 3GPP's mechanisms are adopted. In particularly, the relationship between the VHE provider and the network provider or the VASP and the network provider are handled with OSA. The interconnection between terminal and network providers can be based on various transport protocols and service delivery mechanisms. The terminal providers supply customers devices with standardised environments, which are capable to execute loaded VHE applications. For other relationships (marked with a filled star) the VESPER project proposes own solutions.

A significant addition to the 3GPP's vision was the introduction of the VHE provider as a service operator providing users the access to home environments. As a result, customers are not required to make multiple service subscriptions with different value-added service providers but only one with the VHE provider. This simplifies the charging schemes since fares can be invoiced and delivered in a collected way, instead of delivering several small bills.

The VESPER project also has defined an enhanced roaming model. In addition for establishing agreements between network providers, the service environment level (between VHE providers) and the cross-level (between network and VHE providers) roaming scenarios are also handled.

4.2 VHE Structure

VESPER specified an object and agent-oriented distributed processing platform with VHE capabilities. The platform enables third-party service and content providers to develop

HUT TML Course T-110.551 ISBN 951-22-5959-1 ISSN 1455-9749
http://www.tml.hut.fi/Studies/T-110.551/2002/papers/May/index.html

applications without the need to consider VHE specific requirements. In essence, VESPER introduced a set of service independent components, which can be combined with an application logic and, thus, reduce the time and cost of creating new services.

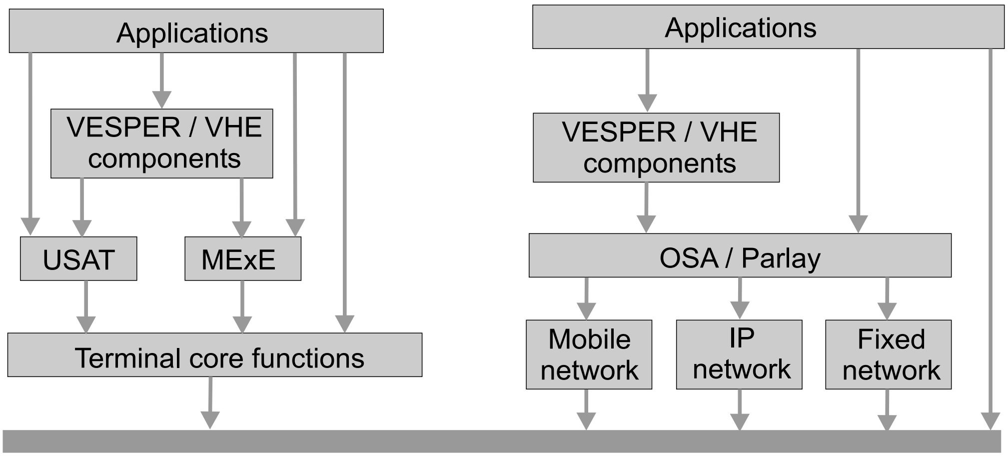

Figure 4: The VESPER VHE Architecture [16]

The VESPER VHE architecture embeds VHE components into a heterogeneous network and terminal landscape. Figure 4 illustrates the architectural placement of different components. Applications in both terminals and servers access the VHE functionality using application programming interfaces defined in the VESPER project. At the server-side, different VHE components can utilise an OSA or Parlay interface implementation to access different networks. At the client-side, uploaded VHE components operate on top of the USAT and MExE compatible platforms and provide a VHE API for the end-user.

Figure 5 illustrates the server architecture and lists the VHE components. Users and administrators are accessing the VHE functionality through own external interfaces, provided by the access and adaptation components, while the value-added services use the service API, provided by the session and adaptation components. Additionally, to enable components interaction with each other internal APIs have been defined. An implementation of OSA or Parlay API is used to provide functionality to manage connections and utilise resources in different networks via a standardised interface. Components, except the adaptation component, access the OSA/Parlay interface through the connection component.

Key VHE components incorporate the following features:

- **Profile management -** *The profile component* provides administrators, users and VHE services the functionality to access, modify or personalise users' profiles and personal service environments.
- **Discovery of services -** Normally after login the end-user will be delivered a service list based on user profiles. In addition to these services, the user can look, discover and start new services using *the discovery component*.
- **Session roaming -** The VHE system provides capabilities to provide services anywhere application transparently. User can move sessions from particular terminals to another terminal, e.g. by suspending them on the first terminal and resuming them

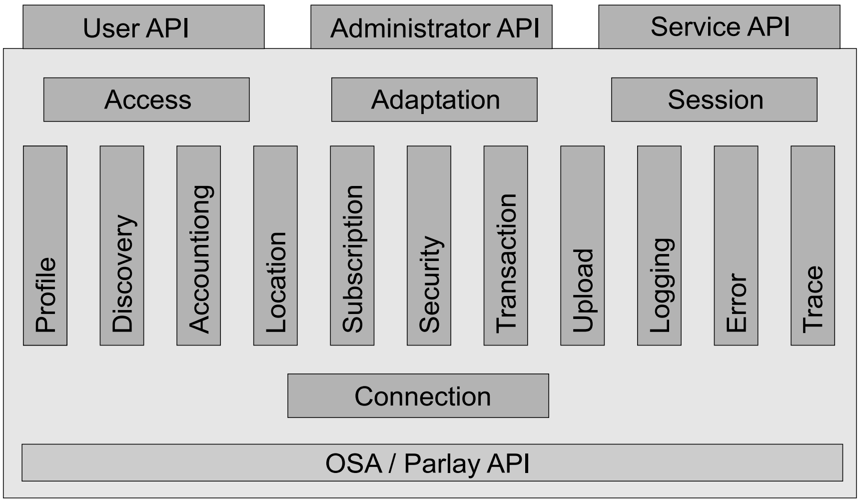

Figure 5: The VESPER VHE Server Component Architecture

on the second. Service sessions between a VASP and a customer are created and connected by *the session component*.

- **Security -** User profiles and services can contain critical data, which should be available only to authenticated entities. On the other hand, authentication is needed to protect services from unauthorised use. To secure the system, *the security component* is used to allow only authenticated users to access the system. Additionally, the component provides means to encrypt the communication and service sessions.

- **Adaptation to terminals' and networks' capabilities -** The VHE system hides the actual terminal, user preferences and network capabilities from the service itself. *The adaptation component* is aware of the context and adapts the content properly. For instance, adaptation to terminal capabilities can be done, by conversing a text document to HTML page, if the client is an internet browser, or to vocal announcement, if the client is a phone. The network adaptability refers mainly to quality of service adjustments, which may be necessary if the network conditions change. In these cases, *the connection component*, which is responsible of connection control and of QoS management, can, for example, change the network provider for better performance or inform applications of problems.

- **Dynamical uploading of client-side logic -** Different services may require that a terminal has a suitable client-side software implementing the service logic. *The upload component* manages the dynamical addition and execution of agents. For instance, if a client does not have required Java application or the existing software needs upgrading, it can be uploaded to the device even without requiring any user interaction.

- **Location -** Applications can query the location of a terminal via the service architecture's *location component*, which resolves the information using OSA.

- **Service subscription management -** Functionality for interaction with user service subscriptions is provided by *the subscription component*. In VESPER, there can be contractual relationships between the consumer and the home VHE provider and between VASPs and the home VHE provider. Direct relationship between the consumer and VASPs are not considered in the VESPER VHE.

- **Accounting management** - *The account component* is responsible for calculating and delivering to appropriate entities the applicable charge for each service and resource provided in the context of a VHE. Different charging schemes can be utilised within the system.

In addition to features described before, the platform provides some core services. Transaction, tracing, logging and error components are used to ensure that the system functions in error situations.

5 Conclusions

The virtual home environment concept provides new capabilities for users by making the use of services easy also when roaming and, thus, new business opportunities for terminal, network and service providers. However, the ability to use same services everywhere is problematic due to diverse networks and terminal capabilities. The network must incorporate advanced intelligence and flexibility to manage service provisioning over underlying heterogeneous networks and various terminals.

Service provisioning strategies have evolved from intelligent network based closed environments to open architectures and, finally, to complete separation of services, service provisioning and transport networks. IN based solutions provide means to provide services to fixed and cellular networks but are restricted to limited set of operator specific services. To enable a wide spectrum of applications, networks should provide open programming interfaces enabling third-party service developers to easily access network resources. A distinct service broker's role is required to add scalability to the service provisioning.

Standardisation bodies and research initiatives are currently working on solutions required to open networks and to realise the VHE concept. 3GPP has proposed solutions for the separation of network and service layers in a form of OSA and MExE standards. To enhance this approach, the VESPER project has proposed a comprehensive solution for the realisation of a VHE system, enabling the service provision. The project specified a service architecture that addresses the terminal and network adaptation issues as well as manages the profiles and subscriptions and, in consequence, hides the VHE specific operations from applications and value-added service providers.

References

[1] 3GPP TS 22.121 v5.2.0. The Virtual Home Environment (Release 5). *The Third Generation Partnership Project*, December 2001.

[2] Report from the UMTS Forum no 1: A Regulatory Framework for UMTS. *The UMTS Forum*, June 1997.

[3] ITU-T Q.1711. Network Functional Model for IMT-2000. *The International Telecommunication Union*, March 1999.

[4] Eurescom P909 Deliverable 5. Enabling Technologies for IN Evolution and IN-Internet Integration. *The European Institute for Research and Strategic Studies in Telecommunications*, June 2001.

[5] IST-1999-10825/INRIA/WP4/D42. Initial Demonstration Services Specification. *VESPER*, May 2001.

[6] 3GPP TS 22.078 v5.5.0. Customised Applications for Mobile network Enhanced Logic (CAMEL). Service description, Stage 1. *The Third Generation Partnership Project*, December 2001.

[7] Vijay K. Gurbani. Et al. The SPIRITS Protocol, Internet-draft. Available from Internet: <www.ietf.org/internet-drafts/draft-gurbani-spirits-protocol-01.txt>. *The Internet Engineering Task Force*, February 2002.

[8] S. Petrack & L. Conroy. The PINT Service Protocol: Extensions to SIP and SDP for IP Access to Telephone Call Services, RFC-2848. Available from Internet: <www.ietf.org/rfc/rfc2848.txt>. *The Internet Engineering Task Force*, June 2000.

[9] Eurescom P920 Deliverable 4. UMTS Network Aspects. VHE Trial review report. *The European Institute for Research and Strategic Studies in Telecommunications*, January 2001.

[10] 3GPP TS 23.057 v4.4.0. Mobile Execution Environment (MExE), Functional Description, Stage 2. *The Third Generation Partnership Project*, December 2001.

[11] 3G TS 22.038 V5.2.0. USIM/SIM Application Toolkit (USAT/SAT), Service Description, Stage 1. *The Third Generation Partnership Project*, June 2001.

[12] 3GPP TS 23.127 v5.0.0. Virtual Home Environment/Open Service Access (Release 5). *The Third Generation Partnership Project*, December 2001.

[13] Parlay API Business Benefits White Paper, version 2.0. *The Parlay Group*, January 2000.

[14] The JAIN APIs: Integrated Network APIs for the Java Platform. *The JAIN Community*, January 2002.

[15] ETSI ES 201 915 v1.1.1. Open Service Access, Application Programming Interface. *The European Telecommunication Standards Institute*, December 2001.

[16] IST-1999-10825/SAGO/WP2/D22. VHE Architectural Design. *VESPER*, April 2001.