Integrated Generic Architecture for Flexible 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[1] and functionality is presented for third party service registration, discovery, management and adaptable provision to mobile users.

I. INTRODUCTION

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. 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 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 service discovery requirements and support of adaptable service provision (based on terminal and network capabilities) and finally to apply 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 framework for reconfigurable service provision to mobile users is introduced, and in more detail the requirements that must be fulfilled by a Reconfigurability Control and Service Provision Manager are presented. Such a component has to incorporate the necessary intelligence for third party service and network reconfiguration, handle the terminal capability negotiation, the respective service discovery and adaptable service offering, based on the open interfaces and interaction with the services. Finally, in the last section, conclusions will be presented.

II. A FRAMEWORK FOR SERVICE PROVISION THROUGH RECONFIGURABILITY

The forthcoming abundance of 3G services that will be typically developed by many co-operating entities and will need to be deployed on multiple types of networks significantly complicates service deployment and

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provisioning and demands a higher level of intelligence and flexibility from the underlying network. Therefore, a need is emerging for intelligent and flexible service provision platforms that will mediate between service developers, network operators and end-users. Challenging issues that need to be addressed by such platforms include the following:

- *Network reconfiguration for optimal service provision*. The multitude of available services, with highly diverse requirements from the network, creates the need for a dynamic and intelligent way of adapting the network to enable optimal service provision. Some examples of the types of reconfiguration actions that would be useful in a mobile network are the following:

a) *Quality of Service (QoS) provisioning*. Network equipment (e.g., routers) could require changes in their configuration, so that they can identify the transport flows corresponding to the usage of a particular service and provide them with the desired QoS. The desired QoS for a service access session by a particular user may be specific to the service (e.g., certain services may require a minimum QoS level to be accessed) and may also depend on the identity and preferences of the user.

b) *Charging and billing*. The system (e.g., as described in [4]) used to gather service usage data, process it and calculate the corresponding charges for the end-user, should be dynamically reconfigurable. This is the only way it can take into consideration the various charging-related events occuring in the network (tariff updates, tariffing policy changes) and subsequently produce an accurate user bill.

c) *Dynamic software downloading*. The optimal provision of a service may necessitate certain software elements to be installed dynamically to the terminal or some place in the network during service deployment or activation. For example, due to limited bandwidth available at the radio communications link, certain service content (e.g., images, audio) should be drastically compressed, so that it can be transmitted in real-time to the user terminal. To do that, an appropriate codec could be downloaded to a node at the edge of the mobile operator's network as well as the terminal.

- Rapid deployment and efficient management of disparate services. Services should be introduced dynamically to the network by their developers, thus reducing time-to-market and increasing the range of services available to end-users. Moreover, post-deployment service management functions like usage monitoring and charging and billing are particularly critical for the commercial exploitation of a service. All these operations should be automated to the highest degree possible.

- Creation of a service one-stop-shop for end-users, where the discovery and optimal provision of a huge number of unrelated services is performed from a single user interface, and is customized to terminal characteristics and user preferences. This, to a large extent, should save users the time and effort of locating and getting familiar with what they need in the plethora of available applications.

In Figure 1 such a framework for flexible, ubiquitous service provisioning is introduced. The RCSPM includes various functions necessary for service deployment and optimal provision, including facilities for network reconfiguration. The RCSPM interfaces with the mobile user (user access session, service discovery, user profile management) and the service developers (service registration with the framework and deployment).

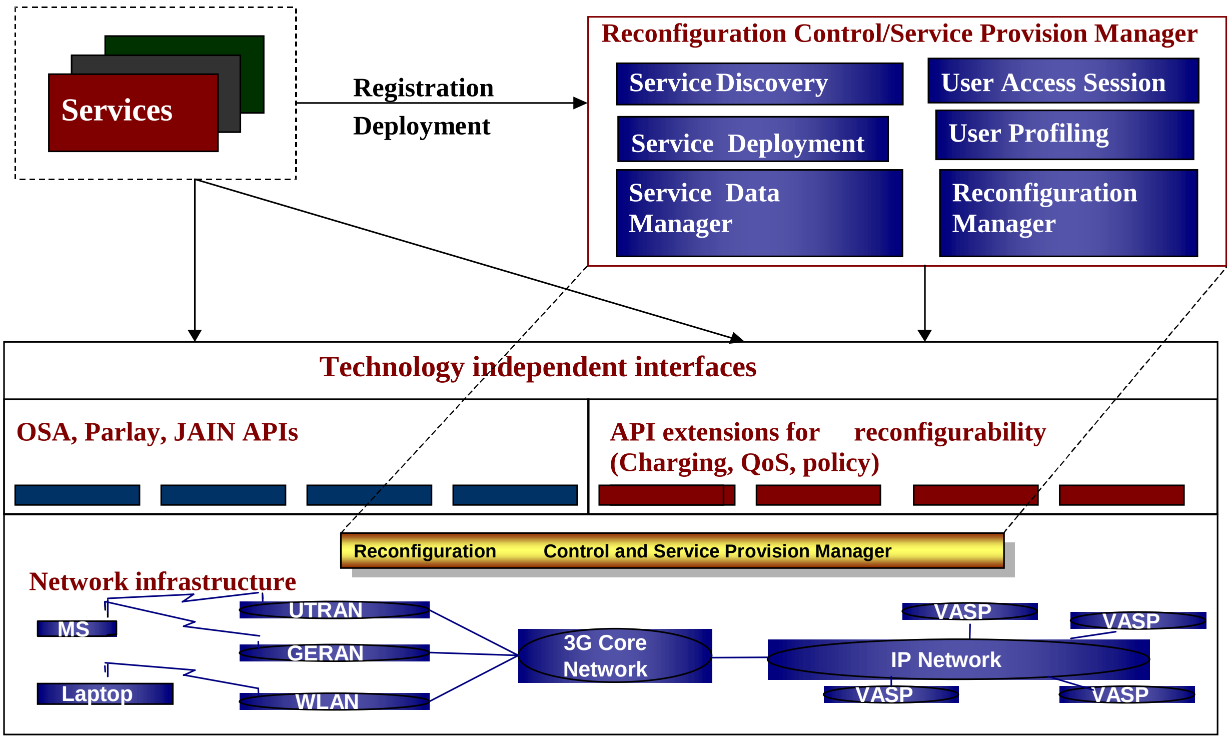

Figure 1. Generic framework for reconfigurable service provision.

Furthermore, standard open network APIs introduced by various standardisation fora and working groups (e.g., OSA) are enhanced with interfaces enabling authorised 3rd party applications to perform reconfiguration actions on the underlying network (e.g., QoS, billing policy).

In more detail the RCSPM cosists of the following modules:

- **The Reconfigurability Manager.** This module serves and supports all the reconfiguration actions that are performed to the underlying network infrastructure. Reconfigurations actions typically are triggered in two ways: 1) By the VASPs during the service deployment (registration) procedure. The necessary reconfiguration actions are identified from the XML-encoded service definition fed by the VASP to the Service Deployment Manager. The latter forwards the appropriate requests to the Reconfigurability Manager. 2) By the services themselves during service execution. Through the reconfigurability extensions to the open network APIs, as shown in Figure 1, network reconfiguration functionality is directly accessible to authorised 3rd party applications. This functionality is implemented via the Reconfigurability Manager. The latter maps actions to interfaces of system elements (e.g., routers, billing system).
- **The User Access Session Manager.** A user should log-in with the RCSPM before he can access the services registered with the platform. State information is maintained during the lifetime of a user RCSPM access session.
- **The Service Discovery Manager.** This module enables mobile users to quickly and efficiently discover the services registered with the RCSPM. Searches for services can be performed according to criteria such as category and keywords. The service listings produced contain all information that can be useful for a user to select a service (service description, indicative tariffs, etc.). These listings are tailored to the capabilities of the current terminal as well as the user preferences (e.g., language, favourite services). A terminal capability announcement mechanism and user profile information is used, respectively, for these purposes [5].
- **The User Profile Manager.** The RCSPM includes user profiling logic, to enable service discovery and provision according to user preferences. The user profile contains information such as user identification data (e.g., name, IMSI, security keys), generic, service independent user preferences (e.g., language, default tariff class), user interface preferences (e.g., font size, preferred media type), as well as a list of user-specific favourite services. The system gives the user the ability to view and update user profile information at any time.
- **The Service Deployment Manager.** Through this module the VASPs are able to register their services with the RCSPM framework and thus make them available to mobile users. Service deployment includes insertion of the service information in the service database, as well as certain reconfiguration actions in the network (e.g., configuring network equipment to produce service usage monitoring information). The actions that should be performed during service deployment are determined by a service definition that is provided by the VASP. XML is a highly appropriate way of encoding the service definition. An example service definition in XML is shown in Figure 2. This definition obeys to an appropriate XML Document Type Definition (DTD).

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE SERVICE_DEFINITION
"service_definition.dtd">
<SERVICE_DEFINITION>
 <Service>
   <SAPPublicKey>365636</SAPPublicKey>
   <ServiceID>1</ServiceID>
   <ServiceName>Soccer results</ServiceName>
   <ServiceVersion>2.2</ServiceVersion>
   <Description>Results of national soccer
     leagues</Description>
   <Language>English</Language>
   <Category>Sports/Soccer</Category>
   <Keywords>Soccer</Keywords>
   <Availability>Yes</Availability>
   <ServiceVersion>
      <ServiceVersionID>2</ServiceVersionID>
      <ServiceVersionName>Light
       Edition</ServiceVersionName>
      <VersionDescription>Plain text
       version</VersionDescription>
      <MexeClassmark>2</MexeClassmark>
      <SoftwareReq>
         <JVM>
           <Edition>Personal Java</Edition>
           <Version>1.2</Version>
         </JVM>
      </SoftwareReq>
      <TransProtocol>TCP</TransProtocol>
      <QoSIndicator>23</QoSIndicator>
      <URL>http://www.soccer.gr/results</URL>
      <IPAddr>195.138.67.173</IPAddr>
      <IPPort>8080</IPPort>
      <PricingModelNum>1</PricingModelNum>
      <TariffClassNumber>1</TariffClassNumber>
      <CostDescription></CostDescription>
      <DSERTimeout>12</DSERTimeout>
   </ServiceVersion>
 </Service>
</SERVICE_DEFINITION >
```

Figure 2. An XML-encoded service definition

- **The Service Data Manager.** This module is an interface to a database of services that is maintained by the administrative entity operating the RCSPM (typically, a 3G mobile operator). This information is used for service discovery, and also for billing purposes. The service database may be dynamically accessed and updated by the VASPs.

III. AN INTEGRATED ARCHITECTURE FOR VAS PROVISION TO MOBILE USERS

For the interaction and provision of available VASs to mobile users an integrated application architecture, implementation of the reconfigurable framework proposed, is introduced (Figure 3). The various VASs will be provided by independent Value Added Service Providers (VASPs) interconnected to a network via a VASP network infrastructure. Towards this end new specialized functional components are introduced.

In the architecture presented in Figure 3, the intelligence required to implement the adaptation functionality enabling service portability [6] is congregated in the network infrastructure, thus lowering requirements on mobile terminals and extending the service provision

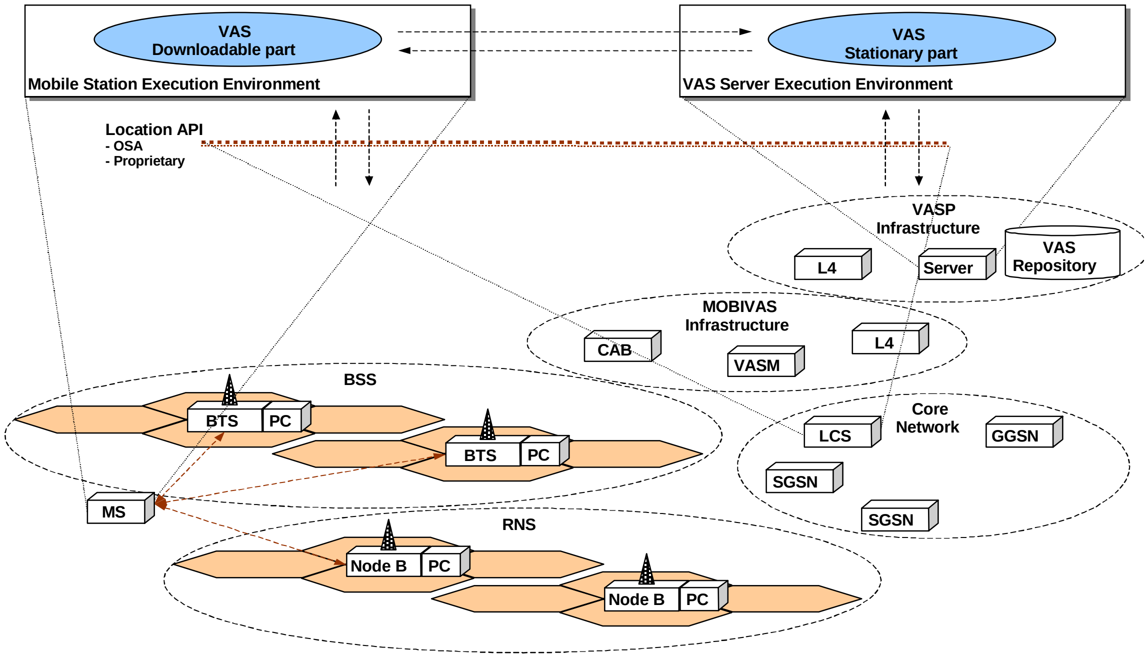

Figure 3. Generic architecture for VAS provision to mobile users

domain. The respective service discovery procedures also provide for service personalization and customisation by accounting on information contained in the user profile.

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 [7] 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, implementation of the RCSPM, co-ordinates the required procedures for service registration and deployment 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.).

IV. SERVICE DISCOVERY AND PROVISION

Taking into consideration the huge range of services available to the mobile users of the forthcoming 3rd generation networks and the competitive nature of the new era, the demand for providing mobile subscribers with an efficient and simple mechanism for personalised VAS discovery and provision, as well as charging for VASs usage, is rapidly raising. The proposed platform addresses this challenging issue.

To support the realization of these mechanisms the standard UMTS infrastructure must be supplemented with an intelligent mediating component [8], the VASM, providing a registrar for value-added services. The existence of this mediator will be announced to the subscribers, possibly as a parameter of the subscription details, and will export operational interfaces toward the involved players: a) The value-added service provider: For the dynamic registration, update and de-registration of value-added services with the Service registrar. b) The subscriber/user: To support the personalised discovery and browsing of value-added services in the service registrar, as well as the negotiation of terminal capabilities, user preferences and location with the platform.

In such architecture the concept of customisation is of great importance since it offers enviable opportunities for personalisation of service provisioning and adaptation to the users requirements. To provide an intelligent VAS discovery mechanism, the mediating

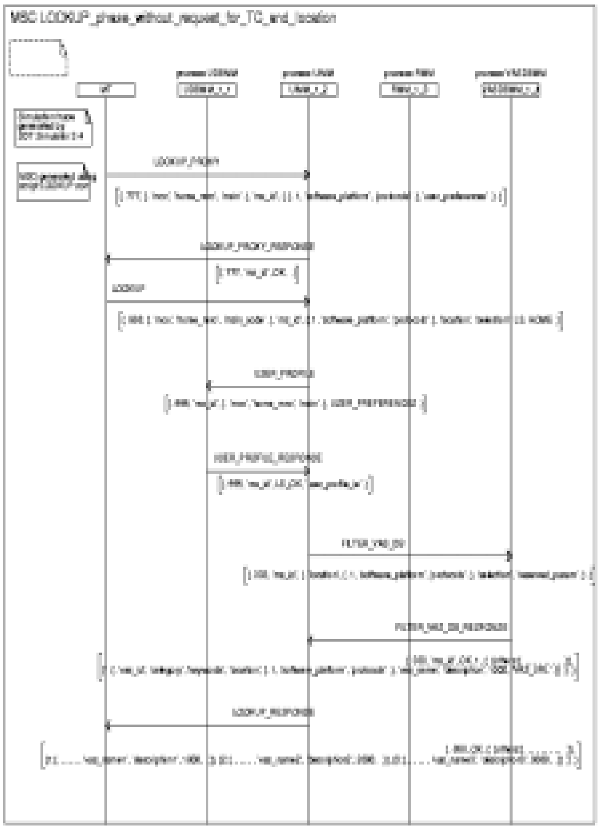

Figure 4. Simulation-part of the interactions between mobile terminal-VASM regarding service discovery in the Home network

component between VASs and users, caters for the provision to the subscribers of listings with the registered and available VASs in the serving network that only apply to the location area, the preferences and the terminal device of the user. Through these listings the user will be given the ability to readily select the VASs he desires. Taking into account the location of the requesting user (if authorised by the user), as well as the applicable preferences from the user profile and terminal capabilities, the mediating component is able to filter the amount of available local services to restrict their number into those that only obey the aforementioned combination. As a consequence the user is presented with customised and personalised VAS listings. Such a mediating component could be situated either on the network of the interconnecting, serving operator or somewhere on the external IP world. In the former the location-specific information of the user is obtained by direct communication with the LCS server of the network, while, in the latter, interaction with the OSA API might be required. The same stands for the retrieval of the User Profile and the terminal capabilities specific information. Additionally to the VAS discovery mechanism, which takes into consideration the location of the user, the User Profile information might also be location sensitive. By discriminating user preferences according to the location (e.g., Home, office, vacation) and the time of the day and by maintaining different User Profiles for each instance (e.g., Home-, office-, vacation- dependent Profiles) [9], better personalisation and customisation can be achieved during the service filtering mechanism. In such a case the service discovery function takes into account only the profile that better applies to the current location and status of the user, customising the VASs filtering and provision accordingly.

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 the request of a user for discovering the services of the serving network.

V. 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.

REFERENCES

[1] 3G TS 29.198 version 4.0.0: "Open Service Architecture; Application Programming Interface”.

[2] OSGi, "Specification Overview", version 1.0, January 2000.

[3] 3G TS 23.057 version 4.2.0: "Mobile Station Application Execution Environment (MExE); Functional description; Stage 2".

[4] M.Koutsopoulou et al., “Subscription Management and Charging for value Added Services in UMTS Networks”, VTC2001, May 2001, Rhodes, Greece.

[5] CC/PP working group home page, http://www.w3.org/Mobile/CCPP/.

[6] 3G TS 22.121: “Service aspects; The Virtual Home Environment (version 5.0.0)”.

[7] V. Gazis et al., “A flexible charging & billing approach for the emerging UMTS network operator role”, SCS ATS 2001 conference, April 22-26, Washington, USA.

[8] S. Panagiotakis et al., “Generic architecture and functionality to support downloadable service provision to mobile users” 3GIS Symposium 2001, Athens, Greece, July 2001.

[9] N. Houssos et al., “A VHE architecture for advanced value-added service provision in 3rd generation mobile communication networks” GLOBECOM2000 Workshop on Service Portability, December 2000, San Francisco, USA.