Pricing Pervasive Services Using Policy-Based Mechanisms

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ABSTRACT

Network operators using next-generation networks have the potential to service users without pre-existing contractual arrangements. Several research groups are working on ways of developing and implementing that type of interaction with game theory techniques, market-based mechanisms (for example auctions) and techniques based on mesh networks among others. We believe the policy-based network management field provides some excellent ideas that can be borrowed and adapted to the field of ubiquitous or pervasive services pricing. This research-in-progress paper explores the prospects of using policy-based mechanisms to adequately price ubiquitous network services.

1. INTRODUCTION

One of the keys for the success of ubiquitous network services is the issue of assigning prices to those services. Furthermore, ubiquitous services based on a network of complementary technologies, both fixed and wireless, have created the expectation of services that can be obtained dynamically and automatically with the minimum possible of interaction between the users and potentially complex network systems. Intelligent agents would negotiate the best conditions to make sure the user obtains always the best possible connection (Voinov and Valladares, 2003). This best possible connection would be selected by comparing the different services, quality of the services offered, prices and reaching a decision based on the policies the user has configured in her intelligent agent and in conjunction with the policies being presented by the different service providers.

It is clear that, from the technical point of view, the scenario depicted above is feasible. There has been continued progress on the integration of technologies such as WiFi, "Mesh" and "Ad-Hoc" networks with the traditional phone networks and fixed sub-networks based on the TCP/IP family of protocols. Telecommunication companies have exploited the popularity of WiFi "hot spots" as access ramps to their 3G services (Legard 2003). However, there is work to be done in the area of agreeing how to price network services, especially when that "network" is supplied by different organizations and potential users may not have contractual agreements with all the players involved.

The current telecommunications environment, in which virtual operators re-sell network services, in which some firms are customers of a traditional "Telco" while at the same time offering services to many other smaller organizations, forces us to redefine many of the business models that had been used so far. Long term contracts are being challenged by many other arrangements that give more flexibility to the users. These changes, in most cases promoted by users' requirements and further "pushed" by competitive, and innovative, new entrants into the telecommunications arena have resulted on a profound transformation in the way services are acquired and billed. This fact will always clash with the tendency of traditional "Telcos" to keep billing as simple as possible (Meyer, 2003).

2. USING POLICY-BASED TECHNIQUES TO PRICE UBIQUITOUS NETWORK SERVICES

Policies have been used as a means of implementing flexible and adaptive systems for the management of Internet services, distributed and security systems. In the last five years policy-based network management (PBNM) received even more attention due to the fact that policies are considered an enabler of the autonomic networking paradigm (Serrano et al., 2006).

As defined in Sloman (1994), policies are rules governing the behaviour of a system. As in any rule-based system, one of the major issues is the detection and resolution of the conflicts. A policy conflict occurs when the conditions of two or more policy rules that apply to the same set of managed objects are simultaneously satisfied, but the actions of two or more of these policy rules conflict with each other. A model to deal with policy conflicts has been proposed by Baliosian et al. (2004) and has been used in the core of an autonomic networking environment proving to be functionally correct and computationally efficient (Vidales, P. et al. 2005). This approach may be used in our pricing context problem. In fact, a user may have policies to drive her access to the network services, whereas different service providers may also have different pricing policies to promote the use of their respective resources. The final outcome will be the result of solving a likely conflicting situation between the user's policies and the service providers' policies.

A different issue arises considering the policy deployment problem. A policy-based managed system (i.e. a pricing system) may be constituted by many different components and these components need to be driven by different enforceable policies that globally ensure a given system behaviour. Even in systems where only a few tenths of policies need to be deployed it would be almost impossible to design these policies independently and guarantee at the same time global system behaviour. Therefore a procedure, also known as policy generation and refinement, is needed that coming from a high level goal assists the policy designer to systematically derive system enforceable policies. In that area is worthy to mention the work of Rubio et al. (2005) that was later formulated as a holistic refinement approach and validated in a QoS management environment (Rubio, J. et al., 2006). This approach could be clearly adopted for the definition of pricing policies.

From a complementary point of view, pricing policies for a network providing ubiquitous services can then be defined using the policy management paradigm, so that when a potential client "walks" into the coverage area of a provider a basic exchange can inform the client about the active policies for accessing the network facilities. Policies may include price structures (tariffs), security restrictions (who is allowed in), and resource allocation schemes (e.g. bandwidth). The potential client (or an agent on her behalf) would analyze those policies which will be expressed on open format (XML) and standard technologies (such as J2EE and Web services; see Agrawal et al (2005)) and decide whether she would like to use the services.

3. FUTURE WORK

In the context of Next Generation services, is worthy to mention pervasive services for their impact on the final users. Nevertheless, deploying such services requires the convergence of several technologies; among those we highlight policy-based network management and pricing. In principle, the flexibility of the policy-based management paradigm is very promising and makes it a candidate for service management, but in a very dynamic and distributed context, not only in terms of the number of users but also in the environment diversity, as it is the case of generalised computing, is not possible to rely on human managers to undertake updating changes in the bulk of policies used in order to adapt to new services or

devices connected to the network, or to be able to cope with any potential policy conflict. Therefore, it is mandatory to make use of mechanisms, not yet available today, for automatic policy generation and refinement as well as for policy conflict detection and resolution.

On the other hand, deploying ubiquitous services requires that users and providers collaborate in order to assign prices to these services. The key factor in the pricing mechanisms in the context of such services is the dynamic adaptation to the environment (context awareness) and henceforth their temporal evolution as a function of the context. Then, we require pricing models that take into account the services context and particularly the availability of resources in a non-cooperative business model. Also, pricing must consider the mechanisms to make the users aware about the evolution of the current prices.

Our research aims to tackle four challenges related to the above described ideas: To develop an automatic generation model for service management policies intended to deal with a variety of devices and services not known beforehand; To develop a formal method to bring and automatic method for policy conflict detection and resolution; To establish dynamic pricing models to represent the real cost of context-aware services; To propose the necessary mechanisms to ensure that the user is aware of the price evolution and hence he/she can react in consequence.

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REFERENCES

Baliosian, J. and Serrat, J. (2004) Finite State Transducers for Policy Evaluation and Conflict Resolution. *IEEE International Workshop on Policies for Distributed Systems and Networks, pp.250-259*

DaSilva, L.A. (2000). Pricing for QoS-Enabled Networks: A Survey. *IEEE Communications Surveys, Second Quarter*, available at http://www.comsoc.org/pubs/surveys

Gutiérrez, J. (2006). Pricing ubiquitous network services: A survey. In *Encyclopedia of Internet Technologies and Applications*, Mário Freire and Manuela Pereira (Eds). Idea Group publishers. In Press.

Legard, D. (2003). SingTel, NTT DoCoMo tie up to push 3G, IDG News Service.

Meyer, D. (2003). AT&T wireless tries simple rate plans, fewer freebies. *RCR Wireless News, 22(7)*.

Rubio, J. et al. (2005) Using Linear Temporal Model Checking for Goal-Oriented Policy Refinement Frameworks. *IEEE International Workshop on Policies for Distributed Systems and Networks, pp.181-190*

Rubio, J. et al (2006) A Methodological Approach towards the Refinement Problem in Policy-based Management Systems. *IEEE Communication Magazine, October*

Sloman, M. (1994) Policy Driven Management for Distributed Systems . *Journal of Network and Systems Management*, 2:333

Serrano, M. et al. (2006) Policy-Based Management and Context Modelling Contributions for Supporting Services in Autonomic Systems. *Lecture Notes in Computer Science, Vol. 4195/2006, 172-187*

Vidales, P. et al. (2005) Autonomic System for Mobility Support in 4G Networks. *IEEE Journal on Selected Areas in Communications, Vol.23, pp.2288-2304*

Voinov, I. A. and Valladares, T. R. (2003). An enhanced socket interface for next generation systems. In the 1st International Workshop on Wireless, Mobile & Always Best Connected pp. 73–85. University of Strathclyde, Glasgow, UK.