Generic architecture and functionality to support downloadable service provision to mobile users

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Abstract: The evolution of 3rd generation mobile systems introduces a new era in advanced multimedia service provision to mobile users. The concepts of service adaptability, downloadability and network reconfigurability based on terminal and user profiles and capabilities are aspects to be considered in the context of future mobile systems and networks enabling new approaches in service provision. In this paper, a generic architecture and functionality is presented for third party service registration, discovery, management and adaptable provision to mobile users.

I. Introduction

With the evolution of broadband and 3rd generation mobile communications, the software reconfigurable radio system and network concept has been heralded as potentially offering a pragmatic solution for the provision of a wide range of sophisticated services to mobile users, such as teleservices (including voice, video and data) and other bearer capabilities. The most significant near term impact of reconfigurability is likely to be in the field of service and applications innovation, as a tool to allow rapid and flexible service customization and new degrees of operator differentiation. Contrary to the application specific mobile system design for 2nd generation systems, the potentials for flexible and adaptive service offerings that can be supported by the introduction of reconfigurable mobile systems and networks pave the path for advanced service provision schemes.

Implementing flexibility and adaptability becomes an issue of functionality and interface definition to ensure conformity with any manufacturer design by keeping proprietary realizations for competitive design. Hence, appropriate models and specifications have to be used to standardize all interactions as detailed as necessary with maximized freedom for changes, flexibility and proprietary solutions. Modeling features such as flexibility and adaptability implies strong reconsideration of existing approaches. Therefore, in order to meet the requirements for flexible service introduction, adaptability and reconfigurability in future mobile systems and networks various efforts have been undertaken by standardization work groups and fora towards the introduction of novel models and integrated architectures and interfaces enabling services to be offered also by independent service providers. Such efforts have been made by the 3GPP (3rd Generation Partnership Project) and ETSI with the introduction of the OSA/OISP [1] concepts, by the OSGi (Open Services Gateway initiative) [2], MExE [3] and other groups. This has lead to new approaches in viewing the role of operators/ISPs (e.g., in IETF), and the way operator differentiation can be achieved with the support of service offerings by independent Value Added Service Providers. The main aspect of the aforementioned models and approaches is the introduction of open generic interfaces between the network and the service providers for the deployment of multiple services, as well as to enable operator and third party applications to make use of network functionality through an open standardized interface (e.g., the OSA API).

In order to fulfill end-to-end QoS requirements, implement service discovery and support of adaptable service provision (based on terminal and network capabilities) and finally to support flexible charging schemes taking into account the transport and service charges (flow, QoS, duration, bearer etc.) the introduction of new functional components incorporating the necessary intelligence for service discovery, management and charging, terminal capabilities negotiation and user / service profile management is necessary.

In the following sections of this paper a generic architecture for third party VAS provision to mobile users will be introduced, and in more detail the work regarding the implementation of the VAS Manager (VASM) will be presented. The VASM is the component incorporating the necessary intelligence for third party service introduction and management, handling the terminal capability negotiation, the respective service discovery and adaptable service offering. Finally, in the last section, the conclusions will be presented.

II. An integrated generic architecture for VAS provision to mobile users

For the interaction and download of available VASs to mobile users an integrated application architecture is introduced (Figure 1). The various VASs will be provided by independent Value Added Service Providers (VASPs) interconnected to a network via a VASP network infrastructure. Towards this goal new specialized functional components are introduced. The functionality of these components is complementary to the functionality of the framework and modules introduced by architectures like OSA/OISP, OSGi etc.

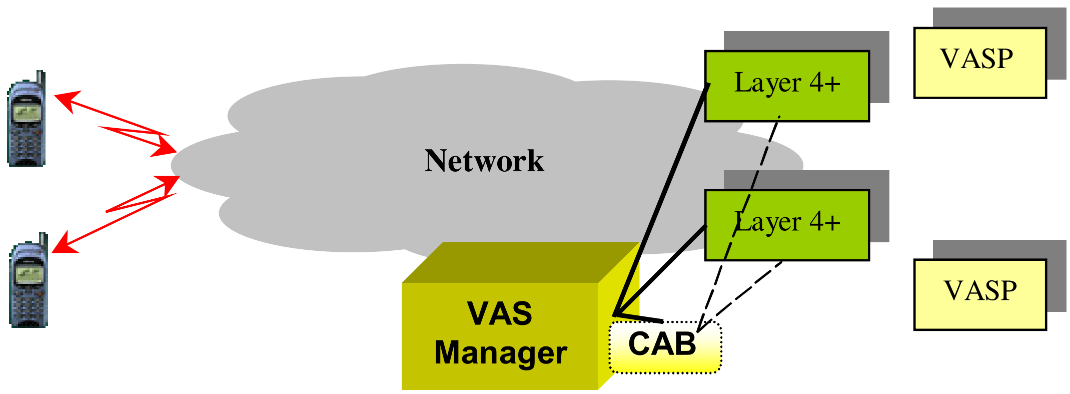

Figure 1. Generic architecture for VAS provision to mobile users

In the architecture presented in Figure 1, the intelligence required to implement the adaptation functionality that enables service portability is congregated in the network infrastructure, thus lowering requirements on mobile terminals and extending the service provision domain. The mobile terminal need not adapt to the service requirements; rather the service delivered via the download mechanisms is adapted to the mobile terminal capabilities by the platform. The respective service discovery procedures also provide for service personalization by accounting for information contained in the user profile [4].

The proposed model for service provisioning allows the logical demarcation between network and terminal specific components. Thus, service portability can be achieved via downloadable technology-specific (e.g. WAP, Java) movable parts that simply conform to an interface specification towards the stationary part.

Furthermore, the application of layered charging approaches [5] enable flexible cost allocation practices and pricing policies, as well as the independent evolution of business strategies for the players engaged in the service provision process, i.e. the network operator and the VASPs.

The VASM co-ordinates the required procedures for service registration and personalized/consistent discovery and provision of VASs to mobile users.

The Layer 4+ routing systems functionality includes filtering IP traffic, monitoring of specific flows and QoS provisioning. These functions are performed by examining transport and application layer information in addition to the network layer data used by conventional IP routers. In the proposed architecture the L4+Sys devices are located between the VASPs and the network so that they process all traffic between VASPs and users. They are configured by the VASM to monitor and provide QoS to specific IP traffic flows that correspond to VAS usage. The collected information that is necessary for charging is formatted into VAS Detail Records (VASDRs).

The CAB (Charging, Accounting, Billing) system deals with the charging, billing and accounting operations induced by a service downloading and access procedure. The CAB using the VASDRs and the information provided by the network for the usage of its resources and the respective configuration performed by the VASM calculates the user charge and apportions that revenue among the operator and the other parties.

The architecture proposed is flexible, portable to various types of networks and radio systems and is also application independent. Finally, there are no limitations posed to the way the services are developed by the VASPs (language used etc.).

III. VASM functionality and internal design

The central and coordinating component in the proposed architecture is the VASM. It serves as a mediator between the interconnecting network infrastructure, the VASP network, the access network and the mobile users. The VASM is responsible for a number of important tasks including mechanisms for:

- VAS discovery,
- VAS data management,
- VASP and user authentication and
- Adaptation of VAS provision to user preferences and terminal characteristics.

Figure 2 depicts the internal structure and interfaces of the VASM, in the form of a Specification and Description Language (SDL) block diagram.

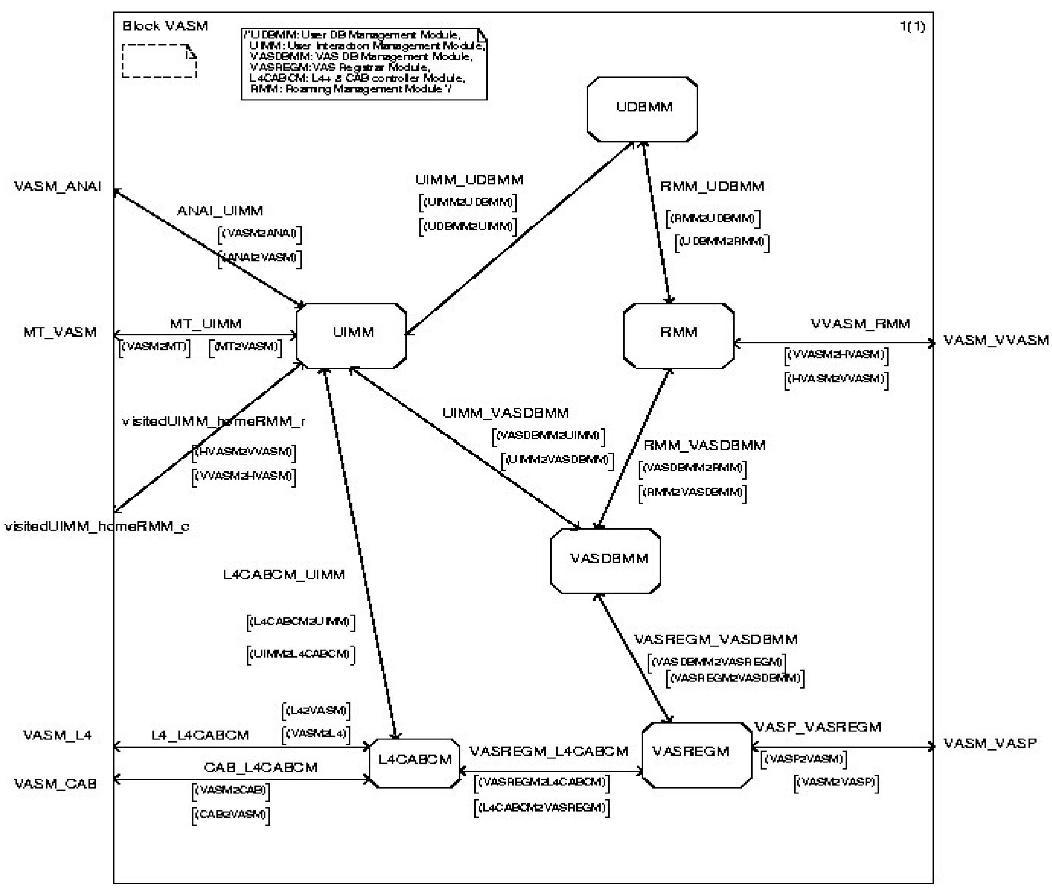

Figure 2. Internal structure and interfaces of the VASM

The ***User Interaction Management Module (UIMM)*** is responsible for all interactions with users regarding service discovery, VAS listings formulation, terminal classification, user location identification, user registration and authentication and user notification.

The ***User DB Management Module (UDBMM)*** manages the user specific information stored in the User Data Base (User DB), such as the user preferences and user registration/authentication data, and serves all procedures that demand such information (e.g., user authentication/registration, VAS listings formulation, etc.).

The ***VAS DB Management Module (VASDBMM)*** manages the VAS specific information stored in the VAS Data Base (VAS DB) and serves all VAS associated procedures (e.g., VAS registration/update, VAS listings formulation, etc.).

The ***Roaming Management Module (RMM)*** serves the subscribers of an operator that currently roam outside the Home network, providing with user specific and Home VAS specific information the VASMs of those visited operators contracted with roaming agreement.

The ***Layer 4+ system and CAB Controller Module (L4CABCM)*** handles the interactions with the CAB system and performs the configuration of the L4+ system.

The ***VAS Registrar Module (VASREGM)*** handles the VASM-VASP interactions regarding VAS management, such as the VAS registration, de-registration and update functions.

IV. VAS Management

With the proposed architecture, 3rd party service providers have the ability to offer their VASs in the form of downloadable applications.

A service can not be made available to mobile users before it is registered with the VAS provision platform by the corresponding VASP. This is accomplished through automated procedures that perform all the re-configuration actions that are necessary to accommodate the new service. These actions include recording the service data in a database (VAS DB) maintained by the operator and the configuration of the L4+ system to monitor the traffic flows concerning access to the specific service. VASPs are also able to update information regarding a specific VAS or remove it from the platform.

In the following paragraphs we first provide a brief description of the concept of downloadable VASs and then outline the VAS data management procedures in the proposed architecture.

A. The concept of downloadable VAS

A service consists of a movable (downloadable) and (optionally) a stationary part. The former is downloaded and executed on-demand at the mobile terminal. Service execution typically, but not necessarily, includes interaction with the stationary part, that is a remote server residing in the VASP premises (e.g., web server). Since 3rd generation networks offer to the terminals transparent access to external IP networks, client code in principle is not affected by the fact that the service is used by mobile users. Moreover, no limitations to service implementation are imposed by the proposed architecture. However, to be suitable for certain classes of terminals the services should comply to standardized mobile terminal execution environments, as defined by 3GPP [3].

There may be many versions of a specific VAS, targeted to particular classes of terminals and accommodating different user preferences. To this end, for each VAS there will be a core part that will provide the basic VAS functionality, complemented by a customised part to produce a full VAS version. Examples of terminal characteristics that are crucial for differentiation of VAS versions are screen size, keyboard, operating system, while the service client language is a typical user preferences attribute that varies between versions.

After receiving a user request for accessing a specific service, the VASM provides the appropriate version based on the characteristics of the current terminal and the user profile.

B. VAS data management procedures

The VASPs are able to register new services with the platform, as well as delete and update existing VASs. These tasks are automated in the proposed system. However, they are preceded by off-line business-level agreements between operator/ISP and VASPs. All the above mentioned on-line procedures are initiated by the VASPs and consist of the following phases:

- Mutual authentication of operator/ISP and VASP.
- Formulation of the request by the VASP via a Web interface (form) in a known, operator-specific URL. The request will include all the necessary service data. Data entry can be performed by filling appropriate fields in the web form or by providing all the required information as an XML document [6], conforming to a Document Type Definition (DTD), supported by all operators. The latter simplifies the procedure for the VASPs, since a VASP can register a VAS with many operators using a single XML description of the service. A (simplified) example of such a XML document containing VAS information is depicted in Figure 3.
- Validation checks on the data provided by the VASP.
- Appropriate update of the VAS DB (insertion, deletion and modification).
- Configuration of the L4+ switches so that the traffic flows concerning VAS access are monitored and the corresponding charging records are produced.
- User notification (not applicable to registration). In the case that a “significant” attribute of a VAS is updated (e.g. increase of service tariffs, change of network address) or a service is deleted from the platform, the users that are currently accessing the service should be notified of this fact, so that customer dissatisfaction is avoided. For example, assuming that the VAS tariffs are updated to a significantly higher value, the end user could end up having to pay a much larger bill than expected. Notification could allow users to close the service session as soon as the service tariffs are increased and thus avoid any undesired charges.
- The VASP is informed of the outcome of the operation.

It is worth noting that the overall system operation is not interrupted during the above procedures and VAS provision is not affected by them.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VAS_INFO "VASInfo.dtd">
<VAS_INFO>
      <VAS>
            <VASPPublicKey>365636</VASPPublicKey>
            <VASID>1</VASID>
            <VASName>Soccer results</VASName>
            <VASVersion>2</VASVersion>
            <VASDes>Results of national soccer leagues</VASDes>
            <Language>English</Language>
            <ValidLocation>Greece</ValidLocation>
            <Category>Sports, Soccer</Category>
            <Keywords>Soccer</Keywords>
            <Availability>Yes</Availability>
            <IPRProtect>No</IPRProtect>
            <Confidentiality>Yes</Confidentiality>
            <SecurityDomain>Operator</SecurityDomain>
            <Proxy>
                        <ProxyID>2</ProxyID>
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                        <ProxyDescription>Plain text
version</ProxyDescription>
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                        <IPAddr>195.138.67.173</IPAddr>
                        <IPPort>8080</IPPort>
                        <PricingModelNumber>1</PricingModelNumber>
                        <TariffClassNumber>1</TariffClassNumber>
                        <CostDescription></CostDescription>
                        <L4Timeout>12</L4Timeout>
            </Proxy>
      </VAS>
</VAS_INFO>
```

Figure 3. An XML document containing VAS data.

V. Service discovery and provision

Taking into consideration the huge range of services available to the mobile users of the forthcoming 3rd generation communication networks, the demand for an efficient and easy mechanism for VAS discovery and provision, adapted to the terminal capabilities, user preferences and user location, is rapidly raising. The proposed platform addresses this challenging issue.

The VASM, which is situated at the interconnecting network infrastructure (e.g. at an operator's core network), co-ordinates the required procedures for personalised discovery and seamless and consistent provision of VAS to the mobile users. In the proposed architecture discovery of VASs registered in the home network shall be performed either when the subscriber is at home or while is roaming, while discovery of VASs registered in contracted visited networks shall be performed only when the subscriber is roaming.

In order to allow discovery by subscribers, the VASM, at first, caters for the dynamic introduction and registration of new VASs in the VAS DB based upon qualitative, beneficial and accounting criteria. Then, through a personalised and web-browsing like user interface, the VASM provides subscribers with the ability to discover and choose which of the registered services they wish to download and use. This is accomplished through the service discovery client (or proxy according to the adopted terminology) that is downloaded to the terminal and which, at a minimum, offers options for:

- Viewing listings of the registered services classified in subject categories (Look-Up Service menus).
- Accessing the user's "favorite" services (Favorites VASs menu).
- Performing keyword-based searches for VASs.

The type of this client depends on the terminal capabilities (e.g. the runtime platforms and profiles installed in the device) and user preferences (e.g. the preferred language of the subscriber) announced to the VASM by the terminal upon its registration to the platform. Each request for service discovery, apart from the user selections for the VASs content indicates to the VASM the capabilities of the requesting terminal, along with the identity of the network location that the terminal has currently entered. The requested VAS listings are presented to the users after filtering the VAS DB records according to the current terminal capabilities, the user location, the user selections and the user preferences specified in the user profile. The prime form of a "Look-Up Service menu" listing basically includes the VASs in the VAS DB that match the selections of the user. Gradually and following the selections of the user the content of this listing is further refined. The final form of the Look-Up menu includes the different available versions of the selected VAS (full version/degraded versions) that the requesting terminal can execute. Similarly, the content of a "Favorites VAS menu" listing includes the VASs from the Favorites menu of the user that the requesting terminal can execute (based on the current combination of terminal capabilities/user preferences/user location). Each VAS in such listings is associated with a short description and indicative tariffing information. Following the service discovery phase the user is able to select the desired VAS client and to initialise the VAS downloading procedure.

Since a subscriber may access the network from different terminals with highly varying characteristics, adaptation to its terminal capabilities is required. Therefore, a universal, flexible format for representing terminal capabilities, as well as an efficient, interoperable way for their announcement to the serving VASM are necessary. To this end the proposed scheme adopts the fundamentals defined in [7][8][9][3] for terminal capabilities propagation. Customisation of service provision according to personal, generic user preferences is achieved via the maintenance of a user profile. Issues such as user profile optimal distribution, representation format and efficient retrieval mechanisms are thoroughly investigated and relevant solutions are introduced in the proposed architecture. These solutions complement relevant work in progress of standardization bodies [10][4], since several of these matters are not currently covered by standardization.

The MSC in Figure 4 (as derived by the simulations that have been performed following the SDL specification of the VASM functionality) depicts the message exchange that takes place between terminal and VASM, following a user 's request for service discovery in the Home network.

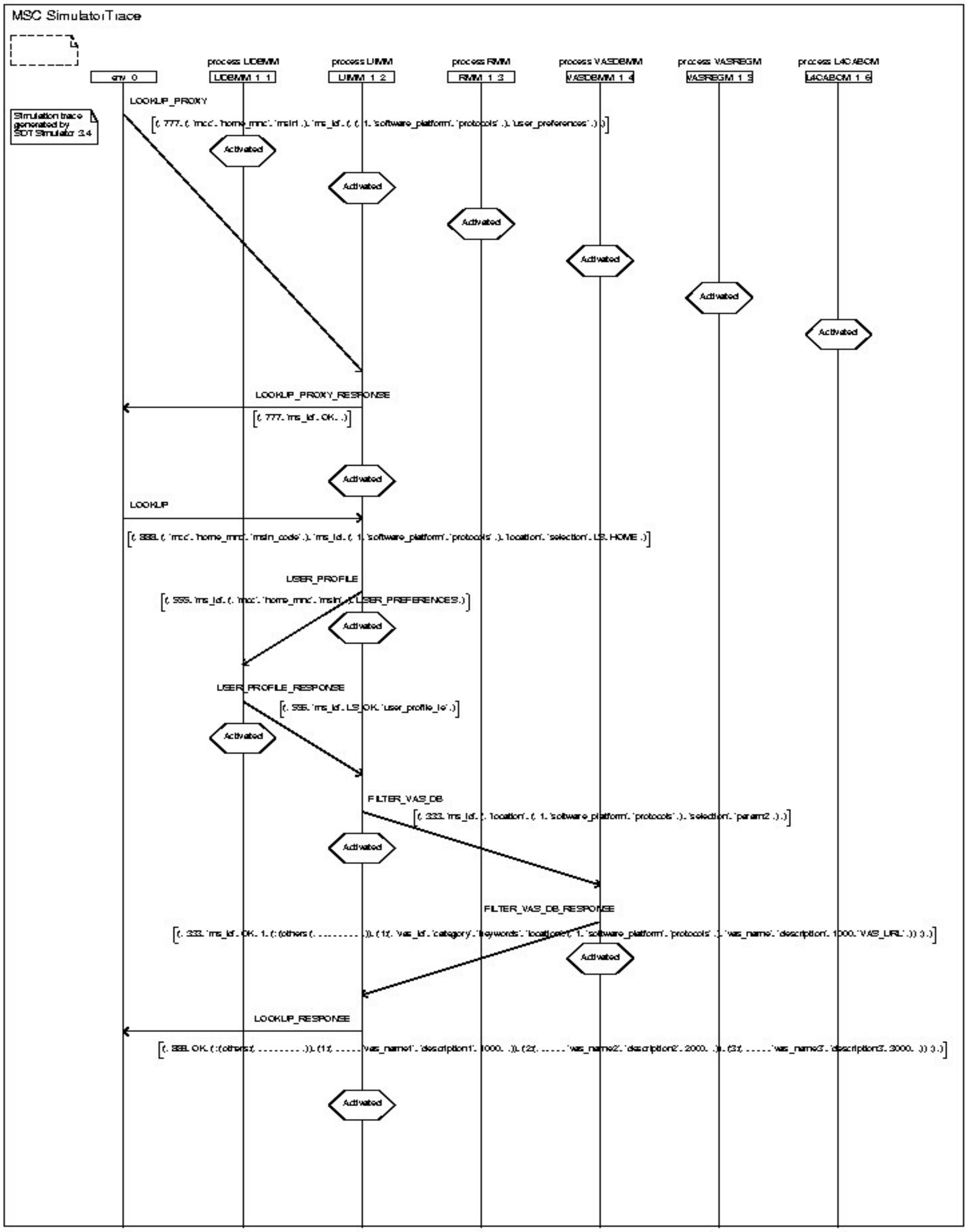

Figure 4. Simulation-part of the interactions between mobile terminal-VASM regarding service discovery in the Home network

VI. Conclusions

In order to support service adaptability and reconfigurability in mobile networks and systems, new models and architectures have to be considered for the introduction of the required functionality and respective components.

In this paper a generic architecture for Value Added Service provision to mobile users was introduced and the functionality of the basic components incorporating the necessary intelligence for VAS management and support of adaptability and reconfigurability aspects was presented. The functionality described is complementary to the work performed in the context of various working groups and standardization fora and provides an integrated solution for the support of service registration, discovery, management and download to mobile users with various terminal capabilities and profiles.

VII. Acknowledgements

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