ADVANCED BUSINESS MODELS AND FLEXIBLE SERVICE PROVISION FOR RECONFIGURABLE MOBILE SYSTEMS

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ABSTRACT

Reconfigurability is an important aspect of future mobile systems. It has enabled and introduced innovative perspectives in service provision. The support of advanced business models and flexible service provision, enabling service differentiation, customization, and personalization in the market of 3G and 4G mobile services and applications are key aspects of the technical advancements in the respective mobile systems and networks. In this paper we introduce advanced business models for the support of flexible service provision as well as present a generic service management architecture that aims to support the applications of such models by enabling network reconfigurability and service adaptability mobile environments from 3G and beyond.

1. INTRODUCTION

With the evolution of broadband and 3rd generation (3G) mobile communications as well as the imminence of 4G systems, the reconfigurability concept has been heralded as potentially offering a pragmatic solution for the provision of a wide range of sophisticated services to mobile users [1]. Although reconfigurability research at its first steps focused primarily on the radio domain (RF processing, A/D conversion, etc) [2], currently a more innovative and forward-looking view is increasingly drawing interest. According to that, reconfigurability encompasses the entire service provision domain, extending from the mobile terminal through the network infrastructure to application services [3][4][5]. 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 [6][7].

Supported by an increasingly strong trend to renounce proprietary monolithic approaches and endorse more flexible modular architectures in communication network elements, reconfigurability is a critical enabler for the introduction of ubiquitous services and applications. Moreover, the convergence of the IP and telecom worlds is pointing at hybrid business models' support. In that context, the business models to be adopted in the new era are encompassing the active participation of third party Value Added Service Providers (VASPs), which will be able to offer their Value Added Services (VAS) through the operators' networks under the respective business agreements. Incipient architectures enabling advanced business model support and flexible service provision, comprise the specification of standardized open Application Programming Interfaces (open APIs) (e.g., OSA [8], Parlay [9], JAIN [10] and frameworks [12][15]. Such APIs hide the network heterogeneity that is likely to dominate the forthcoming mobile communications era by providing independence from the underlying network infrastructure to trusted third parties. Therefore, authorised third parties and VASPs can access network services, as well as develop and deploy their services and applications seamlessly, simply by using the standardized execution environment and the respective methods inherent to these APIs. However, in order to fully support advanced business models and flexible service provision, extensions of the existing standardised APIs with reconfiguration interfaces are required to allow policy based network and device reconfiguration and enable service adaptability, context awareness and third party business entity interaction.

The challenge for network operators is to attract and engage third-party application providers while protecting their networks from harmful misuse. The support of standardized APIs (such as the OSA [8], Parlay [9] and JAIN [10]) combined with the employment of intelligent

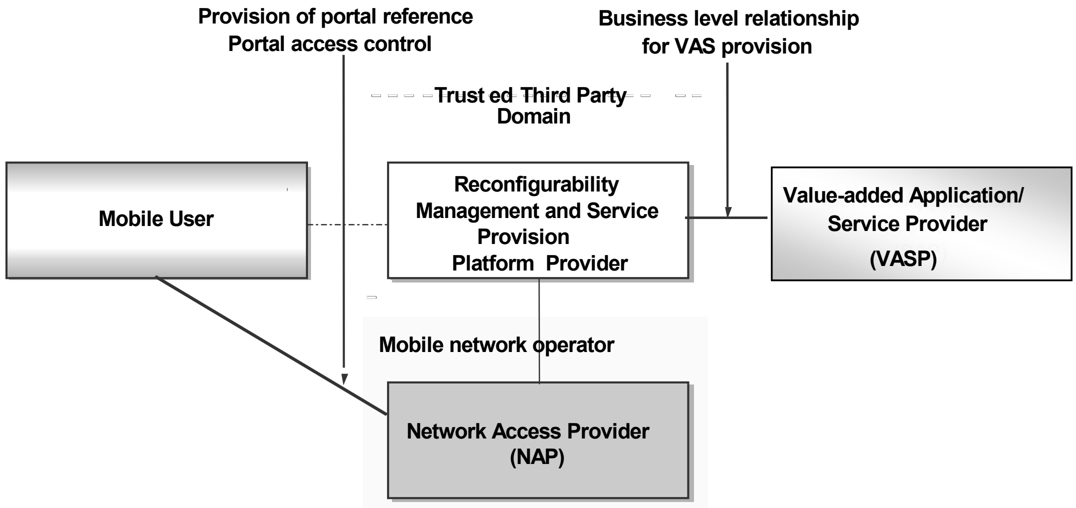

Figure 1 Business model for service provision in forthcoming mobile communications

service mediation is envisioned to enable various business entities in actively participating in flexible service provision, as well as to reduce the complexity involved in delivering applications developed by third parties over public switched and mobile networks [11][12].

Hence, the provision of an integrated open framework that will mediate between end users, network operators, VASPs and other business entities, simplifying and enriching the service provision with advanced features, is a very important issue for the emergence of advanced service personalization in 3G systems and beyond [3][4][5]. In the present paper the enhancement of the dominant business models and the introduction of advanced models incorporating business entities related to Value Added Service deployment and provision are presented in section 2. In section 3 a generic framework and architecture for the support of flexible service provision and reconfigurability management is introduced. Section 4 presents the current status and the future plans of our work and section 5 concludes the paper. The proposed model and architecture have partially been developed under the IST project MOBIVAS [13][14].

2. ADVANCED BUSINESS MODELS

The introduction of 3G systems is expected to be a major step towards a new era in telecommunication service provision. The transition from a rigid strictly operator-centric network to a dynamic open market should be evolutionary and lead to business models that preserve the positive features of the existing paradigms, while removing some of their limitations. Moreover, the convergence of the IP and telecommunications worlds will foster the emergence of hybrid models in service provision, context awareness, and reconfigurability.

The typical mobile network operator possesses significant strategic advantages in the emerging 3G market. In addition to a large subscriber base, it maintains the customer relationship and thus presents a form of “gatekeeper” for application and content providers seeking to position themselves in 3G markets. Furthermore, the 3G-network infrastructure provides integrated robust authentication mechanisms and rigid security features that establish an important level of trust between the 3G mobile network operator and its subscribers. On the other hand, application and content providers are able to provide an abundance of resources (i.e. applications and content) that can contribute greatly to increased revenues for all businesses involved. Moreover, the creation of a dynamic and highly profitable market requires the availability of sophisticated VAS management mechanisms. These mechanisms must allow VAS to be rapidly deployed, quickly and efficiently discovered by end users, and optimally provisioned for end users. Finally, VAS consumption charges must be calculated in flexible ways that make VAS usage more attractive to users. Therefore, we propose a high-level business model that capitalizes on the unique value-adding features of each participant. The roles of this model are shown in Figure 1.

In the proposed business model the following roles are defined:

Mobile User: An entity that is the actual consumer of the available services. The user requests the provision of services and applications from a VASP. The user employs a communication and computing infrastructure contributed by

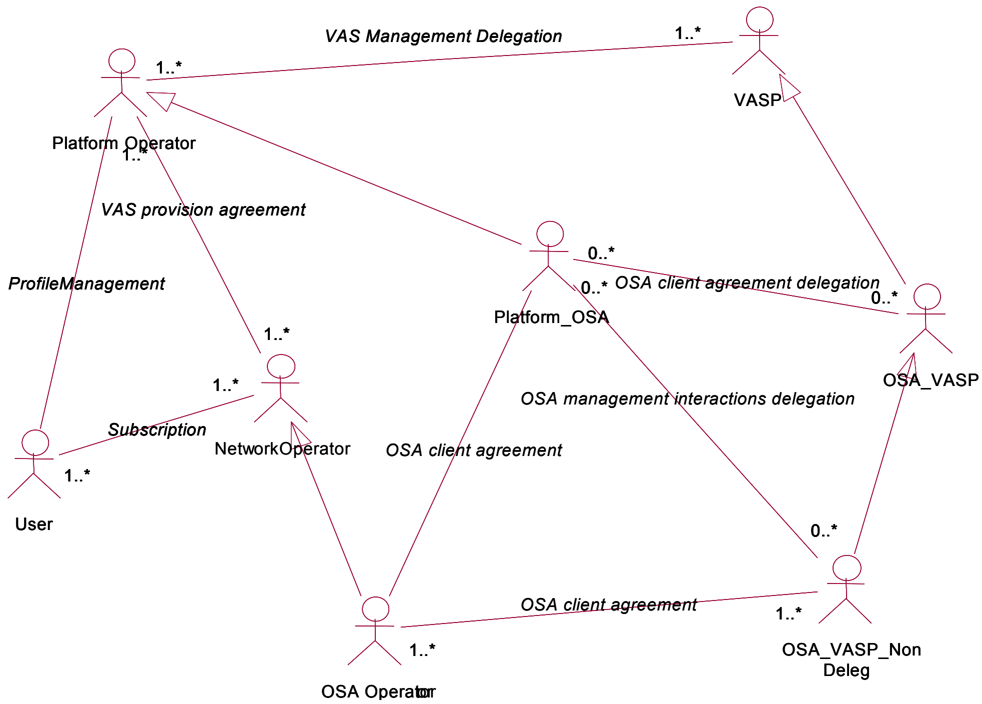

Figure 2. Business relationships and entities involved in flexible service provision

the mobile network operator with whom the user maintains a business relationship.

Mobile network operator: The mobile network operator is the entity that provides a network infrastructure and transport medium for authenticated and authorised mobile subscriber to access standardized circuit-switched and packet-switched services (e.g., voice telephony, Internet connectivity), as well as VAS and content developed by third parties. It also maintains the customer relationship with the user. The network operator will also typically provide independent trusted third parties and VASPs with access to network functionality, through either standardized open interfaces (like e.g., the Open Service Access (OSA) APIs [8]) or a service provision and reconfigurability management middleware.

Reconfigurability Management and Service Provision Platform operator: An entity that mediates between VASPs, VAS developers, network operators, and end-users by operating a software platform for VAS management and provision. The platform operator has agreements with network operators that give him access to the underlying network infrastructure, as well as with VASPs for allowing them to provide services and applications to the subscribers of the network operator.

Value Added Service Provider (VASP): An entity that controls the computational infrastructure utilised to provide applications and services. VAS can range from VoIP and teleconferencing to mobile banking and electronic commerce. VASPs have agreements with platform operators, outsourcing to them the deployment and provision of their VAS on various 3G networks. Business agreements between VASPs and users are not required; however, they are not precluded.

In the proposed paradigm, there is not necessarily a one-to-one relationship between roles and real-life entities. For example, a 3G-network operator could also undertake the role of Reconfigurability Management and Service Provision Platform operator. The above entities and relationships can be viewed more analytically in Figure 2.

3. A GENERIC FRAMEWORK FOR FLEXIBLE SERVICE PROVISION IN RECONFIGURABLE MOBILE ENVIRONMENTS

The support of advanced business models is a basic requirement for flexible service provision architectures Flexible service provision incorporates the support of VAS introduction, deployment discovery and management. Moreover, context awareness and personalized service provision (tailored to the user's profile and location, terminal/network profile, and security profile) should be integral parts of any flexible service offering.

In order to accommodate the aforementioned business models and flexible service provision aspects, a generic framework is introduced targeted to reconfigurable mobile environments. It also supports reconfiguration management

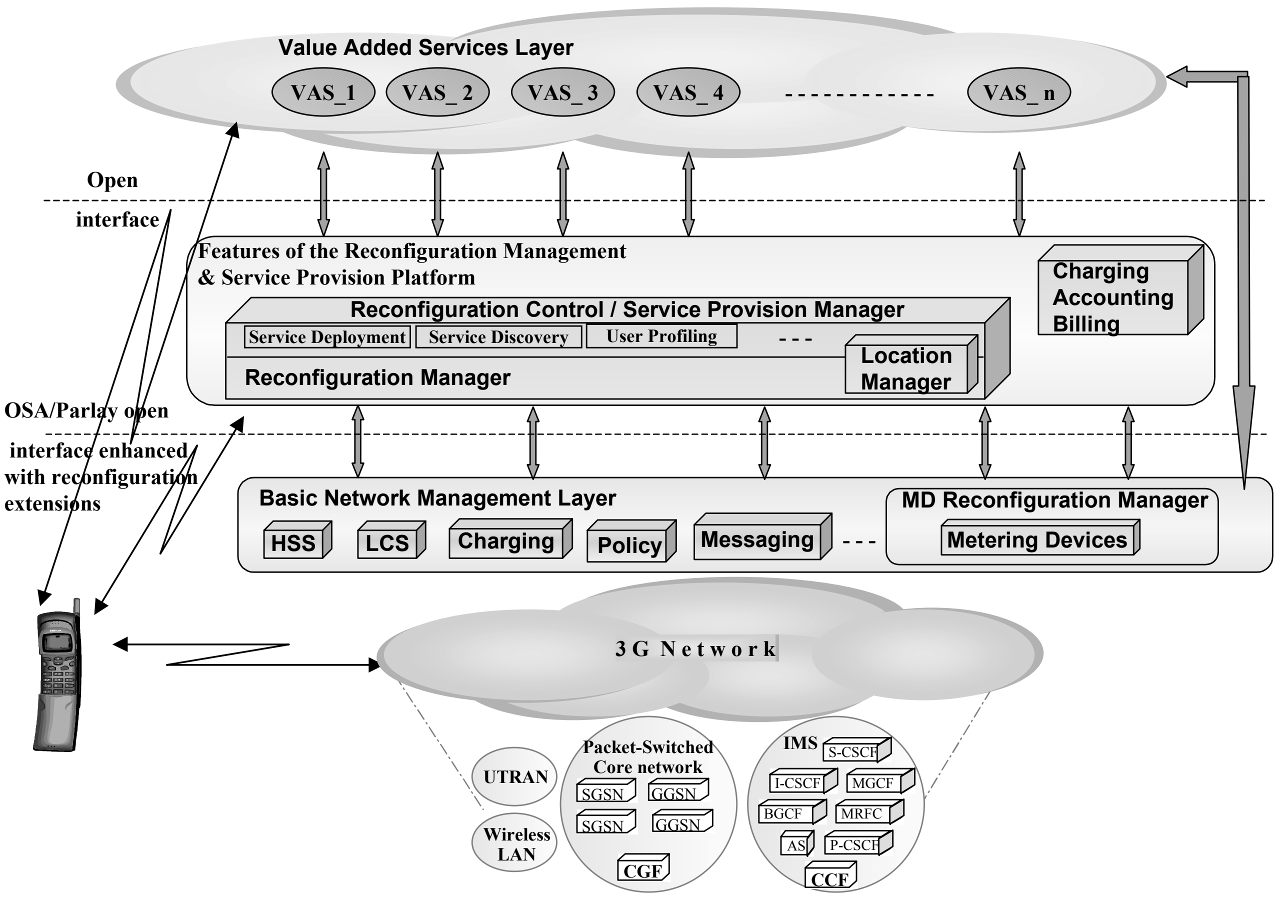

Figure 3. General architecture and example physical placement of the RMSPP

in order to apply policy-based service management and service provision tailored to context information. We define context as the combination of information relevant to the nearest environment of a user such as, the user's location, terminal, network, service and security profiles. The main goal for the design of such a framework is to facilitate the deployment and provision of value added services by independent VASPs, in reconfigurable mobile systems and networks, as well as to support improved quality in the overall service provision experienced by the end users. Context-aware policies are applied to the underlying network infrastructure through an introduced appropriate API for policy-based management to be provided by the mobile network operator. Aspects related to service discovery, service registration, service adaptation, terminal/network reconfiguration, protocol and service downloading, charging, location awareness etc. have been addressed in the design and implementation of the flexible service provision and reconfigurability management architecture.

Figure 3, depicts the general architecture and an example physical placement of the *Reconfiguration Management and Service Provision Platform (RMSPP)* to meet advanced business model and flexible service provision requirements for the 3G and beyond era. It is assumed that the independent *VASPs* offer their *Value Added Services* using the transport service provided by the underlying UMTS network.

The RMSPP constitutes an integrated distributed software framework for reconfigurable deployment and management of VAS offered to mobile users as well as charging for their usage [3][4][5]. The RMSPP can be viewed as an intelligent service middleware that mediates between VASPs and network operator in order to substantiate flexible service provisioning. It takes into account policy based information and context information such as the location and mobility information for the subscribers, the preferences from their user profiles and the current terminal and network capabilities, so that enables advanced service introduction, deployment and discovery and performs reconfiguration actions on the network nodes and end user equipment.

The framework introduces several components involved in service provision namely, the Reconfiguration Control and Service provision Manager (RCSPM), the Charging Accounting and Billing System (CAB) and the Metering

Devices (MDs). Although business roles may be integrated to one entity (e.g. the RMSPP provider and the network access provider business roles may be undertaken by the mobile operator), we see that the business domains can also be physically separated. In more detail:

The *Reconfiguration Control and Service Provision Manager (RCSPM)* may reside in a third party domain. It co-ordinates the required procedures for dynamic deployment, as well as personalized discovery and execution of VAS by mobile users. To accomplish this, it maintains databases with information about the VASs accessible via the platform (the VAS DB), as well as user profile data (the User DB). The service discovery supported by the proposed architecture is triggered from a single user interface, and is tailored to the service provision context (e.g., terminal capabilities, user preferences, location, and network characteristics). Functionality related to user, network and terminal profiles and advanced filtering of available services is incorporated in the platform.

Very important aspects for flexible service provision realisation are context awareness and reconfigurability management. The RCSPM hosts the *Reconfiguration* and the *Location Manager* modules. The Reconfiguration Manager module is responsible for interacting with the underlying network infrastructure in order to configure (or reconfigure) the network nodes and resources. Reconfiguration actions are based on policies (e.g. QoS or metering policies) tailored to user location, terminal capabilities, user preferences, and usage data. The Location Manager interacts with the location information's sources of the underlying network infrastructure (e.g. the Location Service Server (LCS) [16]) to track the location and the mobility of the subscribers [17][3].

Since the RMSPP may be managed by independent business entities (trusted third parties or the network operator etc.), interactions among the modules of the platform and Basic Network Elements should take place through open interfaces (APIs). Various industry initiatives, such as OSA [8], PARLAY [9], and JAIN [10], address the introduction of open network interfaces to third party providers. Common to all these architectures is the provision of a *Basic Network Management Layer* by the mobile operator, which acts as a gateway (mediator) between Third Parties and provided basic network services [11]. Through such APIs authorised entities are given the ability to access certain network elements such as the Home Subscriber System (HSS) of the network operator, the Location and Presence Server, the Messaging Server, and the Charging Service Feature.

However, until now an open API that will enable the policy-based management and reconfiguration of network infrastructures is not mature. Such an API shall grant to the trusted third parties of a network operator open and standardised access to a Policy Decision Point (PDP) [18] for applying reconfiguration policies to the underlying network elements. The proposed Reconfiguration Management and Service Provision Platform assumes the existence of a policy-based reconfigurable network infrastructure. Therefore a proposed specification of a policy provision open API is supported, providing for policy based management of mobile networks. The policy-based management architecture proposed assumes that the communication of the involved Policy Decision Point with the associated network elements is built upon common protocols for policy enforcement such as the COPS [18] or COPS-PR [19]. The PDP, thus, should map all incoming calls on the aforementioned open interface to the appropriate COPS/COPS-PR messages for reconfiguring the network elements.

The API that we proposed includes methods that enable:

- Creation/Modification/Deletion of Policy Classes.
- Activation/De-activation of policies.
- Creation/Modification/Deletion of Policy Events.
- Registration/Deregistration for notification triggered by specific policy-based events.
- Handling of event notification from the network.
- Monitoring of specific sessions between users and VASPs that concern the usage of VAS for charging purposes.
- Gathering real time performance, metering and policy related statistics and records from the operation of network elements on policy classes and events.

Through this API authorised entities will be given the ability first to create and then to apply context-aware policies on the mobile network (thus enabling network reconfigurability by trusted third parties), as well as to create events and register for receiving notifications whenever specific events occur. This is very important in realising flexibility in service provision related functionality. For example in order to apply advanced personalised charging schemes, one of the important aspects is the ability to reconfigure the Metering Devices (such as the IP meter [20]) dynamically by the RCSPM through policies to process and monitor the traffic over the IP layer as well as to meter data about resource consumption in the network (e.g. the transmitted volume) [21]. The collected metering data are formatted into appropriate records, the *VAS Data Records (VASDRs)* and sent to the CAB for further processing. The functionality of the Metering Devices is under the supervision of the *MD Reconfiguration Manager*, which is responsible for the policy-based reconfiguration of the MDs. Access to the reconfiguration of MDs is offered to the RCSPM and other authorised entities (e.g. the Third Party VASPs) through an open API similar to the one proposed for policy-based management of the underlying network infrastructure [21].

The CAB system [21] is responsible for the overall control of the charging process. To elaborate, the CAB collects charging information from both the network infrastructure (in the form of Charging Data Records (CDRs) from CGF and CCF) and the MDs (in the form of VASDRs), applies the appropriate pricing model, calculates the portions that are due to each business entity, and produces a single itemised bill for each subscriber. Additionally, the CAB provides advanced charging services through open APIs in order to enable the RCSPM and independent VASPs to apply pricing policies dynamically, to retrieve VAS usage statistics (e.g. the users that currently execute a specific VAS, or the VAS that are currently executed by a specific user), to add content based charges, and to be informed about current status of their VAS revenues.

4. CONCLUSIONS – FUTURE WORK

The general philosophy of the framework presented in this paper has emerged from the approach adopted during the design and implementation of the experimental platform developed within the scope of the IST project MOBIVAS [13][14]. The work presented includes also extensions to MOBIVAS platform for the support of network wide service provision flexibility, efficient reconfigurability and context information management, advanced location sensitivity, and an open shared context infrastructure for context-aware VAS development.

Most of the functionality described has been designed and verified using the Specification and Description Language (SDL) and a prototypical implementation in JAVA is in an advanced stage of development. The results from the functional simulations show that the architecture concept of the system is valid. Furthermore, work is on going for addressing non-functional requirements like performance and scalability.

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