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A QoS-based dynamic pricing approach for services provisioning in heterogeneous wireless access networks

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ABSTRACT

In this paper we propose a simple QoS-based dynamic pricing approach for services provisioning in a heterogeneous wireless access network environment which attempts to increase user's satisfaction level by firstly, maximizing the provided QoS level, and secondly, by applying dynamic pricing strategies according to the QoS. These strategies will allow service providers to maximize their profits. Simulation results demonstrate that the proposed dynamic pricing approach benefits both users and wireless service providers (WSPs). Results also suggest that users have better overall satisfaction due to a better QoS level and fairer prices. The analysis shows that our proposed pricing approach contributes to an increase in WSPs profits compared to the application of the flat-rate pricing model in a competitive market-model.

1. Introduction

In recent years, we have seen an increase in demand for mobile computing and communication services. Development in wireless access technologies and sophisticated personal user devices are driving the way towards a heterogeneous wireless access network (HWAN) environment which will enable anytime and anywhere communication. Various wireless services such as 3rd generation cellular system, IEEE802.16 WiMAX®, IEEE802.11 WiFi®, and Bluetooth® are now getting popular all around the world. In order to support requests for seamless multimedia and high quality services, the interworking integrated network architecture over heterogeneous wireless networks have been reported [1–4].

Heterogeneous wireless access networks will create a market for the delivery of an extensive collection of novel and attractive services and contents. Obviously, this kind of environment will support services that have a variety of Quality of Service (QoS) requirements (such as: low latency, high bit rate, low error rate, among others); for example, multimedia over broadband networks, voice over Internet Protocol (VoIP), and the Internet Protocol Television (IPTV) are more sensitive to delays, while file transfers are affected by loss [5].

This new market will promote the generation of a multitude of wireless service providers (WSPs), which can use a mix of wireless access technologies to provide these new services to end-users with competitive prices. It is therefore in the

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best interest of WSPs to offer services that appeal to end-users and provide them with a best use to increase the technical abilities of their terminals. From the service provider's point of view, it will be necessary to define mechanisms to maximize user's satisfaction level, allocating the most suitable QoS level to each requested service and the definition of competitive dynamic pricing strategies that adjust or adapt the price accordingly to the provided QoS.

Success in this market will be based on the ability to offer an enhanced user experience. Pricing and resource management are important issues to end-users since the acceptance of the services is directly related to the perceived QoS and offered price. HWAN will change the traditional vision of service model from network-centric to user-centric. Unlike traditional service model where all management functions are controlled according to the service provider's perspectives, the user-centric vision for the future considers end-users in a heterogeneous wireless network environment where they will be free to 'shop around' not only for the service they need, but also for the available wireless access network which meets their current service needs. Users will take advantage of this competition scenario and they will always connect to the network that can best satisfy their needs and preferences for the current application using novel algorithms to select the optimal access network in an intelligent way according to their needs.

In this situation, heterogeneous wireless networks look for the market evolution from traditional monopolies that dictate usage conditions, to a user-centric service-oriented environment. However, within the current service pricing and provisioning model, there is still a strong relationship between end-users with a single wireless service provider. End-users get services from one provider for a period of time based on the contractual agreement. Prices for the various services are based on the charging model for voice services (i.e. free, flat rate or any of their variations). In the flat-rate model price are fixed and do not fluctuate according to changes in network conditions. The price is paid monthly for the usage of a certain facility. However, the current demands of quality of services into wireless service access have demonstrated the need for more sophisticated pricing strategies [6,7].

In this paper we present a QoS-based dynamic pricing approach for service provisioning in a heterogeneous wireless network environment where requirements of new services demand efficient and flexible pricing strategies and charging mechanisms. We propose an adaptable scheme to changeable environments, which satisfies users' demands while maximizing service providers' revenue. Our approach, called QoSDPA (QoS-based Dynamic Pricing Approach), is based on the IETF policy model [8]. In order to maximize user's satisfaction, QoSDPA defines an access network selection mechanism, explained later on, that attempts to allocate the most appropriate network for the requested service, satisfying user's demands and optimizing the usage of resources. As a result, service providers may increase their profits too.

In addition, when the QoS requirements cannot be fulfilled, a dynamic pricing strategy and a negotiation procedure are defined. The main objective is to maintain a high QoS or to recover it as soon as possible when degradation occurs, thus obtaining the highest user's satisfaction.

The rest of the paper is organized as follows: A brief description of related work is discussed in Section 2. Section 3 describes in detail our QoS-based dynamic pricing approach. An evaluation of the performance of QoSPAMS is presented in the Section 4. Finally, Section 5 shows the conclusions of our work.

2. Related work

The evolution of pricing strategies for telecommunication mobile services is in a continuous process. Several pricing strategies have been proposed and some of them have been implemented in the commercial environment. However, pricing in heterogeneous wireless access networks is still a challenge that requires more research. There are some works that define a list of requirements that network designers must meet [9,10]. Basically, recent pricing works can be classified into two categories: management architectures and control algorithms and strategies.

Regarding management architectures we can mention several research results. Ref. [11] discusses a charging system called CAB. The main problem of this proposal is that the solution is based on a centralized architecture for accounting management used in the current communication systems. However this architecture is not adequate for a heterogeneous wireless network environment where the accounting and pricing will be made in a distributed way.

A component-based charging in a next-generation multimedia network is proposed in [12]. The work analyzes the set of components that are relevant in the accounting process. However authors do not define a model to calculate the price. Ref. [13] proposes a comprehensive component-based accounting and charging architecture to support service session provisioning across multiple domains. The architecture incorporates an interim accounting and charging mechanism to enable the processing and exchange of accounting information needed to update intermediate charges for separate service components and the user's credit. However, these works do not consider situations in which different access technologies and high users' mobility are involved. In future mobile networks the complexity of accounting and charging increases in different forms e.g. in the seamless provisioning of service access across administrative domains (different network and service providers), the use of different technology domains (cellular and/or wireless networks) and Quality of Services (QoS) constraints. Ref. [14] defines a role model for pricing and accounting that covers all participating entities of a distributed service providing an environment for mobile networks. The model defines that accounting is configured to agree upon user profiles and service classes. The main disadvantage of all the proposed models is that they consider that the user has a strong association with a single WSP. However, the new vision of HWANs is focused on a user-centric model where users have more freedom of dynamically connect to any WSP for any service and they can disconnect at anytime. In other words, there is not any contractual agreement for a fixed time period.