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A User-Centric Approach for Beyond 3G Business Models

Artemis Koutsorodi, Evgenia Adamopoulou, Konstantinos Demestichas,
Michael Theologou

Abstract—This paper presents a robust business model, capitalizing on the capabilities of an innovative Terminal Management System (TMS). The TMS is targeted for devices operating in heterogeneous environments, and incorporates intelligence for supporting mobility and roaming across legacy access networks, as well as dynamic user profiling. The proposed focal role of the mobile terminal in the B3G context renders the current business models insufficient and raises the need for the development of a highly dynamic yet simple business model.

Index Terms—access selection, heterogeneous networks, user-centric.

INTRODUCTION

THE evolution of wireless communication systems over the past years demonstrates a clear trend towards architectures that will support multiple access technologies and types of terminals, capable of alternatively operating in the diverse radio segments available in the infrastructure. These access technologies (Wireless Local Area Networks, third-generation cellular systems, and broadcast networks, such as Digital Video Broadcasting) will thus constitute cooperating components of a composite radio infrastructure, interconnected by a backbone (e.g., an IP-based fixed network) and jointly operated in an optimized fashion that will allow for an improved overall resource management. This trend is often referred to as 'systems beyond 3G' or '4G wireless systems' and continues to attract notable research attention ([1]-[4]).

Towards this direction, in our past contributions, presented in the Wireless World Research Forum (WWRF), an innovative B3G Terminal Management System (TMS) was proposed, allowing for the joint utilization and seamless integration of the above-mentioned heterogeneous network infrastructures, by adopting a terminal-centric approach.

In WWRF #14, the core of the proposed TMS was presented and demonstrated ([5]). The TMS was capable of selecting the optimal access point and quality level for each service running on the terminal, given the current network conditions, the user's preferences and each service's specific requirements. The TMS was able to evaluate each access point's suitability for the provision of a service, independently of the access point's network technology. The main target of the implemented TMS was the fulfilment of the Always Best Connected (ABC) notion ([6]), requiring the user to constantly receive any desired service at the best possible way, in terms of connectivity and user satisfaction.

In WWRF #15, the TMS was further extended ([7]) by incorporating the ability of inferring the user's preferences, on the basis of the usage context ([8]-[10]) (i.e., time, location, communicating counterpart, etc.).

Over the last few years, technological research conducted to fulfil the B3G vision has been intense, and is expected to grow further in the coming years. Consequently, the technological requirements for fulfilling this vision will likely be met. However, complementary research should be conducted towards the direction of the business models that need to be applied for the unobtrusive exploitation of the capabilities

of the existing heterogeneous networks.

A business model can be defined as the set of interactions among a group of cooperating companies intending to generate revenue by offering satisfactory products and services to customers. Hence, in extension to our work presented in the WWRF #14 and WWRF #15 meetings ([5],[7]), this contribution will elaborate on the suggestion of a new business model, namely the SCENTRINO (User Centric Approach for B3G Business Models) model, with a view to rendering the application of the proposed innovative TMS not only a feasible but also a highly attractive approach.

The structure of the paper is as follows: Firstly, an overview of the proposed TMS is given, and the functionality of the entities comprising it is described. What follows is the presentation of the most typical business models that are today in use. An innovative framework (SCENTRINO) is then proposed, in terms of business and commercial agreements. The role and functionality of every entity involved is thoroughly examined, and a comparison between the state of the art and the proposed model is depicted, in terms of functionality. The paper concludes with some overall remarks.

Overview of the Proposed Terminal Management System

The proposed TMS (already implemented in [5],[7]) will play an integral part in the functionality of the SCENTRINO model, so its capabilities should firstly be explained.

In the context of effectively managing wireless terminal operation in composite radio environments, two problems can be identified: Intelligent Access Selection (IAS), which involves the computation of optimal allocations of services to access networks and to quality levels, given network availability and user preferences, and Modelling and Adaptation to User Preferences (MAUP), which involves, firstly, the processing and the 'decoding' of contextual information for the purpose of determining the usage context, and, secondly, the automatic determination of the user's preferences, according to the usage context and the set of services under consideration.

The goal of the proposed TMS is to successfully handle these two problems. The main modules comprising the proposed TMS are depicted in Fig. 1.
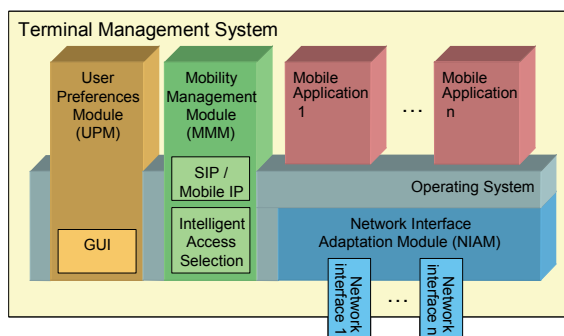

Fig. 1. TMS architecture

Network Interface Adaptation Module (NIAM): This module provides a level of abstraction from the different network drivers present in the terminal. It is responsible for identifying and monitoring each network interface, and for collecting measurements reflecting the network conditions. After an access selection decision has been reached, this module selects and deselects the appropriate network interface.

User Preferences Module (UPM): This module provides the graphical interface between the user and the mobile terminal. It is responsible for handling the user's profile and for addressing the MAUP problem. Through this module, the prioritization of factors affecting the access selection process is achieved either manually, or automatically, by exploiting contextual data.

Mobility Management Module (MMM): This module is the heart of the proposed TMS and has to cooperate with all the other components of the TMS. It is responsible for handling all events relating to mobility management and access selection. Its main task involves the execution of the access selection function. In more detail, MMM triggers the execution of its Intelligent Access Selection (IAS) sub-module, providing it with the required input (i.e., the current network measurements and the user's preferences).

Intelligent Access Selection (IAS): This process results in the allocation of services, firstly, to networks interfaces and, secondly, to appropriate quality levels, in an optimized fashion. It operates seamlessly and does not require the user's intervention. IAS receives as input the network conditions, the set of the already running and of the requested applications, along with the special characteristics of each one, and finally the user's preferences, as determined by the UPM. The process involves the computation of the value of an objective function, for each

permissible allocation choice. The value of the objective function depends on the quality, cost, operator type, and technology type of the allocation choice, with the weights of every factor being determined by the user's preferences. Higher values denote better allocation choices.

Modelling an Adaptation to User Preferences (MAUP): The user's preferences can be defined either manually or automatically. In the latter case, the UPM addresses the MAUP problem. The approach followed makes use of Bayesian meta-networks, which are an extension of classical Bayesian networks to multi-level probabilistic models. These models have proven to be valuable tools for encoding, learning and reasoning about probabilistic relationships. Firstly, through appropriate mechanisms, the user's context is inferred, given contextual information about the 'location', 'time', 'communicating counterpart', etc. Then, the usage context which is identified, combined with the requested service, serves as input for the determination of the most probable values of the user profile's parameters.

Concisely, there are several advantages in allowing the terminal, instead of the network, to incorporate the access selection process, including: (a) the terminal's ability to gather information about network availability in its surroundings; (b) its awareness of the network adapters it incorporates; (c) its ability to store or/and infer the user's preferences.

Existing Business Models

This sub-section aims at providing information about existing business models adopted by the mobile industry, focusing especially on those that have been applied in 2G and 3G mobile systems ([11]).

2G Business Model

The 2G business model is rather simple, with the mobile operator holding the central role. Fig. 2 illustrates the 2G business model.
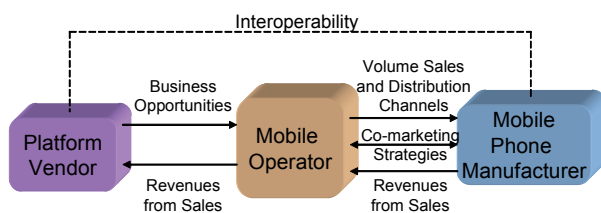

Fig. 2. 2G business model

The mobile operator owns the network

infrastructure and provides users with voice services, as well as simple data services. Users have to subscribe to the mobile operator, in order to be able to receive the offered services through the mobile operator's network infrastructure.

Most mobile phone manufacturers, at least in Europe, advertise not only the mobile operator's brand, but also their own. However, they acknowledge the mobile operator as the prime customer-facing unit, and this is why they use it as their main distribution channel. In general, by being so close to the end user, the mobile operator has managed to gain a dominant position in the existing business model, often regulating the interactions among the various players.

3G Business Model

The evolution of cellular technology from 2G to 3G triggered changes to the business model as well. Fig. 3 illustrates the 3G business model. Probably the most famous business model is that of NTT DoCoMo ([12]).
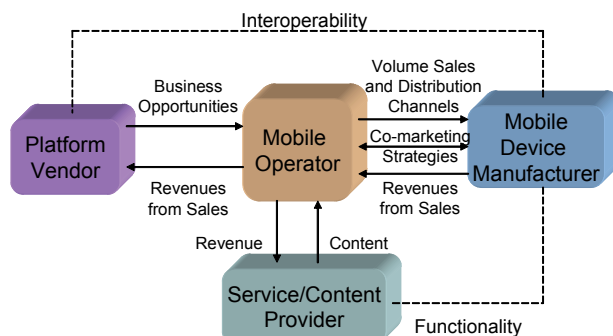

Fig. 3. 3G business model

In the 3G context, mobile phone manufacturers have become mobile device manufacturers, due to the increased capabilities of the terminals appearing in the market. From early on, it was realized that the business model should capitalize on the experience gained from 2G systems, by allowing the mobile operator to continue having the guiding role in the market. In the 3G business model, relations with mobile device manufacturers and platform vendors had to be further enhanced, in order to support the bloom of data services.

Besides this, however, new partnerships had to be forged with additional members of the mobile industry, namely the content providers. These new market players aim at the provision of multimedia content (e.g., games, ringtones) to the end users, who

subscribe to these services, or use them on demand.

In the 3G business model, the mobile operator agrees to publish content originating from cooperating content providers, on condition that the revenue produced is shared and the content's quality meets certain standards. According to NTT DoCoMo's paradigm, the percentage of the total revenue that is attributed to the content providers is rather significant. The policy of most European mobile operators, which tend to share only a small part of the total revenue with the content providers, makes NTT DoCoMo's model even more attractive.

As far as the end user is concerned, a contract or subscription between the latter and the mobile operator is required. This allows the user to browse through the mobile operator's portals (as in the cases of i-mode and Vodafone Live); however, when the user requests the delivery of a particular service, a further subscription is required with the content provider, or an additional on-demand cost has to be met by the user.

Inter-domain Handovers in Existing Business Models

In current 2G and 3G networks, roaming is the only case in which a user may be assigned to a different network operator from the one to which he is subscribed (home network operator). The process is often referred to as inter-domain handover. Roaming occurs when a subscriber of one network operator uses the facilities of another network operator. The latter operator has no direct pre-existing financial or service agreement with the subscriber who requests the delivery of a service. If the home carrier's signal is too weak, roaming can occur even if the user's mobile phone is operating in his own home calling area. The most essential requirement for inter-network roaming is for the home network operator to have a roaming agreement with the network to which the user has moved. As will become clear in the following, the establishment of roaming agreements between network operators will be insufficient in the B3G context, in terms of business relations.

B3G Business Models

B3G systems will comprise several heterogeneous networks, each one possibly operating under a different network provider. Today, wireless access technologies, such

as WiFi and WiMax, are becoming more and more widespread. Although the coverage they provide is relatively limited in comparison to cellular networks, the bandwidth they offer is more than sufficient. Furthermore, the deployment of broadcast technologies, such as DVB-T, is also gaining ground, creating an additional reliable means of service delivery. Thus, a robust scheme would potentially involve the interconnection of all heterogeneous access technologies, with a view to combining the distinct advantages of each one and rendering their disadvantages less constraining.

Fig. 4 depicts a simple representation of a B3G business model ([6],[11],[13]), from a mobile device manufacturer's perspective. As may be observed, new players have been added to the previous business models, namely the Wireless Operators and the Broadcast Operators, which in the future are expected to play an even more considerable part in the telecommunications market.
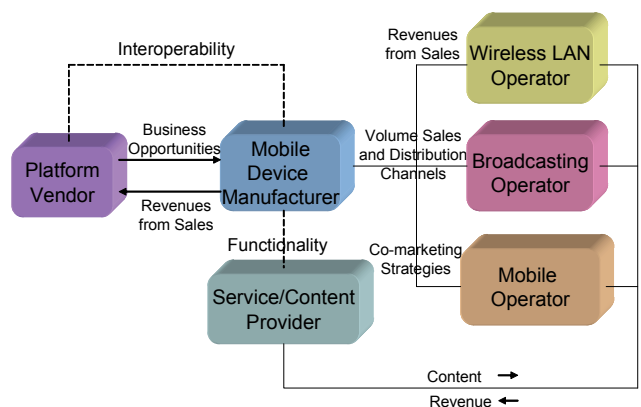

Fig. 4. Simple representation of a B3G business model

In this light, the challenge of B3G systems will clearly be the joint exploitation of the different wireless access networks.

One approach would be the establishment of several different business agreements among the various key players of the market. The user will be obliged to acquire a separate contract with each one of the network operators whose infrastructure he wants to be able to use. This creates a really complicated business model, in which the user is required to handle several different contracts in parallel.

Another approach would be for the user to continue having only one contract, with the network operator of his choice. Then, this network operator would cater to establish several different business agreements with

the other network operators. However, this would again create a highly complex model, in which the network operator should be able to handle multiple business agreements. In this case, complicated policies for inter-domain roaming should also be developed, as the 2G/3G roaming model would not be sufficient, since, in the B3G context, signal loss is not the only case in which a handover should take place. The application of these policies would require a complex handover decision-making process in the network side, increasing its computational load.

A more efficient approach would be to capitalize on the capabilities of the implemented TMS, briefly presented in the above, and to find a suitable business model which will reflect the focal role of the mobile terminal in the B3G context. Such an approach is discussed thoroughly in the following section.

SCENTRINO – The Proposed B3G Business Model
Overview
The SCENTRINO model requires a single subscription from the user's part to the SCENTRINO provider. This provider plays the role of a virtual B3G network operator, granting access to all heterogeneous networks comprising a B3G service area, independently of the physical network operator they belong to. In this way, the user is able to exploit the special characteristics of each one, without having to deal with every network operator separately.

Technical Aspect
Fig. 5 illustrates a typical B3G network architecture, which integrates a new network module, namely the SCENTRINO network module. A B3G service area comprises, in general, several different wireless access networks, interconnected by an IP backbone network. The SCENTRINO network module resides in this IP backbone network, and is responsible for rendering, in cooperation with the TMS, the use of the heterogeneous networks transparent to the end user. Specifically, its target is to verify the allocation of a requested service to one of the underlying access networks present in the service area. The allocation decision itself is generated by the TMS and the SCENTRINO module guarantees that this decision is respected and the corresponding handover is executed.
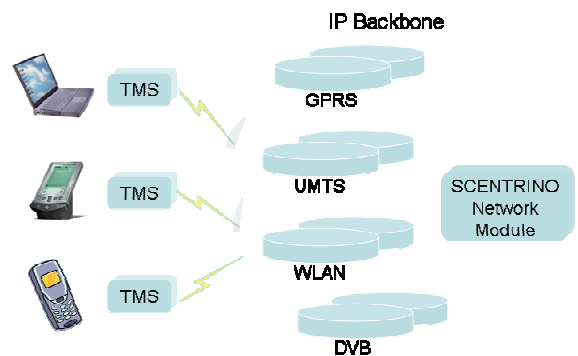

Fig. 5. SCENTRINO-enabled Network architecture within a B3G service area

Fig. 6 depicts the information flow once an allocation decision has been reached by the mobile terminal until this decision is executed by the network. Initially (1), the user's TMS examines whether a handover is needed for the provision of a particular service and an allocation decision is made, depending on the current network conditions, the user's preferences and the service's specific requirements. The request for handover to the target access point is transferred firstly through the Radio Access Network (RAN) in use (2) and, then, through the corresponding Core Network (3). Finally, the handover request reaches the SCENTRINO module (4), which authenticates the originating user and his request (5). Then, the SCENTRINO module informs the mobile terminal (6) about the approval of the handover request. As a last step, the handover process takes place (7).
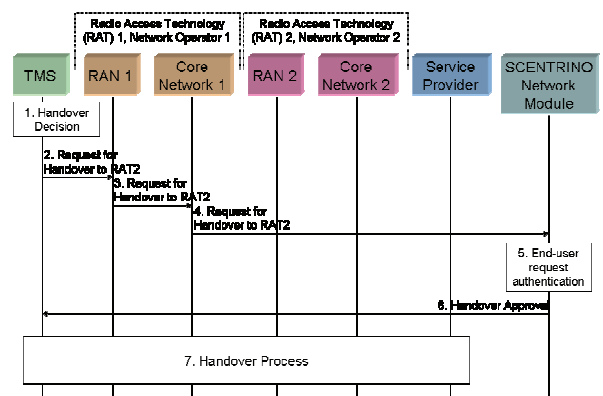

Fig. 6. Information flow within the SCENTRINO model

A slightly differentiated yet similar approach would involve the TMS sending a prioritized list of the possible handover

targets (i.e., ordered in decreasing preference) to the SCENTRINO network module. This list would then be used by the latter module, in order for the most appropriate handover target to finally be selected, according to the network's criteria (e.g., network load balance within the B3G service area).

SCENTRINO Advantages

The SCENTRINO model offers several advantages compared to both the existing business models and the possible alternative B3G models. These advantages are highlighted in what follows.

Simplification of user's business agreements: the end user may have a contract only with the SCENTRINO provider, instead of having a separate agreement with every operator of the deployed networks. The SCENTRINO provider will be responsible in turn for handling the business associations with the plethora of the business partners.

Better exploitation of network resources: in the framework of current business models, the provision of a certain service is handed over to another network operator, only in the case of complete incapability of delivering the service. On the contrary, in the proposed model, the user has the ability to seamlessly receive the desired service through the best available access network. This ability caters to greater user satisfaction, in terms of both the quality and the cost of the received services.

Scalability issues: when a new operator deploys its network within a B3G service area, the user will not need to establish an extra business agreement with this operator. Instead, the SCENTRINO provider will be associated with the new operator and will hide the details of the newly established business agreements from the user.

Triggering of open market mechanisms: the user's ability to freely select the network operator from which he will receive the desired services elevates the level of competition among the operators. Thus, the end user benefits from the reduction of costs and the increase of the service quality offered. On the other hand, from the network operator's perspective, although the risk of a percentage of customers being shifted towards competitive access networks is always present, a long-term enlargement of the customer basis will probably be noticed, since the total number of potential customers

is highly increased, thanks to their joining to the SCENTRINO provider.

As can be deduced, the SCENTRINO model attempts to eliminate the insufficiencies of present business models, and, in the same time, exploit the new technological capabilities of the emerging B3G market.

Use Case Scenario

In this section, an assessment of the proposed model's performance will be carried out, by demonstrating a simple yet representative scenario. Let us assume that in the B3G service area of interest three networks have been deployed, each one belonging to a different network operator, namely NO1, NO2 and NO3. An end-user is moving within the service area, passing through the positions (a), (b) and (c) depicted in Fig. 7.
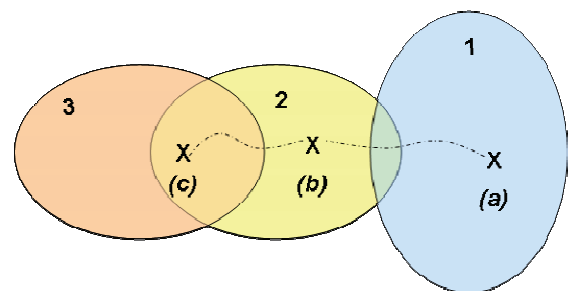

Fig. 7. Use case scenario

First, we will examine the allocation decisions for the provision of the requested services within the framework of a current business model. The end-user has a subscription with NO2. This operator has a business agreement with NO1, according to which, in case of incapability of NO2 (signal strength loss, insufficiency of network resources) to deliver a service, NO1 will handle the provision of that service. The end-user under discussion resides initially in area (a) and moves towards area (b). While in area (a) the end-user is serviced by NO1, due to lack of coverage from NO2's access network. As soon as he enters the coverage area of NO2, his service is handed automatically to NO2, since the latter is his home network operator. While he approaches area (c), he continues to be serviced by NO2, although a new access point belonging to NO3 and possibly offering a higher quality of service level has become available.

We will now examine the allocation of

services in case the SCENTRINO model is used. The end-user has a subscription with the SCENTRINO provider of the service area under consideration, which in turn has established business agreements with NO1, NO2 and NO3. While residing in area (a), the end-user is again service by NO1, since this operator is the only one covering this area. When approaching NO2's coverage area, the user's TMS automatically examines which of the two networks, NO1 or NO2, is best suited to handle the provision of the running services, in terms of quality and cost. When the user reaches area (b), the TMS becomes aware of the unavailability of NO1 and a handover to NO2 is executed if necessary (i.e., if NO2 was not already servicing the user). Finally, when the user approaches area (c), the TMS evaluates the available allocation choices (NO2 and NO3) and assigns the running service to the best access network, based on the user's preferences, the network conditions and the specific requirements of the service.

By comparing the two aforementioned models, within the framework of this scenario, we observe that the user clearly benefits from the SCENTRINO approach, as this approach guarantees that, at any time, the requested services are provided through the best available access network. The user's business agreement remains simple, since he still has only one subscription (with the SCENTRINO provider). The difference is that the end-user can now unobtrusively exploit the infrastructure of all three network operators and seamlessly choose among them the one that best suits his needs.

Conclusions

Business models are dynamic in nature and tend to get influenced by a number of factors. A successful model should be flexible and able to adjust to the technological advances. It should also be open to innovations and new ideas. Under this concept, a user-centric business model was proposed, exploiting the features of an advanced TMS, and providing the user with more flexibility. In this way, customer satisfaction can be raised significantly and network resources can be managed in an effective and efficient manner.

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