INTERNET ACCESS QUALITY MONITOR

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Abstract: Assessing the perceived Quality of Service (QoS) offered on Broadband Internet accesses from end-User standpoint is important not only to monitor the performance, but also to assist end-Users to quantify the effective quality offered by their Internet accesses and compare it with the quality parameters specified in the Service Level Specification (SLS) of the connectivity service contracted to the ISPs (Internet Service Providers). Other key benefits are end-Users being aware about the Geographic quality distribution of the Internet accesses, pinpointing congestion links or areas, and being able to make price-performance tradeoffs and subscribe better ISPs. In this paper, we present the design principles of a practical and comprehensible Internet Access Quality Monitoring (IAQM) system and some aspects regarding its deployment and security. IAQM aims at supporting accurate assessment of the performance of Internet Broadband accesses and satisfaction of end-Users at large scale. A collection of tests are planned to measure several Quality of Service metrics of an Internet access, such as (but not limited to) download and upload rates, latency, jitter or DNS (Domain Name System) lookup times.

1 INTRODUCTION

As the Internet is growing it is increasingly changing the social relationships between people, the business relationships between customers and enterprises and the relationships between citizens and governments. Major advantages of the Internet are the numerous powerful communication and multimedia tools, such as electronic mail, instant messaging or Internet phone, it makes available to users for fast share and access to information in any geographic location. High speed accesses to the Internet are thus recognized as an essential tool for fast success. An important fact is the recent exponential increasing of the number broadband accesses to the Internet at home, enterprises or governmental institutions.

One key factor driving this increasing is the emergence of mission critical and multimedia applications, such as VoIP (Voice Over IP), video streaming or virtual reality, that are increasingly demanding stringent bandwidth guarantees and so quality of service.

Internet Service Providers (ISPs) are also contributing for this change as they are offering better quality of service and capacity to end-Users. First, it is becoming common the negotiation of Service Level Agreements (SLA) or private agreements for increasing the quality of service and interconnection capacity between ISPs. Second, ISPs are also providing end-Users better Internet accesses and services. For instance, regarding the ADSL technology one technique for improving the lines capacity that has been adopted by ISPs is Dynamic Spectrum Management (DSM) by using automated intelligent control of ADSL (Asymmetric Digital Subscriber Line) lines parameters (DSM, 2003, Song, 2002).

Unfortunately, most of ISPs only reveal publicly few or partial measurements regarding the quality and reliability of their networks due to business constraints. The IAQM (Internet Access Quality Monitor) project aims at answering to common issues and concerns raised by end-Users about the perceived Quality of Service and parameters of the Internet accesses contracted to ISPs.

There has been relatively little work (e.g., (ANACOM, 2005, TCP/IQ, 2007) on the design and deployment of tools for assessment of the performance of Internet accesses and satisfaction of end-Users at large scale. Most of this work relies on an approach in which software agents installed at the Internet accesses autonomous and asynchronously collects measurements that can be related to the parameters of the Internet links contracted from

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ISPs, such as maximum download and upload rates. But, unfortunately none has rigorously providing measurements about the effective quality of service of the Internet accesses and end-Users satisfaction at large scale.

In contrast to previous approaches, IAQM introduces significant improvements in the way it quantifies the quality of the Internet accesses and end-Users satisfaction. More specifically, IAQM system follows the client-server architecture model. It proposes a thin client –a software agent– which basically performs the measurement tests regarding the performance of the Internet access; and a central server that is responsible not only for composing and scheduling of the tests and controlling the IAQM clients activity, but also for the subsequent analysis of the individual user results and, above all, crossing these results in order to allow users to compare the quality among the available services, ISPs and geographic areas. Others key concerns are on the selection/invitation of end-Users to participate in the study and on the type of tests and their scheduling methodology.

In this paper, we present the base design principles of IAQM and some aspects regarding its deployment and security. We believe that IAQM deployment path is as interesting as the envisioned end state. That is, it is expected that IAQM would offer several benefits to users of broadband accesses, such as auditing the effective quality of service offered by its ISP, the ability to make price-performance tradeoffs and finding better ISPs to subscribe, and providing a powerful tool for diagnosing and troubleshooting of the Internet accesses.

The rest of the paper proceeds as follows. Section 2 motivates IAQM system and briefly describes its architecture. In Section 3, we present the IAQM architecture in detail. In Section 4, we discuss the security issues regarding the IAQM utilization. Section 5 reviews related work and Section 6 concludes.

2 MOTIVATION AND SYSTEM OVERVIEW

There are numerous factors that are driving the growth of the number of the Internet accesses and end-Users (eTForecast, 2007). The low cost of Internet accesses and devices will continue to be the main growth factor. However, there are other key driving factors, such as the emergence of a wide range of services, the impact of broadband technologies on Internet accesses (e.g., cable modem and ADSL connections) and Web-driven productivity gains.

Recent statistics revealed that in many countries there are more than 600 Internet users per 1000 people (eTForecast, 2007). Among these Users, it is likely that a significant fraction has contracted its own Internet accesses. For instance, in Portugal one of top 15 countries in terms the number of Internet users, this growth trend continues at a rate of about 30% a year and it estimates that there are already more than 1.8 million of broadband customers, among an universe of about 10 million of people (ANACOM, 2007). Inclusively, it is expected that at the end of 2007, 50% of Portuguese homes would have a basic access to the Internet.

This motivated the need to analyse if there are also a corresponding increasing in end-Users satisfaction and in the quality of service of the Internet accesses. Moreover, none work has rigorously providing measurements about the effective quality of service of these accesses and users satisfaction.

The aim of the IAQM project is therefore to design and provide a client-server application that allows assessing and studying the underlying perceived quality of basic connectivity services offered on the Internet access methods from multiple ISP, such as Asymmetric Digital Subscriber Line (ADSL) and Cable, available to Home users.

The IAQM framework focuses on two distinct, but complementary evaluations (not limited to):

- Overall evaluation and comparison of the effective quality of service offered on broadband accesses (ADSL and Cable) from multiple ISPs.
- Evaluation of specific services provided by ISPs and violation rates of SLAs, including the assessing of geographic distribution of quality (i.e., throughout districts or regions) and eventual disparities among broadband accesses from multiple ISPs.

To assess quality of service there is need to collect data at each broadband access. The IAQM includes two main software components. First, an IAQM software agent is installed on computers of end-Users invited (or that wish) to participate in the study. This software component is launched automatically at periods of time pre-defined and accesses to a central server from which it downloads the tests to run. Upon the measurements tests are completed, it sends the measurements to the central server. On the other hand, the central server, besides controlling the agents activities and gives them tests to run, is responsible for storing and processing the measurements samples collected during the tests.

3 CLOSER LOOK AT THE SYSTEM ARCHITECTURE

Figure 1 shows IAQM system components: the IAQM Client, the IAQM Server and the IAQM Web Server. Both the IAQM Client and the IAQM Server were developed with the C# programming language (MSDN, 2007), and the communication between them is implemented using the Microsoft .NET Remoting Layer infrastructure (Rammer, 2002). The IAQM Web Server relies on the ASP.NET web application framework.

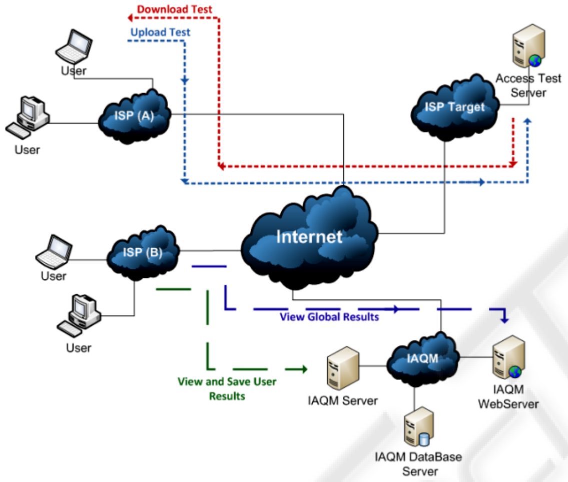

Figure 1: IAQM System architecture.

The set of IAQM Client functionalities include the monitoring and displaying of the End-user's download and upload rates on real time basis on its GUI in a graphic representation (see Figure 2), and, above all, the execution of a pre-defined set of tests to quantify the quality of the access. IAQM Server supplies this tests that are performed in a transparent way, in order to be not intrusive and to not degrade the user's Internet experience. Each test has its own specification, such as the type of the test and the time of day to be executed.

The IAQM Client is responsible for accessing to the IAQM Server that indicates the tests that it must download and execute (Figure 3). For each of the executed tests, the client registers the results obtained and transmits them to the server.

IAQM Server is responsible for preparing and scheduling tests, receiving the results sent by the IAQM clients, assuring the validity of the user's credentials and results, and for the analysis of the measurements.

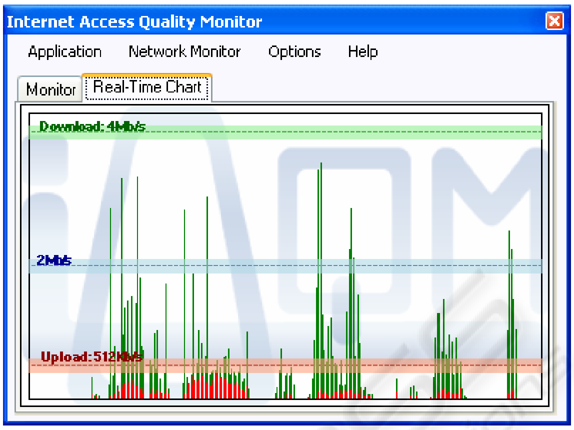

Figure 2: IAQM Client monitoring download and upload rates.

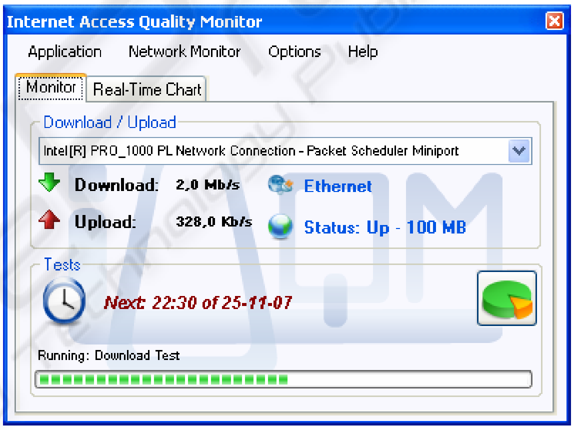

Figure 3: IAQM Client downloading test information

The tests objectives are to measure several quality of service metrics of an Internet connection, such as (but not limited to) download and upload rates, latency, jitter or DNS lookup times. Diagnosing route congestion is also an interesting feature to be explored. The influence of user's computer hardware and software (e.g. operating system, firewall, anti-virus, anti-malware), and its local area network characteristics is also considered.

Each of the tests has a particular purpose like for example to evaluate the upload rate using FTP, or the HTTP access time, or the round trip time using Ping. They are executed at specific times of the day and on specific days of the week. Furthermore, they are applied to servers located on the network of the ISP's client, and located on different ISPs on the same country. Finally, they are also applied to international servers. The analysis of the measurements returned by clients will allow to identify variations on the Internet access quality on different ISPs, regions and districts a country (e.g., Portugal), and also to locate points of congestion on national and international Internet accesses.

The scheduling of the tests is based on data statistics regarding the diurnal cycle of the End-user accesses, popular Web sites visited and age of users as in (NetPanel Report, 2003), using a proper methodology as the base methodology proposed in (ANACOM, 2005).

IAQM Server analysis of the measurements is only available for registered users and can be viewed either by consulting the IAQM Client, or the IAQM Web Server. By using the IAQM Client GUI a user may check his individual results, analyzing and comparing them through time (day, week, month and year). A consult of the data stored on the IAQM Web Server allows viewing the global study, enabling users to evaluate Internet access quality on different ISPs, regions and districts.

4 SECURITY CONSIDERATIONS

One major requirement of the IAQM system is to protect the user's data and to avoid to tampering attempts on the obtained measurements. To accomplish this requirement, the communication between the IAQM Client and the IAQM Server is encrypted using an asymmetric key algorithm. .NET Remoting Layer channel codification is also used.

Another important aspect is related to controlling where the IAQM Client is running. In order to guarantee the validity of the measurements, IAQM needs to check if the tests are being executed with the same conditions that were defined on the user's profile. To assure this, a tracking algorithm will evaluate the user's IP address, geographic place, and the type of network where it is connected. If some incongruity appears, the tests are not executed and a warning is sent to the user.

To participate on the Internet access quality study, a user must access the IAQM Web Server where will find a register form. The correct fulfilling of the user profile (contact details, computer hardware and software attributes, and the ISP contracted service) will permit to download and install IAQM Client. During execution, the IAQM Client will only collect information about the computer's hardware, IP address, monitored download and upload rates, and results from the tests.

5 RELATED WORK

Some studies and software solutions to evaluate the Internet access quality have been proposed, such as the ANACOM study (ANACOM, 2005), the Speakeasy Inc. Speed Test (SpeakEasy, 2007), the Bandwidth Place Speed Test (Bandwidth Place, 2007), the DSLreports.com Speed Test (Broadband Reports, 2007), the Visualware Inc. MySpeed PC (Visualware, 2007) and the TCP/IQ Line Speed Meter (TCP/IQ, 2007).

There are some similarities between IAQM and these approaches. We intend to develop a system that will also give the possibility to make a general study about the user's perceived Internet quality access and satisfaction, but as a major contribution it will focus on particular details that have not been exploited and studied yet.

Except the ANACOM study, the other presented software solutions access external servers to measure only the Internet connection speed. IAQM aims to do a more complete study, measuring several quality of service metrics of an Internet connection, on download and upload accesses to servers located on the user's ISP and on others ISPs from the same country or located on foreign countries, using more accurate measurement methods.

Online internet connection speed tests from Speakeasy Inc. Speed Test and DSLreports.com Speed Test, do not permit to cross and compare the individual user results with the results experienced by other users. Since it is the user that starts the test whenever he wants to, the test can be influenced by Internet traffic characteristics, so it is not possible to have a correct idea of the connection performance though time. Line Speed Meter and ANACOM approaches permit to analyze the Internet performance connection over a period of time. ANACOM concentrates its study only on Portuguese ISPs, Line Speed Meter provides comparison of global Internet connection speeds throughout the world. However, further work can be done since Line Speed Meter does not have the possibility to directly compare country's ISPs as ANACOM does. But ANACOM's study can be enhanced, by examining the variation of Internet access quality along a country, comparing it along regions and districts. The number of users, their profile, and how they were selected to run the tests is also a weak point of these studies.

Furthermore, none of the above-mentioned systems takes into consideration the user's computer hardware and software, and the user's local area network characteristics. However, it can be interesting to evaluate if these aspects affect the accuracy of the tests, so IAQM will also analyze them.

6 CONCLUSIONS

In this paper, we presented the base design principles of IAQM and some aspects regarding its deployment and security. We believe that there are several advantages in the use of the IAQM system, namely in obtaining a more comprehensive view of the real conditions and quality that End-users usually experiment. First, IAQM will comprise large enough number of quality metrics, which would allow to capture and a give broader characterization of the effective conditions and quality of the Internet accesses when comparing with previous work.

Second, our IAQM system will enhance the gathering of this data and the amount of information about the Internet accesses through the use of a specific set of tests to be performed during each period of time, the level of communication with servers within the ISP network or within an external or international network. Finally, as the IAQM server has the ability to control the exact periods of time when the clients should perform the tests, and their geographic location, it would allow obtaining more consistent results. The association of the geographic location to the quality of each access will allow building a map with the distribution of levels of quality of service or asymmetries throughout a country and identifying eventual bottlenecks in the Internet (e.g., internal links, access links or peering links).

In short, we believe the envisioned end state of IAQM will provide a useful study of the quality of service on broadband Internet accesses that would for sure benefit the customers.

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