VHE PROVISIONING IN 3G MOBILE NETWORKS

Tasos Dagiuklas* and **Panos Philippopoulos****
* INTRACOM S.A., Develop. Progr. Dept., GR-19002, Greece,
Tel: +30 1 6690084, Fax: +30 1 6860312, email: ntan@intracom.gr
** OTE-CONSULTING, Funded Progr. Dept., 32 Kifissias Ave., GR-151 25, Greece,
Tel: +30 1 6879744, Fax: +30 1 6848573, email: pfilip@ieee.org

Abstract

A critical concept for the provision of global integrated 3G services is the Virtual Home Environment (VHE), where users can personalize and retain their service environment preferences across network boundaries and between terminals. This paper focuses on the requirements for VHE provisioning in 3G mobile networks. The most important aspects discussed include service scalability, service personalization, and QoS requirements in terms of network access, mobility management and terminal capabilities.

1 Introduction

Over the last years, Europe, Japan and USA have been working jointly ([1], [2]) towards a common framework (IMT2000) for the standardization of 3G mobile networks. The main features of 3G (UMTS in Europe) include provision of multimedia services at rates up to 2 Mbps (pedestrian mobility), with QoS characteristics comparable to those of fixed networks, convergence towards terminal and personal mobility and operation on a global multi-environment basis to allow service portability while roaming. A critical concept for the provision of global integrated services is the Virtual Home Environment (VHE), where users can personalize and retain their service environment preferences across network boundaries and between terminals.

VHE allows the 3G user to experience a common "look & feel" interface and a common service execution, independently of the visited network. Such services are personalized by / for the end-user and could be anything the user wants, from easy access to stock market prices, home shopping and travel information, to video and audio applications, personal banking, etc. Dynamic tariff selection or call control may also be available, and users should in principal be able to dynamically customise most service features, within the VHE context. In essence, the VHE promises an intelligent and secure preferences management environment for offering seamless, universal communications.

This paper focuses on the requirements for VHE provisioning in 3G networks. The most important aspects discussed include service scalability, service personalization, and QoS requirements in terms of network access, mobility handling and terminal capabilities.

2 VHE Provisioning

VHE is defined as a system concept for personalized service portability for users roaming in 3G networks [3]. Within the context of 3G, the following objectives have been identified:

- Offer multimedia services at rates up to 2Mbps (pedestrian mobility).
- Enable personal terminal and network mobility convergence.
- Offer QoS comparable to that offered by the fixed networks.
- Operate on a global basis in diverse environments and allow roaming between these environments.
- Provide an open system for the creation of new applications and services on demand.
- Support seamless handover for all the services provided to each user in any environment.
- Provide means of supporting 2nd generation systems (e.g, DECT, GSM) within UMTS.

Figure 1 depicts the overall UMTS Framework and the positioning of the VHE concept along with the tool to implement it as defined by the 3GPP: the Open Service Architecture [4].

The VHE concept raises the need for standardising several requirements such as the interoperability between different network technologies, the interworking between

different layers and the secure exchange of user information.

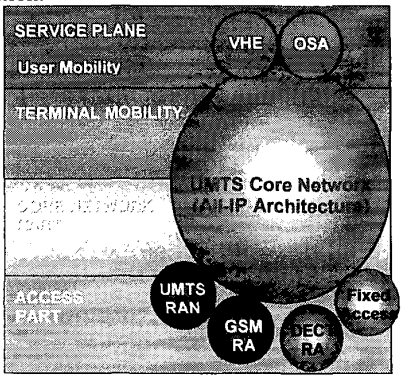

Figure 1: **UMTS Framework**

However, the key concept of VHE (i.e., new services) cannot be standardised due to the competitive environment that network operators and service providers face. It is expected that only a minimum set of services and their respective specifications will be agreed among a number of network operators and service providers. It is however necessary to define and specify the means for service creation, service operation, service management and service portability.

2.1 VHE Provisioning mechanisms

A number of mechanisms can be applied for provisioning of the VHE:

- ***Service Emulation*** is one method for the transfer of user-specific information from the service provider's serving node to the serving node of the current serving network. Objects might be introduced to the user's personal identification card (USIM) or the terminal where they are stored. With this information available, the serving network is capable of emulating the behaviour of the home environment (HE) to a required extent.
- ***Service Remote Execution*** ('service tunneling') gives subscribers the possibility to use their own HE services, although the serving network might not be able to support the desired service, or the storage and execution of the appropriate data. For example, when using 2G systems for accessing 3G services. This solution would require the setup and maintenance of appropriate channels for tunneling service user & control data between the home and visited environments.
- ***Service Enabling*** covers cases where certain services will be made available in the serving environment although not foreseen in the subscriber's original VHE profile. Basic mechanisms of the service emulation and the remote service execution apply here, but there are some additional requirements regarding flexible charging capabilities and mechanisms for online subscriptions to value added services (VAS) e.g. via Trusted Third Party, electronic purse (e-cash, etc.) or online VAS Provider (VASP) subscription.
- ***UMTS standardised service capabilities***. UMTS services are actually based on standardised service capabilities, which are common throughout all UMTS compliant environments. This means that users will experience a consistent set of services when they roam between UMTS operators. VHE will also enable terminals to negotiate functionality with the visited network, possibly even downloading software to reconfigure network and/or service characteristics, so that it will provide a "home-like" service, with full security, transparently across non-homogeneous access and core networks. The ultimate goal is that all networks and procedures (negotiation, connection, registration, etc) are transparent to the user, so that mobile multimedia services are simple, user-friendly and effective.
- ***UMTS open service creation.*** UMTS marks a major step in advancing mobile telecoms as it contains a service creation environment, which allows UMTS providers to create rapidly entirely new services. The VHE will include high level tools for service design and testing, so that operators, VASPs and other service value chain entities can introduce new services with speed, confidence, and quarantee that they will function independent of network access, or terminal. Traditional methods of service definition, for example through standards fora, are time consuming and can hinder operators working in today's fiercely competitive environment. VHE avoids this problem by allowing easy provision of new services. VHE and its associated tools (OSA [4], MexE [5]) provide an ideal platform for use by independent entities (such as private networks and Intranets) that seek to deliver telecommunications-based services to their subscribers. The flexibility introduced by VHE not only increases the range of services offered to subscribers and users, but also allows them to be tailored to different user types and market sectors, even down to an individual user.

2.2 Service Personalisation Scenarios

The central element of the VHE is service personalisation. The user may access service operation & management, to personalise and dynamically modify his

/her service profile. Due to the number of the offered services, user-friendly and flexible methods are required for a user to synthesise a profile that best suits his/her needs. To this end, several usage scenarios may be identified:

- **Max User Customisation.** The service provider may offer to the user the means for selecting from all available services that satisfy his/her needs in terms of charging, terminal capabilities and QoS provision. Then the user is free to construct, in an object-oriented approach, his/her profile by simply choosing the required components / modules (*max personalisation granularity*).
- **Limited User Customisation.** An alternative solution would be restricting users to select only among predefined sets of services, appropriately configured to cover most users needs in a cost-efficient manner (*limited personalisation*).
- **Service Provider Classes.** A possible scheme for service personalisation could be based on an object-oriented data model, whereby each operator maintains a number of pre-defined service classes with certain default service parameters as class attributes and a number of supported terminal type classes with also default service parameters. Such classes may be maintained in the Home Environment (HE) of the user. By creating instances of the above classes the user practically builds a valid service profile which can later be altered to his/her convenience (i.e., override the default attributes). Such service profile is stored in the HE and consulted (in a secure way) by Visited Environment (VE) entities in case of roaming.

The supervision/control of user profiles within the network can be assigned to a number of co-operating agents, each one dealing with some specific task. Part of the personalised user profile (i.e., pointer referring to detailed and more extended data structures) could be stored in the USIM of a user, while the rest of the profile information could be stored in appropriate network components within the HE. Each time a user roams in a visited/serving network, he/she should be notified about the services that can be supported, unless of course the HE could undertake a proxy role (execution of the service logic in the Home Environment).

Each user must subscribe to the HE for the services that he/she prefers to receive. This profile may include preferences in terms of scalability, QoS degradation policies and user interface options when he/she moves to other types of networks. For each specific service, the subscriber may assign a number of weights, which determine the importance of these elements in service adaptation. This profile preview must be provided to the serving (visited) network to be adapted according to terminal capabilities and network characteristics.

2.3 Service Scalability

Service scalability identifies the process of adjusting data of an application, to retain the content of the information, in accordance to QoS fluctuations. This adjustment depends on the service logic, serving network characteristics and terminal capabilities and is important in cases where:

- Reducing the bit rate generated from an application is preferred than delivery of service under packet loss, in case on network congestion.
- User requests access to a certain application with bandwidth and QoS requirements, that cannot be met by the serving network.

Since UMTS will deliver multimedia services to end users with diverse requirements and characteristics, different scalability schemes are investigated and addressed for each media (video, still images, audio/speech, text data). E.g. for real-time services scalability can be implemented in terms of transcoding, i.e. modification of coding parameters and media transformation. A layered architecture is proposed in order to implement service scalability for VHE provision. Figure 2 illustrates the functional decomposition of such a system.

The upper layer includes *multimedia orchestration*, which involves the synchronisation of the individual media components and the appropriate manipulations for data presentation at the terminal. This necessitates interaction of the multimedia orchestration and the User Interface (MMI) of the terminal. Additionally, this layer may automatically modify the service logic due to signals triggered by the lower layers. The multimedia system layer decomposes multimedia data into components. Users' customisation may be employed as an input in terms of weights to select the appropriate transcoding and media transformation. Each media component is then driven towards the *media-processing layer*. This layer receives the bit stream from each media (compressed or not) from the above layer and collects information regarding terminal capabilities and network characteristics to perform functions such as transcoding and media transformation. The lower layer of the multimedia scalability architecture is responsible for performing functions related to communication control for the transmission of the information flow to the users. Such functions may include *protocol conversion* and *rate adaptation.*

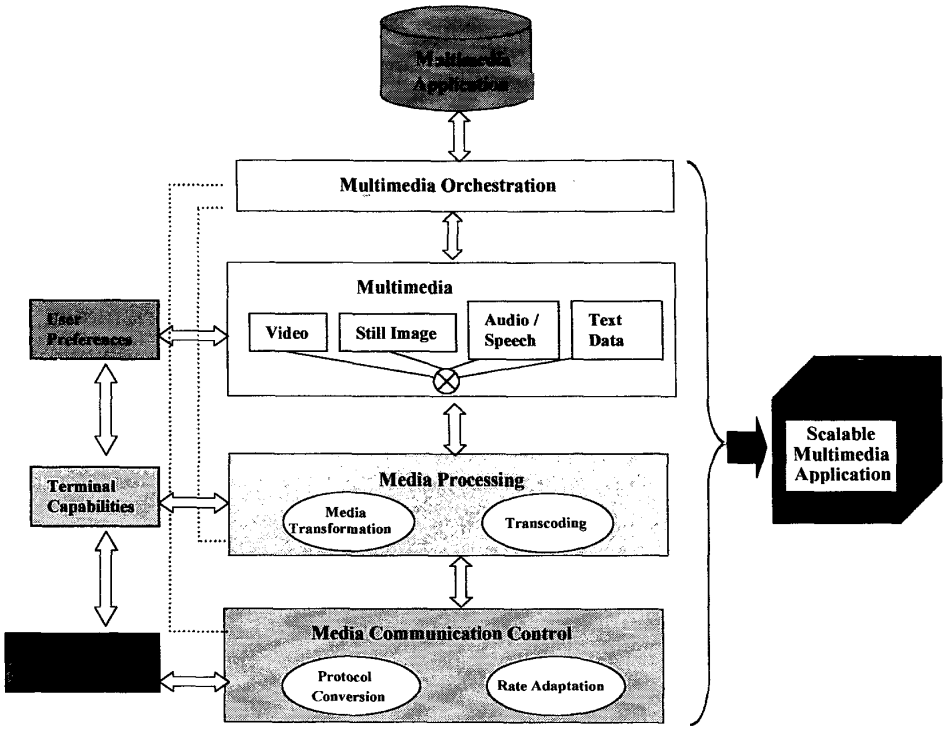

Figure 2: **Service Scalability Architecture**

2.4 QoS Aspects

The other critical element of VHE is QoS with respect to network access, mobility and terminal capabilities. Service provision in visited networks could be supported through the introduction of a series of entities like Terminal Agents, Service Agents, Conversion agents, etc. Such entities hold information pertaining to the roaming user, retrieve the user's profile from the home network, and invoke content type, or protocol conversions if required (e.g. WAP proxy). Several mobile applications may also require the existence of additional functionality within the access network (e.g. a web architecture based on a proxy cache within the access network to diminish retrieval times. Such cache could reside in base stations and be relocated to other network components as necessary).

The issues of QoS requirements with respect to mobility addressed are the following (see also [6]):

- *Service restart*: An intelligent mechanism must be employed such that service is restarted / resumed from the point where it was terminated due to resource exhaustion.
- *Service re-negotiation*: While the user handovers to an access network with different requirements and characteristics, services must exhibit adaptation in terms of bit rate and QoS requirements, depending on dynamic resource availability.
- *Handover procedure decisions*: When the Mobile Terminal performs handover (HO), the transition must be as seamless and transparent to the user as required. The user may then define criteria such as maximum service quality and/or minimum cost which directly affect the HO procedure (e.g. can determine the selection of the target cells).
- *Additional QoS metrics*: These QoS metrics are related to mobility and consist an approach to the definition of a mobile QoS (M-QoS) framework. This M-QoS could be seen as consisting of a fixed-network (F-QoS) and an air i/f component (AIF-QoS) (see also [6]).
- *Relocating Application servers*: Alternative application servers must be identified when the MT is handed over and the connection path up to the application server may get lost. This is especially crucial for location-based applications.

Terminal capabilities issues, which are associated with QoS service requirements, are also addressed:

- *Battery power*: The battery must be capable of providing enough power to the CPU for applications requiring on-fly intensive processing.
- *CPU capability*: The CPU must be capable of processing data of multimedia applications in real time.
- *Memory Size*: Since the mobile devices will not carry any hard disk, the memory size must be large enough to store temporary data from the applications, which are downloaded to the terminal.
- *API QoS & VHE Support*. Terminals must be provided with APIs to support the VHE concept. Additionally, these APIs should provide QoS interfaces to the applications. Possible alternatives when applications are adapted must be provided.
- *Display Capabilities*: Display screens must provide information regarding supported video and/or image formats. As an example, current PalmPilot systems support 4 level of grayscale.
- *Interfaces*: Inter USIM-card interface, PCMCIA-interface and software interfaces and its interaction with APIs must be defined.
- *Multiple environments*: Advanced UMTS terminals must provide services to more than one subscriber simultaneously. Additionally, one user may employ multiple home environments concurrently (access services for more than one providers simultaneously).

3 Conclusions

One important feature of UMTS, is the concept of the VHE, where users are provided with advanced service personalisation capabilities and intelligent personal environment management irrespective of serving network. There are different mechanisms, which could be employed for the provisioning of the VHE. Such mechanisms include service emulation, service remote execution, service enabling, UMTS standardised service and UMTS service creation. This paper investigates VHE provisioning issues associated with service personalisation, QoS and service scalability. Service personalisation concerns mechanisms where users dynamically modify their service profiles. Parameters that affect the desired QoS include terminal capabilities, access methods, mobility, user preferences and user constraints. Finally, adaptation of the applications can be considered through the employment of service scalability architectures.

4 References

[1] 3GPP Home Page: http://www.3GPP.org

[2] 3GPP2 Home Page: http://www.3GPP2.org

[3] 3G TS 22.121 V4.0.0 (2001-03) : "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; The Virtual Home Environment (Release 1999)".

[4] 3G TS 23.127 4.0.0 (2001-03): "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Virtual Home Environment / Open Service Architecture".

[5] 3G TS 22.057: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Mobile Station Application Execution Environment (MExE); Service description, Stage 1 (3G TS 22.057 version 4.0.0)".

[6] P.I. Philippopoulos, C.E. Georgopoulos, E.D. Sykas, "QoS Interpretation in 3rd Generation Wireless/Mobile Systems", *Proceedings of the 49th IEEE Vehicular Technology Conference (VTC'99 spring)*, Texas, USA, May 16-19, 1999.