CoLisEU – A Management System Based on Quality of Service and Quality of Experience for Wireless Networks

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Keywords: Quality of Service, Quality of Experience, Management System

Abstract

Quality of Service (QoS) parameters, *e.g.,* throughput, delay, and jitter, provide a quantitative view about the quality of the network and these parameters are usually used by the administrator [1]. The end-user, in turn, tends to ignore QoS parameters, being rather focused on his/her experience when using an application or service. This experience can be measured using Quality of Experience (QoE) parameters, such as satisfaction level with application navigation and network efficiency [2]. The combined observation of QoS and QoE parameters is fundamental for the management of wireless networks, because one observation alone is not sufficient accurately to point out specific problems such as network flaws and degradation of user satisfaction.

The management of a wireless network involves the radiofrequency infrastructure, the backhaul, the backbone, and the Internet service provider [3]. Each one of these infrastructures may present different problems, like intermittent wireless signal, insufficient coverage of large metropolitan areas, traffic overhead, non-optimal service level agreements, and virtual links misconfiguration. These problems degrade the QoE, *i.e.*, the satisfaction that end-users have with applications and services. In this sense, a management system based on both administrator and end-user viewpoints is desirable for global wireless networks, *e.g.,* EDUcation ROAMing (EDUROAM) [4].

The state of the art in management systems considering QoS and QoE parameters to quantify the administrator and end-users perspectives is still underexploited by the scientific community. Investigations point out that QoS and QoE can serve as a guiding paradigm [5] for improving management in wireless networks [6]. Other investigations focus on architectural models for management systems in wireless networks that are centred in the end-user [7] [2], but neglecting QoE parameters. Thus, in the current context, there is a need for a management system that explicitly takes into account QoS and QoE considering the viewpoints of both administrators and end-users.

In order to enhance the management of a global wireless network, such as EDUROAM, the Brazilian Research and Education Network, RNP, started a research and development initiative that resulted in the management system called CoLisEU [5]. This system enables the integration of both administrator and end-user viewpoints through rich visualizations of wireless network performance (QoS) and user satisfaction (QoE). The architecture of CoLisEU is composed of three modules with distinct functions: agent, gateway, and central server, as can be seen in Figure 1.

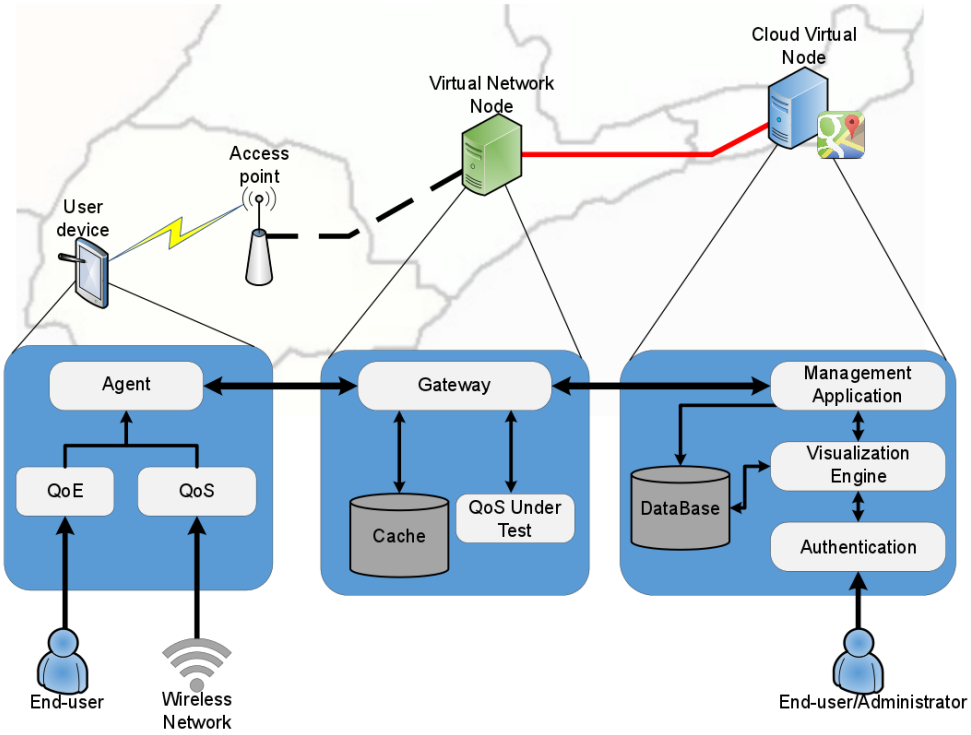

Figure 1. CoLisEU architecture

The agent module is able to extract two types of information from mobile devices accessing the wireless networks: (*i*) data about the quality of network services, including features such as delay, jitter, packet loss, etc., and (*ii*) data regarding the user experience in the use of wireless services. Thus, the agent was designed to obtain relevant information regarding the characterization of the QoS and QoE considering both administrator and end-user viewpoints. The Gateway module should forward the information collected from users to the management application. The Gateway is installed in a virtual machine located at each Point of Presence of RNP's network, *i.e.*, close to the wireless networks access points. The Management Application module is designed to receive and process a large amount of data, such as periodic information about the QoS and QoE from all users who use the wireless network.

The design of CoLisEU was based on the Mobile Cloud Computing concept [3]. The agent was developed using JAVA and the software development kit provided by Google for mobile devices with Android OS. The Gateway was developed as a Web system over an Apache Web Server using PHP combined with a MySQL database. A virtual node was used to deploy the Management Application, which is an Asynchronous JavaScript and XML (AJAX)-based web system. In the Management Application, reports and visualisations are processed using Web Service composition, *e.g.,* Google MAPs and Google Big Tables services. These visualisations intend to explore the benefits acquired from the combination of QoS and QoE. To analyse these benefits, we chose the main screen of our prototype, as shown in Figure 2. This visualisation composes a heat map showing the experiences that end-users had when using the EDUROAM network. The colour amorphous shape on the map represents the estimated geographic coverage area of the analysed network. The spreading gradient colours stands for the average end-user experience within the selected network.

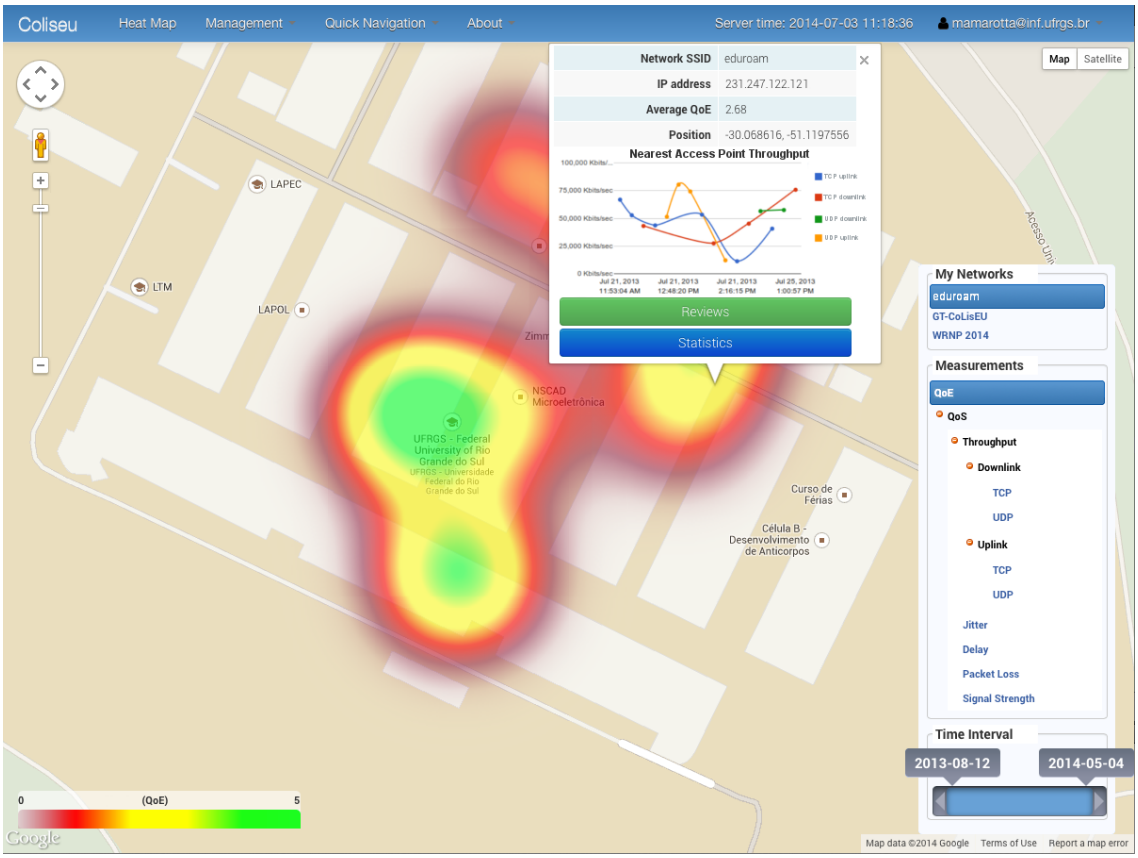

Figure 2. CoLisEU graphical user interface

The preliminary version of CoLisEU has attracted the attention of the Brazilian scientific community. Since the combined observation of QoS and QoE parameters improves the awareness of administrators and end-users about the network efficiency and satisfaction level of users. Considering the benefits acquired from the combination of QoS and QoE, we believe that the CoLisEU can become the auditing system of the EDUROAM network in RNP. For example, the administrator can analyse the features of the network such as delay, jitter, packet loss, and the satisfaction level of users in a solo management system. CoLisEU roadmap includes the integration with MonIPÊ Service [9], a network performance measurement service developed by RNP that uses the perfSONAR protocol and the same measurement tools used by similar initiatives from other academic networks around the world, such as Internet2, ESnet, and GÉANT, in order to gather QoS information.

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Biographies

Cristiano Bonato Both is an associate professor at the University of Santa Cruz do Sul (UNISC), Brazil. He received his Ph.D. degrees, in computer science, from UFRGS 2011. He received his M.Sc. degree in Computer Science from the Ponthifical Catholic University of Rio Grande do Sul, Brazil, in 2003. His research interests include wireless networks, next generation networks, traffic control on broadband computer networks.

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Matias Schimuneck is a graduate student in Computer Science at the University of Santa Cruz do Sul (UNISC), Brazil. He is Android developer at the Embedded Systems and Microelectronics Design Team (GPSEM).

Michael Stanton is Director of Research and Development at RNP. After a PhD in mathematics at Cambridge University in 1971, he has taught at several universities in Brazil, since 1994 as professor of computer networking at the Universidade Federal Fluminense (UFF) in Niterói, Rio de Janeiro state. Between 1986 and 2003, he helped to kick-start research and education networking in Brazil, including the setting-up and running of both a regional network in Rio de Janeiro state (Rede-Rio) and RNP. He returned to RNP in 2001, with responsibility for R&D and RNP involvement in new networking and large-scale collaboration projects.

André Marins is a Research and Development Project Manager and leads RNP's Working Group Programme. Graduated in Computer Engineering at Pontifícia Universidade Católica do Rio de Janeiro – PUC-Rio (1996), with MBA in Executive Management at IBMEC Business School (2001). Received his MSc. in Computer Science from PUC-Rio in 2008. Leaded high performance teams as IT Manager at Cadê (internet catalog acquired by Yahoo) (1996-1999). Acted as Operation and IT Manager, Business Development Manager and IT Director at Starmedia (1999-2002). As an IT Consultant at Vogal also managed document management projects (2003-2006). Contributed as an IT researcher at TecGraf, PUC-Rio (2007).

Rafael Valle is Coordinator of Research and Development at RNP. Rafael has graduation and M.S. degrees in Telecommunications Engineering at Federal Fluminense University (UFF) in 2008 and 2011, respectively. He works at RNP since 2011and currently has been coordinating R&D projects involving advanced Internet, wireless networks, dynamic circuits, video applications and accessibility.