A personalization and mobility aware service enabler for a service continuity in heterogeneous networks

Chunyang Yin[1], Noëmie Simoni[1], Ghislain du Chéné[2]
[1] Ecole Nationale Supérieure des Télécommunications
CNRS/ LTCI/ UMR 51 41
46, rue Barrault, 75634 Paris, France
{yin, simoni}@enst.fr
[2] SFR DRDP
1, place Carpeaux, 92915, Paris La Defense, France
ghislainduchene@fr.sfr.com

Abstract. The rapid growth of wired and wireless access technologies integrated with great needs of user nomad supporting services provides strong motivations to focus on the service continuity in a heterogeneous environment. In this paper, we present a personalization and mobility aware service enabler through the session mobility to support service continuity. A four-leveled architecture in the aim of obtaining service session mobility is designed first. User personalization enables us to propose an information structure of user preferences (user profile) and heterogeneous resources around him (usage profiles). Then a user level oriented Virtual Private User Network (VPUN) can be automatically constructed which permits to select the most adequate offers according to the user. By constructing a Virtual Private Network in the Service level (VPSN) thanks to VPUN, we can finally obtain service session mobility to response service continuity. A demonstration will be given out in the end to evaluate the service enabler.

1 Introduction

Nowadays, users are making use of more and more devices like PDAs, mobile phones, laptops, etc. It becomes popular for a person to have several portable devices together with the fixed and higher performance devices they have at home or in office. A tremendous choice among the different types of devices makes user no longer be satisfied with entertaining these networked equipments in the same site, but rather at anywhere, anytime, to employ easily any of their devices and to use the application as fluent as possible. That is so called the requirements of user centric.

Firstly, to response these requirements, we start our consideration with the informational aspect. For each user, there should be a knowledge base. Since the information in the knowledge base is the capital of making decision in the right place. A user is willing to be recognized easily though his environment is changing, on the other hand, he is also eager to have the information about what he has, what he can use during his move, in order to have a more fluent mobile service. So how to reorganize the information system and services around him is desired.

Secondly, all the connectivity demands are based on a communication networks. Communication networks are basic tools that enable users to communicate as well as to access information and services. The rapid development of access technologies enlarged the user network access possibility by benefiting each user with a various choice of wired and wireless access networks. Thus, it enables user to have coverage of networks everywhere. The all IP network technology enables us to focus on the access network facing an end-to-end service demand thanks to a ubiquitous backbone. So to keep the user ongoing communication regarding the switch between access networks brings us to face the technology of handover. In additional, to offer a specified terminal's mobility crossing heterogeneous access networks, a type of heterogeneous handover should be taken into account. A possible solution is already available now like handover between WLAN/UMTS (UMA) [Mo05]. However, the QoS mechanism for this kind of handover is not in its scope of consideration yet.

Thirdly, user centric services are often end-to-end real-time multimedia applications over the ambient Internet, which requires the target heterogeneous handover not only to be a connectivity issue but rather to be as seamless and transparent as possible.

Therefore, the way to provide continuous and seamless service to a user considering the heterogeneity and his nomad with his service preferences becomes the subject we are going to examine.

In this paper, first, in §2, we analyze the current position of terminal and user mobility in heterogeneous environment respecting user centric requirement. After reasoning out what is most important in realizing service continuity, we arrive at focusing the problem on resolving service session mobility respecting the user preferences. In §3, an architecture is designed in order to work out a global and abstract vision of heterogeneous networks, basing on which we propose a personalization and mobility aware service enabler. In §4, we evaluate our conception of service enabler through a demonstration. Finally we close our paper by a conclusion and perspective.

2 Analysis of the existing proposals

We begin our problem definition with an examination fields shown in the figure as following. First we reduce and simplify our consideration domain into 3 subfields.

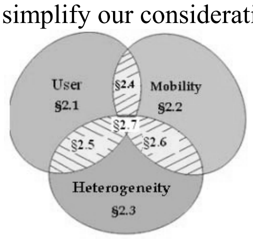

Fig. 1. From existences to concerned problem

1. User requirements and preferences, the former abstracts all user demands in form of user continuous multimedia services requirements. The latter represents all his personal information in the aspects of utilization, security and etc (§2.1).

2. Mobility, which refers to two types as terminal mobility and user mobility (§2.2).
3. Heterogeneity, which represents the nowadays heterogeneity of the networks, as well as the heterogeneity of the services and so caused heterogeneous end-to-end QoS mechanisms (§2.3).

Then, we try to analyze current advancements between each two sub fields we defined.

1. User continuous services availability considering terminal mobility (§2.4).
2. A user preferences and heterogeneous resources informational representation and user connectivity to a heterogeneous network (§2.5).
3. A proper E2E QoS mechanism to enable terminal mobility crossing heterogeneous network (§2.6).

Finally, basing from the user centric requirements, according to the analysis of Top-Down, we propose to highlight service session mobility considering user nomad crossing heterogeneity to realize service continuity (§2.7).

2.1 User centric requirements

The increasing multimedia applications benefit user to enjoy different types of data. The convergence of telecommunication services and Internet services brings us a new generation of service. These new services (e.g. the data services and multimedia services) can be used by different users in diverse manners. Users are no longer satisfied with a single phone call but are willing to have as many available services as possible. Such as a live football show on his road home by using PDA while having a telephony conversation with friends. These requirements demand not only the possibility to always have the accessible when he is moving but also have QoS guaranteed applications of different types simultaneously.

2.2 Mobility

Mobility is the ultimate requirement for all mobile related services, two kinds of which are notably important:

Terminal Mobility refers to a terminal to move across networks access points' coverage while having access to the same set of subscribed services. Terminal mobility strongly depends on the technology of handover which is a procedure by which a mobile node obtains the preservation of facilities for supporting traffic flows upon occurrence of a link-switch event.

In UMTS the key technology to realize this kind of mobility is considered as the hard handover, soft handover and softer handover, classified by the range of the handover.

User mobility, or personal mobility, refers to the user's ability to use any terminal to access services from anywhere, at anytime. One potential solution is using a single personal identifier to identify the user in all occasions, regardless of the terminal(s) used or their network locations. [Va00a][SW00][Va00b]

2.3 Heterogeneity

Recently, technology has gone through tremendous evolutions in terms of access techniques, security, bandwidth usage and also convergence into packet switching based on All-IP network. Pressure is mounting to harmonize various technologies under a common IP. This leads us to a seamless handover aiming to be smooth, loss-less and transparent. The researchers try to modeling out an architecture, like the Logical Network Reference Model shown in the figure 2[Ie06], for heterogeneous networks, basing on which they hope to realize heterogeneous handover mechanisms.

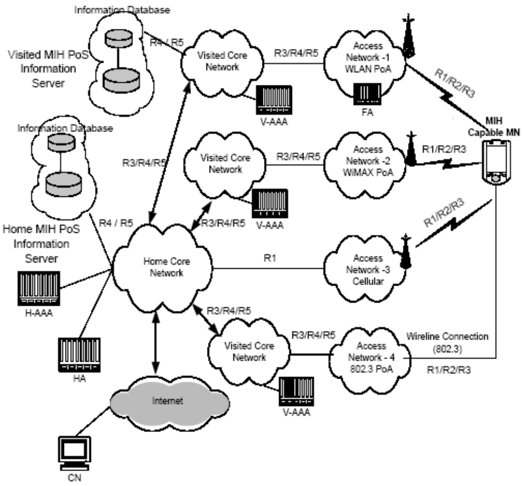

Fig. 2. Heterogeneous Networks

In Figure 2, the different access networks based on an ambient core network are shown to be owned by a unique home operator that provisioned the user. So it is possible for the user nomadizes among these heterogeneous access networks in the same administration area. When SLA is established, user can even nomadize any other access network owned by other operators.

Unfortunately, this architecture modeling is insufficient since it covers only the levels of equipment and network. Even if it can help guarantee some QoS criteria, it can not offer a heterogeneous QoS mechanism supporting dynamic change of QoS because it cannot represent all the necessary components in the point of the user's preferences and services organizations.

2.4 User application needs during real time nomad

A mobility related user application leads us to detail different types of handover. Depending on whether the handover is a simultaneous connectivity to Access Routers or not, a Break-before-make (BBM) handover and a Make-before-break (MBB) handover are defined. [MK04]

If the user demand can be performed by switching two sessions, a Break-before-make (BBM) handover is sufficient. During a BBM handover the network breaks the old connection before the new connection is made. Thus, the user cannot communicate simultaneously with the old and the new server.

On the other hand, a Make-before-break (MBB) handover makes the new connection before the old one is broken. Thus, the user can communicate simultaneously with the old and new server during the handover. [MK04]

Obviously, users are not willing to experience degradation in service quality, security, and capabilities. But actually the user is bearing from all of that even an interruption of the applying session, because he is limited by the quality of handover in the network layer and the session of a continuous service is not user demand oriented.

2.5 User Connectivity to a heterogeneous environments

When associated with a specified user application, connectivity means no more a pure link issue, but rather to keep all the user nomadic information to enable him to be easily connected to any network where he preferred and has the right.

Virtual Home Environment (VHE) is a concept for Personal Service Environment (PSE) portability across network boundaries and between terminals. The concept of VHE is such that users are consistently presented with the same personalised features, user Interface customization and services in whatever network and whatever terminal (within the capabilities of the terminal and the network), wherever the user may be located.[Um04]

But the limitations of VHE are that it only takes into account the information rounding a certain user, few information is indicated about his real time situated environment like the available access networks and available services which are also very important to make the decision of connectivity.

2.6 Terminal mobility crossing heterogeneous networks

Terminal mobility challenges us with how to keep the connectivity crossing heterogeneous networks. Vertical handover is defined for the situation of terminals moving between access points of different type, such as, UMTS to WLAN. On the contrary, horizontal handover involves terminal moving between access points of the same type (in terms of coverage, data rate and mobility), such as, UMTS to UMTS, or WLAN to WLAN. Note that the difference between a horizontal and vertical handover is vague. For example, a handover from an AP with 802.11b WLAN link to an AP with 802.11g WLAN link may be considered as either a vertical or a horizontal handover, depending on an individual’s point of view. [MK04]

In UMA (Unlicensed Mobile Access) suggestion, this kind of mobility is based on the conception that in the future the users prefer with a powerful single terminal rather than several devices. UMA is designed for the residential or small office market, it provides a wireless access networks which is integrated into an operator’s cellular core network. User with dual-mode (GSM and WLAN) handsets is able to move between access networks [Mo05]. Although UMA proposed a possible continuous connectivity solution, it doesn’t support any QoS mechanism during the heterogeneous handover between GSM and WLAN.

2.7 Service session mobility in service continuity

From all what we analysed in each aspect we presented before, how to maintain an end-to-end service session with the mobility and the heterogeneity becomes as our key challenge. User centric requires the services should be accessible by any of his devices. Meanwhile, since user and the mobility of terminal should also be taken into account, the MBB handover becomes our target type of handover to maintain the service continuity. In this context, it is proposed to focus on the problem of service session mobility. Service session mobility is defined as how to realize a continuous personalized service organisation by updating dynamically the services according to the user/terminal mobility among the heterogeneous networks.

From the fact above, the following items are required:

1. An architecture for heterogeneous networks which should cover the user's vision, the services availability, and current environment;
2. A connectivity anywhere considering user nomads and all the information around him which can be static or dynamic;
3. A continuous session to be hold respecting the QoS demanded by the nomadic user.

3 Proposition: Service session mobility enabler

After a strict problem definition, service session mobility is highlighted as the first step to realize service continuity. We will begin with an architecture for activation of the service session mobility, covering all the components serving for a user demand service (§3.1). Via this generic architecture we can progress to the informational aspect for activation of session mobility (§3.2). By applying the user personalization in our defined architecture, it can help us to realize a mobility aware service, which gives us a functional part of the service enabler to offer service session mobility (§3.3).

3.1 Architecture for activation of the service session mobility

In the part of existence analysis, we have already remarked that a generic architecture is desired to abstract all the essential components considering nomadic user demands and heterogeneous environment. Considering the heterogeneity distribution, we should first abstract the components as representative as possible. So in each visibility level, we follow a meta model of <Node, Link, Network> [DS04]. With the help of this meta model, we propose our generic architecture which rolls out into four levels: the level of user, of service, of network and of equipment. Between each two levels, there is a relationship as demanded service and offered service. These four visibility levels permit us to construct all necessary information for our context. As shown in figure 3.

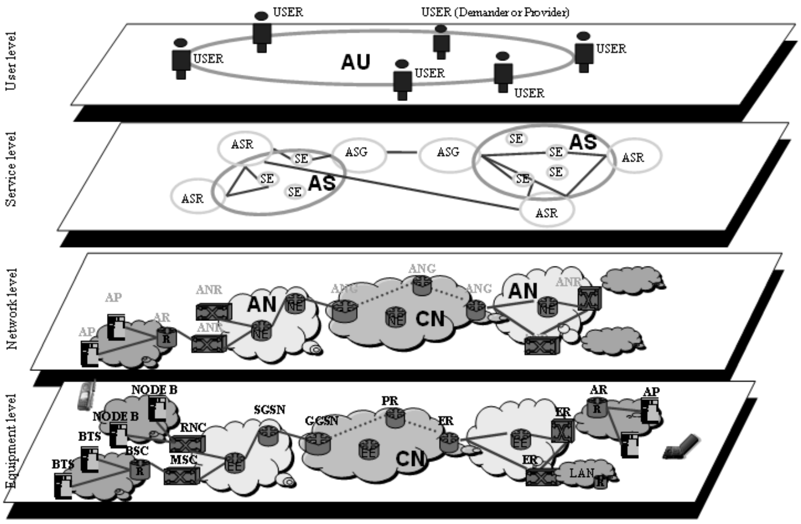

Fig. 3. Generic architecture

Firstly, in the network level, the goal is to have all the logic components to represent the heterogeneous networks. Hence, the APs (Access Points) with the ARs (Access Routers) are situated in the first part of access in order to simplify and abstract the access part directly in front of a terminal. Then we have NE (Network Element), ANR (Access Network Router) and ANG (Access Network Gateway) as the essential nodes in the access network to the CN, the connectivity is represented as the dynamic links between them. A group of nodes which apply a same technology is treated as a sub network of AN (access network).

In the equipment level, we have all the instantiated equipments according to the network level though the heterogeneity of the real network deployment.

Thus, in the level of equipment and network, we applied successfully our meta model of <Node, Link, Network>. Now we try to apply the same architectural components definition methodology and meta model to the upper levels of service and user.

Secondly, in our architecture, service level and user level are separated. To accommodate the dynamic user multi-services demands and user concerned information, we must have a separated user level. Meanwhile, a service level is proposed to contain all the services that we may be interested in, and organize them as the enabled services by the network, the available services offered by service providers and the services required by the user.

Therefore, in the service level, we classify the services by the service providers. Suppose we have two providers here. Accordingly, we have two ASs (Access Service) here as service domains. Each SE (Service Element) is regarded as a service component and can offer a specified service. An ASR (Access Service Router) is the enter point for the users to this service provider domain. An ASG (Access Service Gateway) situates between two ASs in case of the interconnection of the two service domains. Noting that the ASG has an own network which is grouped by equivalent ASGs in case that an ASG is no longer usable and it has to access another provider's service domain. The link between two components is the real time service session that relates suitable service components. Then service session mobility may be dynamically obtained regarding the same end-to-end service and respecting the demanded QoS.

What's more, in the user level, basing on the peer-to-peer concept, all the components on this level can play the role of demander or provider. Regarding a universal identifying convergence, an AU (Access User) is constructed by the link of these peers. The dynamically constructed AU permits us to adequate the user nomad and always to be kept informed with the heterogeneous environments.

3.2 Information for activation of the service session mobility

In fact, to offer user the session mobility in *anytime*, *anywhere* and *anyhow*, different usage knowledge, the users' current context and ambient environment knowledge have to be taken into account and exploited to construct the adaptable services. To enable user have a right decision at the right moment, we propose to situate this knowledge base in the user level, that is, the information should be organized according to the individual user and his preferences and a specific environment is needed. What's more, this knowledge base can dynamically guard the user demands and let him to have a best choice of what should have in the rest three levels of service, network and equipment. That leads us to propose a user personalization service for a nomadic user through constructing an informational user knowledge base which is defined as infosphere in our proposition. An infosphere includes a user's own essential identification information and desiring services information, as well as the dynamically updating available environment resources information caused by a user's nomad. To construct an infosphere, we need to pass two stages as the following:

Firstly, a user profile is desired to formulize all the information oriented from a user. It is necessary not only to store all the user personal information as identity to enable the universal addressing, but also to keep in pace of user changing preferences facing the user nomads. We regard this information as personalized user information which can be employed to prepare a personalized service demand.

For example, in a specified user profile, there is information about all the equipments he possesses, the networks he subscribed, and the services he has the right to entertain.

Secondly, the personalization should consider the ambient context because that is the environment we will execute the services. It will help the services to adapt the context and maintain the QoS as well. In fact, the constraints and possibilities of the ambient environment will have an impact on the moment to make the choice of services and providers. Then we identify for a given user a set of authorized resources among current ambient resources into three usage profiles: service resources usage profile, network resources usage profile and equipment resources usage profile. All these usage profiles are dynamically discovered results from the user current arrival environment and are user demanded service context related. What's more, in infosphere, these usage profiles can be organized with the help of agenda and localization. Agenda is to predict the user activities according to his movement. Localization can let us have the real time location feedback from a nomad user. With the help of localization and agenda, when a user moves into a different site, he will dynamically get the available resources of the environment. User adaptable preferences related with user current situation and QoS demands can be then expressed. For example, network resources usage profile can include all the available access networks information for a specified user and meanwhile, user has a preference applicable to this network usage profile.

3.3 Functions for realization of the service session mobility

In our generic architecture part, we have already designed the service components to accommodate the user centric services demands. Actually, the realization of service session is a dynamic routing among these components. Hence, the terminal mobility and user mobility can be regarded as the demand of the dynamic rerouting to obtain the service session mobility for an end-to-end user application. In order to avoid the degradation of the QoS during the service session, the main functions to realize the dynamic service rerouting is actually the QoS rerouting functions.

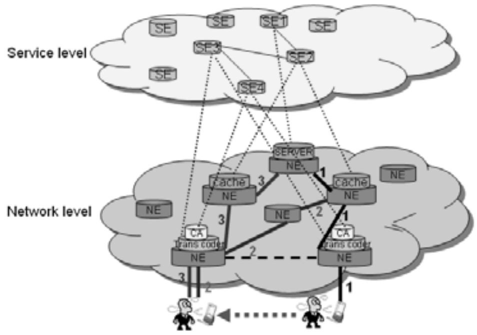

Fig. 4. Function for obtaining mobility

Figure 4 illustrates how to support session mobility with the best QoS. In our proposition, when a user nomadizes to another area while applying a service routed by route 1, a dynamic rerouting is guided by SE4 (mapping to CA *Client Agent*) according to the user requirements, which permits him to be automatically connected with the most adequate transcoder without the interruption of the service session. As shown the route 2. This choice is considered as the better one than simply extending the route to the new attach point. The same kind of rerouting can be applied if there is a degradation of service during the user service session. For example, during the service session, SE2 finds that another route is more suitable for preserving the demanded QoS, and then route 3 is established in the network level.

Always respecting the design pattern of Top-Down, we begin to consider the services personalization which depends on the user nomadic information like user localisation or the request moment. In fact, to exploit adaptable services for a nomadic user in *anytime*, *anywhere* and *anyhow*, we should find out the right process to access these offered services, which brings us to face the following challenge: how to discover and construct the services respecting the demanded QoS with a procurement management which should be as autonomy and generic as possible. The function of filtering is based on the profiles we defined concerning a certain nomadic user. In the user profile, real time user demand together with his QoS preferences is considered as constraints. All the potential available resources are in each usage profile of network, of service and of equipment. Once we obtain all these profiles, we need to run a preference filter which permits to construct a subset of current resources to which user has the permission to access. The possible resources' filtering is done by a matching of all the constraints and possibilities. Meanwhile, we determinate and set the state of each resource profile according to the user's preferences. The result is a set of accessible resources which we called active profile. The whole procedure is shown in figure 5.

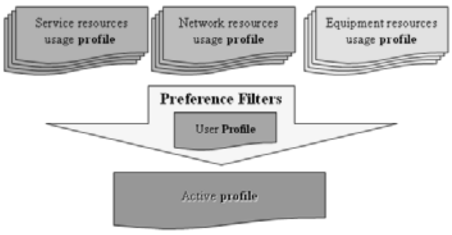

Fig. 5. Profiles construction procedure

After the filtering of the usage profiles, all the active profiles constitute an infosphere. So now all the information about current environment is really prepared for a nomadic user.

The dynamic construction of infosphere permits us to keep on acknowledging of all the available resources around a user in every moment. i.e., when a user formulates a demand, all the information is prepared.

We have completed now the informational and functional design of our service enabler. In section 4, we will evaluate this service enabler by a demonstration.

2 Demonstration: services enabler and service session mobility

Our demonstration is in the project of seamless userware [RS04] participated by SFR (Société Française Radiomobile). This project is the following of VTC2E [RS04] a userware is developed in order to realize the user service access in *anywhere*, *anytime* and *anyhow*.

We have developed the four kinds of profile in the knowledge base part. To integrate our personalization and mobility aware service enabler in the userware, we have two interfaces to monitoring the dynamic construction of the infosphere according to the localization and VPUN who translates the demand of the user in real time.

Fig. 6. Two interfaces in userware

One interface situates in the user side to accommodate the user demands and to be kept in touch with user agenda and service preferences, as shown in the left figure. This part permits user update the user profile to feed infosphere. User can also express in advance his preferences according to the four leveled architecture in each site he may pass. For example, at his home, he can set the preferred service to SFR Video on Demand; while at his office, ENST Video on Demand, and etc.

The other one is in the side of administrator. It is in charge of managing the infosphere by formulating the heterogeneous resources as the usages profiles in terms of QoS criteria. What's more, the usable resources are dynamically prepared for a nomadic user and the real time constructed VPUN can also be seen in the side of administrator.

Now we concentrate on the case that a user who is entertaining VoD service, meanwhile, the QoS is guaranteed by the auto management of VPSN. Then, he wants to move to another area. Because of his move, his ancient provider can no longer guarantee his service even to offer it. An auto organization of VSN permits the recalculation according to the user service continuity demand. Basing on the results of VPSN, in the supporting user level, we can selects equivalent servers to construct VUN, a VPUN is supported by several VUNs and is constructed dynamically when a user demand arrives. As soon as the suitable service provider is found by VSN, the VPSN can also be re-configured without the cut of the service and neither the interrupt of the service session. The service session mobility is so obtained.

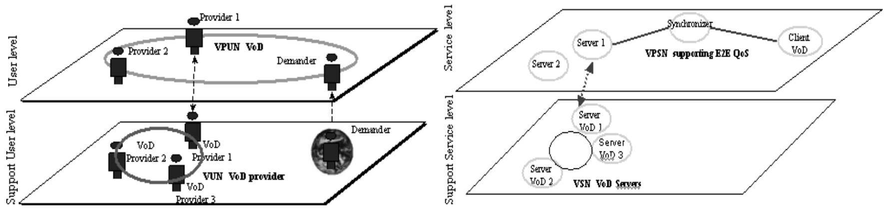

Fig. 7. The construction of VUN/VPUN and VSN/VPSN

3 Conclusion and perspective

In this paper, we began with the analysis of nowadays nomadic user personalized service requirements facing the tremendous development heterogeneous networks respecting the QoS demanded. After reasoning out what was most important in realizing service continuity, we arrived at focusing the problem on resolving service session mobility respecting the user preferences. To achieve that goal, a four leveled architecture was proposed. The level of user helped us to gather all the personalization information, the service level enabled us to have all the possible services including the user demanded service, networks offered service and proposed services, the network level and equipment level offered the upper levels the essential materials for realizing a certain service for a user. This architecture was to provide a global and abstract vision of heterogeneous networks, based on which we proposed a personalization and mobility aware service enabler. We have also translated this architectural vision into a structured knowledge base to have always the right decision at the right moment. The filtering mechanism is working in the way of monitoring the QoS and the proposed MBB handover, which allows us to ensure a continuity of service session. Finally, we evaluated our conception of service enabler through a demonstration.

Since we regard service session mobility as the first step for realizing the service continuity, we have already a four leveled architecture and a user personalization knowledge base (infosphere), according to which, we exploited a service enabler. Our next consideration will be taken in the more detailed functional and organizational aspects which respect our five dimensional frameworks [BDS06]. Especially in the service level, we need a service signaling as the part of provisioning of the service continuity.

Bibliography

[BDS06] F. Bennani, Z. Benahmed Daho, N.Simoni, Chunyang.Yin: An Informational Framework for Autonomic Networking (2006)

[DS03] Z. Benahmed Daho, N.Simoni, Provisioning process: from customer needs to resource allocation (2003)

[DS04] Z. Benahmed Daho, N.Simoni: An information model for service and network management integration: from needs towards solutions (2004)

[DS06] Z. Benahmed Daho, N.Simoni,: Towards Dynamic Virtual Private Service Networks: design and self-management», IEEE/IFIP NOMS'06, Vancouver, Canada (2006)

[LLC03] Hyejeong Lee, Sung Won Lee, Dong-Ho Cho: Mobility Management Based on the Integration of Mobile IP and SIP in Next generation Mobile Data Networks (2003)

[MK04] J. Manner, Ed. M. Kojo, Ed. Category: Network Working Group Request for Comments: 3753 Mobility Related Terminology (2004)

[Mo05] Motorola UMA: A residential seamless mobility solution white paper (2005)

[NMH04]Naoki,I., Manabu, I., Hiroki,H.: Flexible and Seamless Service Migration for Real-time communication with ubiquitous and Heterogeneous networked devices (2004)

[NDS03] Nilanjan B, Sajal K DAS, Spencer D.: Mobility support in wireless Internet (2003)

[NSB04] Tarek Nadour, Noémie Simoni, Antoine Boutignon: Architecture Engineering: Mastering Architecture Evolution and Traffic Engineering Rules IEEE International Conference on Communication (ICC'04) (2004)

[RS04] Sasan Rostambeik, Noemie Simoni,: Userware: Virtual Service Access towards Usage Integration", NGNM, Athens, Greece Networking (2004)

[SW00] Schulzrinne, H., and Wedlund, E.: Application Layer Mobility using SIP, ACM Mobile Computing and Communications Review, vol. 4, no.3, 2000, 47-57.

[Um04] UMTS 22.70 version 3.0.0: Universal Mobile Telecommunications System (UMTS); Service aspects; Virtual Home Environment (VHE) (2004)

[Ie06] IEEE Draft 802.21: Draft IEEE Standard for Local and Metropolitan Area Networks: Media Independent Handover Services (2006)

[Va00a] Vakil, F., Dutta, A., Tauil, M., Baba, S., Nakajima, N., Shobatake, Y. and Schulzrinne, H.: Supporting Service Mobility with SIP, IETF, 2000

[Va00b] Vakil, F., Dutta, A., Chen, J., Tauil, M., Baba, S., Shobatake, Y. and Schulzrinne, H.: Mobility Management in a SIP Environment, IETF, 2000