A User Advising Approach for Resource Reservation Support in Hybrid Networks

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ABSTRACT
In hybrid networks, the management and operation of service virtualization can't depend solely on human agents. The current human-based support solutions don't scale well in environments that are continually growing and changing their contexts. This paper presents a novel approach for resource reservation support in such networks that establishes a relation among network circuits, user's profiles and applications' characteristics. This approach allows the presentation of user-tailored advising information based on previous circuits' requests and degree of satisfaction reported by the users.

Categories and Subject Descriptors
C.2.3 **[Network Operations]**: Network management.

General Terms
Management, Measurement, Performance, Human Factors

Keywords
Monitoring, Network Virtualization, Network Management, Performance advising.

1. INTRODUCTION
Network virtualization has been seen as a mean to provide end-to-end network services to applications that require performance levels that go beyond the ones provided just by best effort. Its increasingly acceptance by Research and Education (R&E) communities relies on the need to use network applications that require high-bandwidth links which cross multiple network domains involving different network technologies. Hybrid networks consist of virtualization solutions which try to combine the advantages of packet and circuit switching approaches to provide dedicated network paths, serving a large number of applications.

In the context of these networks, there is a common sense that some of the operational and management activities should be done by end-users to alleviate the centralized management. Therefore, the current provisioning systems have been designed to allow the rapid circuits provisioning through the specification of just few parameters, which describe the required bandwidth, path, starting time and duration of the circuit. The problem, however, is that such simplicity offers few resources to aid the users in the search of alternatives for non-attended provisioning requests. Besides that, the use of the available resources relies just on the network operator knowledge.

So, to better assist users on the non-attended provisioning requests, we propose a network performance advising approach that automatically offers similar choices to such requests. To identify these choices we add to the decision process, the characteristics of the application that would run and the user's community general preferences. The advising stems from the *User* x *Application* x *network performance level* relation, where the recommendation space S is defined as a Cartesian product $S = D_1 \times D_2 \times D_3$. D_1 and D_2 represent the dimensions comprising a set of attributes that defines the users' profiles and applications' features, respectively. Dimension D_3 comprises a set of attributes that defines the available network resources.

2. OUR APPROACH
The advising approach for circuit reservation presented here is based on a recommendation process [1], which draws heavily on the e-commerce recommendation problem, originally formulated by Adomavicius, G., and Tuzhilin, A. [2]. The problem has been extended upon and adapted to meet the requirements for S space processing. Let $U = (u_1, u_2, \cdots, u_o)$ be the set of all users that have already requested a circuit reservation, $A = (a_1, a_2, \cdots, a_m)$ be a set of known network applications (as described on the previous section), and $R = (r_1, r_2, \cdots, r_n)$ be a set of available network resources. Let $f(u_o, a_m, r_n)$ be an utility function that measures the usefulness of a network resource r_n to a user u_o to run an application a_m, i.e., $f: U\ x\ I \rightarrow R$, where R is a totally ordered set. So, for each network user, $u_o \in U$, it is chosen the network resource that maximizes the utility function *f.* More formally:

$$\forall u_o \in U, r^{max, u_o} = \arg max f(u_o, a_m, r_n) \quad (1)$$

In order to identify the applications' characteristics from the elements of the space A and users' preferences from the elements of the space U, we defined the advising approach depicted on Figure 1. It describes a hybrid recommendation solution that combines conversational and knowledge-based methods to help the provisioning systems on better matching the users' preferences.

The first step (*data gathering*) should implement a conversational method to facilitate the user profile identification adopting dialogs that interact with the users to elicit their preferences and intentions. As the user informs his/her intentions, the queries are matched against previous application knowledge until it finds the corresponding application's class. Afterwards, the second step (*reasoning*) should recover the network performance metrics values related to the identified application class. This can be done by rule-based induction, which is usually supported by classification trees that have built-in "*is-part-of*" and "*is-a*" hierarchy relationships. The remaining information of application class can be obtained by additional rules not supported by hierarchy relationships. Finally, the *recommendation processing and network testing* step obtains the remaining information required to advise the user. Based on the network condition (measured or specified by the user), it looks for other similar previous situations on a recommendation base to find the best alternatives for the non-attended request. This information then feeds the advisor which, in turn, supplies the circuit provisioning system that sets the domain controllers (DC).

We have developed an advising infrastructure following the approach depicted on Figure 1. A monitoring domain ontology knowledge-base for the classification-tree [3] was adopted, the case-base problem solving paradigm for recommendation processing, and the PerfSONAR measurement services [4] to gather network performance data.

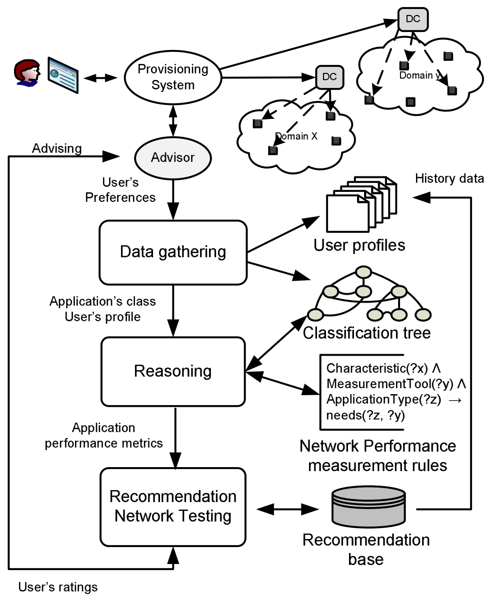

Figure 1. The network use advising approach.

The monitoring domain ontology has been used as the starting point for the development of descriptive metadata-information of the so-called "grid application". This is a group of applications that are capable of running on one of the e-infrastructures and, in general, requires distinguished network services through network virtualization. The advising results from the rating assigned by the users from a certain community and its retrieval should count on the k-nearest neighbor's algorithm to find similar cases to the current one. The similarity formula used for the algorithm is presented in (2), where T is the current case, S is the case in the base, n is the number of attributes of each case, i is an individual attribute, f is the function used to compute the local similarity of the attribute i of case T and S, and W is the weight for each attribute i.

$$sim\ (T, S) = \frac{\sum_{i=1}^{n} f(T_i, S_i) \times W_i}{\sum_{i=1}^{n} W_i} \quad (2)$$

3. PRELIMINARY RESULTS

We have made some experiments in laboratory, through an advisor prototype that provided preliminary results, showing the applicability of such approach in the improvement of circuit provisioning systems. In these experiments we simulate a network environment and a network advisor that helps the users run their applications. In order to address the rump up problem, an initial base of 45 cases was built combining the application classes from the monitoring knowledge-base (*Messages*, *Collaboration*, *Services On Demand*, *DataTransfer*, *Information Services, and Grid*), the user's types (*regular user, researcher, network manager*), and the ratings (*excellent, good, bad*) values.

The performance metric values were obtained by the emulation of a real network cloud with diversified performance conditions. Shell scripts were used to randomly generate the performance conditions, varying the delay between 0 and 500ms; the bandwidth between 16 kbps and 6Mbps; and jitter between 0 and 9%. The simulation of users' ratings assignment was obtained by the investigation of the general users' satisfaction for the applications type. After running the simulation by six hundred requests, it was observed that in both tests the system made bad recommendations for a while and, after approximately 55 cases, improved its accuracy, having success in most of situations, as shown on Figure 2.

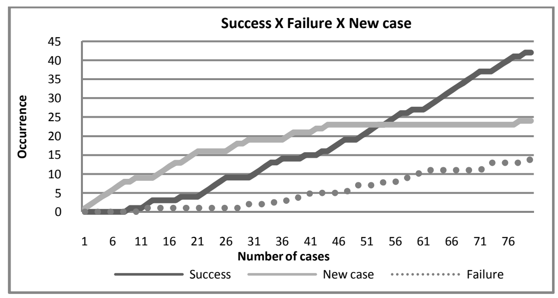

Figure 2. Advisor behavior.

4. CONCLUSION AND FURTHER WORKS

The study described herein aims at investigating the management of hybrid networks and interactions with users. It is within the context of G3 study group of Future RNP project activities, supported by RNP, the Brazilian NREN. The preliminary results showed the applicability of the proposed approach in real scenarios, such as the RNP's Cipó network, currently under deployment. In further works, we plan to add more parameters to better define a case and improve the prototype to enhance end-user systems in line with CANARIE's UCLP (*User-controlled Lightpath*).

5. REFERENCES

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