Business Model and Generic Architecture for Integrated Systems and Services: The ANWIRE Approach

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Abstract

The evolution of mobile communication systems to 3G and beyond introduces a new era in advanced multimedia service provision to mobile users. The success of next generation networks is highly dependent on the availability of a plethora of applications, accessible via a variety of network infrastructures and terminals. This vision can be realized only through the co-operation of various business players (e.g., application developers, content providers), in addition to the mobile operators. The specification by major standardization organizations of open APIs for network access by third parties is a significant step towards this direction. However, the road to a dynamic, open environment includes major further challenges like taming the unprecedented complexity of service provision and management that spans multiple domains and the introduction of network and systems that are dynamically reconfigurable and adaptive in order to accommodate service delivery over highly diverse contexts.

1. Introduction

The European IST Project ANWIRE (Academic Network for Wireless Internet Research in Europe, IST-2001-38835 ANWIRE) [1] is a thematic network established by academic and industrial partners from various EU countries acting in two main overlapping research tracks: i) Wireless Internet and ii) Reconfigurability. ANWIRE aims at organizing and coordinating parallel actions in key research areas of Wireless Internet and Reconfigurability, in order to encompass research activities towards the design of a fully integrated system, and promoting and disseminating Wireless Internet and Reconfigurability solutions, in order to make them available to the research and industrial community.

The coordination activities encompass common efforts and tasks for covering open issues identified in the various specialized areas, relevant to the provision of a coherent integrated framework in next generation systems. The work is organized in Task Forces, each one of which focusing on a specific thematic area.

The objectives of the related research activities, especially with focus to WWRF WG2, are:

- To identify the requirements for the Always Best Connected (ABC) concept in conjunction with reconfigurability and flexible service provision mechanisms.
- To introduce generic hybrid business models for flexible/adaptable service provision and reconfigurability
- To identify an integrated architecture that apart from reconfigurable mechanisms and flexible service provision actions will cater for a MT to be always best connected to a specific network access technology. This architecture will also support advance and flexible charging, billing and accounting mechanisms

To be more specific, we consider that a MT will be able to have access to the network through different access technologies. The choice of a specific access technologie at a certain point will be made based on several parameters such as the user's profile, the current load on the network components, the requirements imposed by a running service (e.g., high quality real time video requires the appropriate bandwidth) etc.The aim is for the MT to be Always Best Connected to the network. Since the MT is capable of using different access technologies, it will sometimes need to be reconfigured to cope with a new situation (e.g., upgrade a specific protocol, download and execute a new codec, apply a different MAC algorithm etc),

This dynamic relation between MTs and the access technologies creates the need for flexible service provision. In these terms we mean the type of execution of each service will be based on several parameters such as the current access technlogie used, the current network load, the user's preferences etc.

Obviously, the aforementioned concepts and mechanisms affect the design and implementation of the overall protocol stack of existing and future network components. The reasons to do this are plently but perhaps the most important one is that these systems open the possibility to create new business models and enable the service provision from a wide variety of players. In this paper we present these future business models and we sketch the architecture that can support them.

2. Business model and protocol development implications

The topic of the design of an integrated future system and service architecture has been chosen due to its importance in the introduction of advanced and flexible service provision for 3G systems and beyond. 'Always Best Connected' (ABC) is perceived as one of the

characteristic traits of future generations of wireless networks, with the underlying technological implications of multi-band multi-mode user terminals which are adaptable and reconfigurable (which soon may be capable of simultaneously holding more than one connection on more than one mode and in more than one band), and reconfigurable networks with seamless vertical handoff capabilities to a wide range of wireless access networks (satellite as well as terrestrial) enabling the possibility of an overall wide system integration [2]. In n the process of bringing about this reality it is important to address the question of feasible business models: what kind of generic business model would be attractive and would drive this vision? What are the technical implications of this model?

If the underlying business model is to be founded on the necessity of a mobile wireless user (MU) having an account with at least one of the dominant network operators before it may start exercising ABC policies, it will always be difficult to escape the constraints and limitations effected by these operators for their own business reasons including those serving market dominance goals within the access network (AN) provision, and even within the application service provider, market. It will also be a very difficult business place for new access network provider (ANP) entrants as the business agreements with dominant network operators (for interoperability, interworking, Authentication, Authorization and Accounting, AAA, etc.) will always be a critical and necessary component for their entry and survival.

This is the trend in the business models used today, with the User Home Access Network Provider (UHANP) being placed at the centre as both the effective manager of all the user's wireless communication activities and the supplier of part of these wireless communication services. It may be well argued that this uniquely strong position of the UHANPs is in conflict with the user's, with its potential to constrain their freedom and independence in seeking best value for money. Prospective UHANP entrants will be faced with having to have customer administrative and management support in place, plus most of the business agreements with the other parties before they might hope to start seeking 'home user accounts' and make inroads into the market. Naturally this will be a brake on fast deployment and flexible provision of new services, as well as a serious barrier to new ANP entrants.

Within this context, ANWIRE suggests an alternative business model, one which separates out the administration and management of customers' one-stop-shop authentication and accounting system from the business of supplying a wireless access network service, and locates it with a 3rd party AAA service provider. Through business agreements with the 3rd party AAA service providers, all types of Service Providers (xSP) and ANPs will be able to offer their fee-based services to MUs who have credit arrangements with a 3rd party AAA service provider. MUs will have arrangements with one or more 3rd party AAA service provider, just as they have one or more credit cards, and similarly through this entity will receive periodic itemized bills for all services used. The MU's choice of 3rd party AAA service provider at any time for any service will be dictated by decision processes similar to those in deciding which credit card to use for a particular bill. In this case the 3rd party AAA service provider becomes the central player; an explanatory example is illustrated in Figure 1.

A typical implementation approach is for the user to be identified by a smart card (e.g. containing her/his credit card details, or a specific authentication code acceptable, or even provided by the 3rd party AAA service provider) inserted in the terminal currently used, with a suitable public key encryption system. In this way each service charge (e.g. to ANP or xSP) may be paid directly to a 3rd party AAA, indicated by the payee. Any xSP (VASP, CP, etc) charges may be similarly processed. Financial institutions, such as present day credit card companies would probably be the most suitable contenders for the 3rd party AAA service provider business. (This scheme has the potential to become the credit card system of the future, as payment activities have the potential to be made much safer than by present day credit card; it would also be an important new lucrative wireless service, akin to SMS).

Naturally new internationally agreed protocol structures would be required to support this approach to AAA. The user is not the only party interested in ABC vertical handover decisions [8]; the drive for, and management of these decisions will also likely be located in all major players e.g. ANPs and xSPs. This also has to be taken into account in the new protocol structure.

Besides giving the MU much greater freedom of movement, this approach and facility would be particularly attractive to new entrants, and to existing ANPs and xSPs trying to extend their market share, streamline their business, fill niche ABC markets, and so forth. Thus we see this generic AAA-centric business model as having the potential to open the wireless communications market more from a business point of view, by providing easier and fairer access to AN and xSP markets for both providers and MU alike. Hence it would also be an important business driver for the evolution of ABC networking, as competition, interoperation, and collaboration advantages will be underpinned by efforts to provide a wide range of QoS offerings with greater flexibility and with wider range of price-performance ratio options. As the range and sophistication of wireless AN increases it is only a matter of time before financial companies such as present day credit card companies join with ANPs to capture this business opportunity.

Clearly other support functionality, and thus other internationally agreed protocol development, will be required to underpin this generic business model structure. These especially include service advertisement, discovery and association, in the first place for ANs but also for all services. ANWIRE therefore is currently developing a generic framework architecture to accommodate those needs. The proposed Generic Anwire system and service Integration Architecture (GAIA), while at first sight seems to lean towards the traditional or present day AAA services, allows for the evolution of the proposed generic business model.

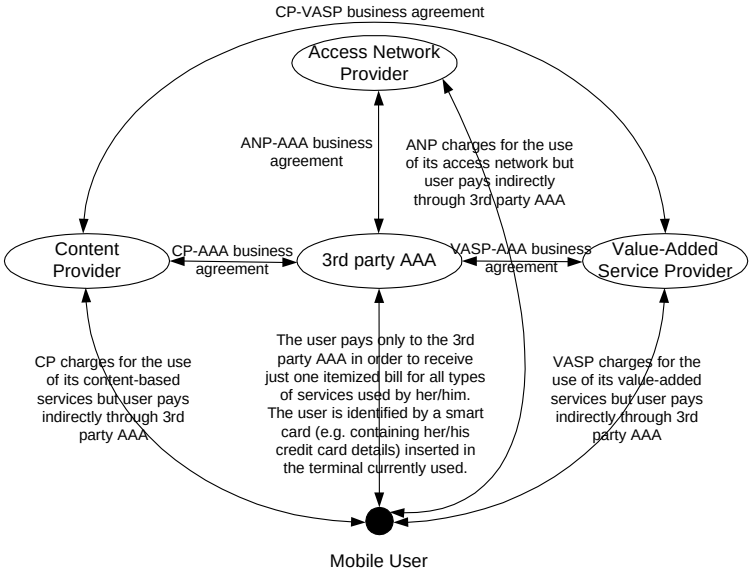

Figure 1: Business model with a 3rd party AAA service provider at the center

3. Architectural Approach

To attain an integrated system we need to solve various issues as we go and as far as this integration could go. These issues are related to the *network*, the *terminal*, the *services* and the *user.*

From the *network point of view*, the integration system level depends on the network layers' integration: The loose integration is achieved with the integration at the high layer. The tight integration can be achieved at the link and the physical layer. The integration process at the

high layer may be achieved by the integration of the system management of the different networks, and the AAA system. In this integration we need to consider these requirements:

- *System management integration requirements*: The management system of each network can exchange management information with each other. The management information can be related to QoS, mobility and security. In the integrated system, the system management has to consider the personal and service mobility management. Here, session continuation issues, service portability issues, roaming users' issues, and security issues need to be considered.
- *AAA integration requirements*: Depending on the level of integration, the system integration can have a unique AAA system (tight integration) or just exchange AAA information between the integrated networks.

The integration process at the network layer needs to consider these requirements:

- *AAA integration requirements*: Depending on the level of integration, the system integration can have a unique AAA.
- *Seamless Mobility management issues*: Mobility management in homogenous networks intends to define seamless mobility, which is a challenging issue. In addition to the issues in the mobility management in homogenous networks, the integration of different networks needs to consider vertical handover issues.
- *Routing issues*: Depending on the network type (e.g., wired, ad-hoc, multi-hop networks) different routing issues have to be considered

The integration process at the link and physical layer should provide the tight integration between the network technologies; this is the most difficult integration. Here signal interference and interoperability issues need to be solved.

From the *terminal point of view*, the integration system process needs to consider these requirements:

- *Multimode terminal*: The terminal needs to support different interfaces from each network technology.
- *Adaptive and reconfigurable terminal*: Reconfigurability (software radio), adaptability, multiple SIM support, wide band receivers.

From the *user and service point of view*, the integration system process needs to consider these requirements:

- *User identification*: The user should have a unique identifier in the network
- *User contract*: The user should be able to negotiate with one administrative operator or several operators. This depends on the level of the system integration. In case of integrated AAA system, the user will have only one contract; in case of separate AAA systems, the user could have several contracts.
- *User services, adaptive services, always best connected user*: In the integrated system, the user needs to be always best connected having continuous service when changing network technology or changing terminal (adaptive and reconfigurable).

Finally, security issues need to be considered in each integration system level. The general architecture GAIA is illustrated in Figure 2. We assume that the initial subscription of the mobile user takes place in the so-called user home network. All user related definitions and subscriptions e.g. with respect to services are administered here. The User home network maintains a user profile. The terminals are also subscribed in the terminal Reconfigurability networks where a terminal profile is maintained in order to propose for instance a terminal configuration to a given user service. The mobile user will have access to several network access providers, which also maintain their network profile. These visited networks are named user foreign network and they can be any wired or wireless network access technology. VASM

(Value Added Service Managers) will be deployed in each wireless access technology in order to take care of the reconfigurability and service adaptability management.

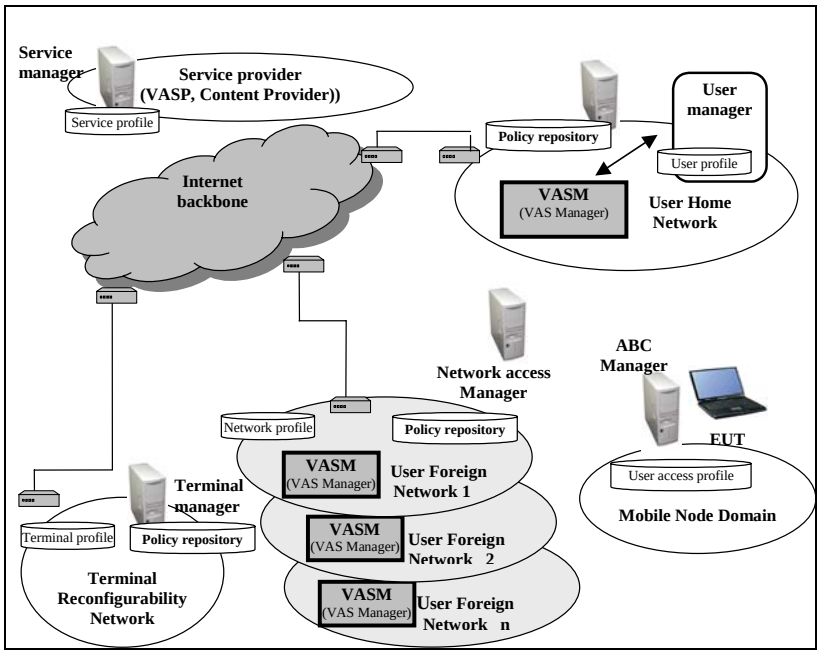

Figure 2: Generic ANWIRE system and service Integration Architecture (GAIA)

We define a Domain as a set of network elements administrated by the same policy manager. The policy repository is a set of policies [2]. A policy is one or a group of rules, where a rule is of that form: (If <condition> then <action>). In our architecture, we propose to define five domains. In each domain we define a manager entity, a policy repository and a profile. We use five profiles. Each profile can have public and private information.

Terminal profile: contains the terminal capabilities (radio access options, display options, reconfiguration option, antenna options, supported execution environment, power supply, terminal resources, protocol environment).

User profile: In this profile, we have the user preferences, and his personal services description. QoS and tariff preferences (minimum acceptable data rate, authentication information,), service subscription requirement, service personalization, authorization information,

Network profile: contains the network capabilities description (access technology, QoS framework, handover support, supported user velocity, network coverage, access point penetration)

User access profile: contains the initial network preferences of the user (service dependent)

Service profile: Service description (at the service provider)

Within the different domains, we define six main automatic managers, which are:

ABC manager: physical layer intelligence, decision module, reconfigurable module, mobile initiated handover control, service discovery.

Network access manager: network initiated handover control, AAA, connection admission control, radio resource management (joint), load balancing, location awareness, multi-

technology communication. Depending on the level of integration, we can have one network access manager for all the access network technologies or one for each of them. The first case will achieve a high level of integration; the second one will be a low level of integration.

VAS Manager: is responsible for flexible service provisioning, service adaptation and reconfiguration control and management.

Terminal manager: Reconfigurability control.

Service manager: service characteristics negotiation (service profile, terminal profile, network profile), service adaptability, and service billing.

User manager: user authentication (AAA), service subscription and billing.

4. Conclusions

Ongoing work within ANWIRE aims at research activities towards the design of a fully integrated system. Design fruits to date include the development of an overall framework, referred to as Generic Anwire system and service Integration Architecture (GAIA), addressing all issues related to ABC, reconfigurability and service adaptability and provision. Together with this new generic framework, a new business model is proposed propagating a 3rd party centric AAA. By such, it is expected that mobile users are given much greater freedom of movement with respect to ABC requirements on the one hand, while new access network providers are encouraged to enter the market in parallel to existing ANPs and xSPs trying to extend their market share.

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