QoS Adaptation in Multimedia Multicast Conference Applications for E-Learning Services

Sérgio Deusdado, Instituto Politécnico de Bragança, Portugal
Paulo Carvalho, Universidade do Minho Braga, Portugal

ABSTRACT

The evolution of the World Wide Web service has incorporated new distributed multimedia conference applications, powering a new generation of e-learning development and allowing improved interactivity and prohuman relations. Groupware applications are increasingly representative in the Internet home applications market, however, the Quality of Service (QoS) provided by the network is still a limitation impairing their performance. Such applications have found, in multicast technology, an ally contributing for their efficient implementation and scalability. Additionally, considering QoS as a design goal at the application level becomes crucial for groupware development, enabling QoS productivity to applications. The applications’ ability to adapt themselves dynamically according to the resources availability can be considered a quality factor: Tolerant real-time applications, such as video conferences, are in the frontline to benefit from QoS adaptation. However, not all include adaptive technology able to provide both end-system and network quality awareness. Adaptation, in these cases, can be achieved by introducing a multiplatform middleware layer responsible for tutoring the applications’ resources (enabling adjudication or limitation) based on the available processing and networking capabilities. Congregating these technological contributions, an adaptive platform has been developed integrating public domain multicast tools, applied to a Web-based distance learning system. The system is user-centered (e-student), aiming at good pedagogical practices and proactive usability for multimedia and network resources. The services provided, including QoS adapted interactive multimedia multicast conferences (MMC), are fully integrated and transparent to end-users. QoS adaptation, when treated systematically in tolerant real-time applications, denotes advantages in group scalability and QoS sustainability in heterogeneous and unpredictable environments such as the Internet.

Keywords: groupware; multicast; Web-based learning; quality of service

INTRODUCTION

Technology has been a strong catalyst for educational innovation and improvement, especially when the World Wide Web is involved. The next generation Internet needs technological support to accommodate promising new applications, such as interactive real-time multimedia distribution. Predictable bandwidth
availability and capacity solvency imply QoS management to regulate resources in heterogeneous environments. Actually, increasing the network capacity through advanced network and media technology is not per se a ubiquitous and definitive solution to overcome the network capacity problem. Historically, the users have always managed to consume the entire system capacity soon after it was enlarged (Ferguson & Huston, 1998). IP Multicasting techniques (Deering, 1998; Kosiur, 1998; Moshin, Wong, & Bhutt, 2001; Thaler & Handley, 2000) are attractive solutions for this capacity shortage problem as bandwidth consumption is reduced when network resources are shared. On the other hand, the QoS support (Moshin, Wong, & Bhutt, 2001) should be, in a first instance, inherent to applications in order to integrate conveniently enhanced real-time multimedia applications in the present Internet, barely QoS aware and increasingly heterogeneous.

With the advent of wireless and mobile networks, heterogeneity is likely to subsist; envisioned applications should merge QoS adaptation and multicast in a proactive utilization of resources. Applications should be designed with adaptation in mind; they need to employ built-in mechanisms that allow them to probe the conditions of the network environment and alter their transmission characteristics accordingly (Miras, 2002). Self-adaptive applications, in the sense of proactive behavior for transmission of continuous media in multiparty applications, are a well-accepted solution due to the correct integration of new services in today’s Internet (Deusdado, 2002; Li, Xu, Naharstedt, & Liu, 1998).

E-learning, as a component of flexible learning, encompasses a wide set of applications and processes which use available electronic media to deliver vocational education and training. It includes computer-based learning, Web-based learning, virtual classrooms and digital collaboration (Eklund, Kay, & Lunch, 2003). Our work aims to integrate interactive multimedia e-learning applications in a proactive fashion taking into account the available network resources and QoS sustainability. In this way, our motivation is to offer improved learning experience based on ultimate technology with QoS warranties.

The system architecture proposed in this article includes an adaptive module based on Java applets and embedded Javascript, responsible for assessing the existing operating conditions, by collecting metrics reflecting the client’s end-system performance (e-student’s host), the current network conditions and relevant multicast group characteristics. The collected data are subsequently computed weighting parameters such as the available bandwidth at the client side, the round-trip time between the client and the e-learning server, the client’s current CPU load and free memory. The obtained results are used for proper multicast applications scheduling and parameterization in a transparent way.

**MOTIVATIONS**

Basically, e-learning services are used to promote connections between people (e-students) and training resources (Steeples & Jones, 2002). E-learning research is wide and growing in importance, especially in higher education. Several institutions are developing interactive Web-based learning systems, integrating rich media streaming which may compromise network performance. The design of e-learning systems should consider QoS as mandatory for successful learning experiences, selecting the appropriate technologies and applications, and regulating proactively the information and communications technology (ICT) resources utilization (Allison, Ruddle, McKechan & Michaelson, 2001).

The Multicast Backbone (MBone) is a network overlaying the global Internet designed to support multipoint applications. MBone tools comprise a collection of audio, video and whiteboard applications that use Internet multicast protocols to enable multiway communications (point-to-multipoint and multipoint-to-multipoint), satisfying most of the needs of group communication, such as e-learning services. Using these applications by common e-students drives recurrently to poor QoS satisfaction due to the heterogeneity of resource conditions and
Related Content

Economic Models for Distance Learning
www.igi-global.com/chapter/economic-models-distance-learning/12179?camid=4v1a

Stories of Engagement with E-Learning: Revisiting the Taxonomy of Learning
www.igi-global.com/article/stories-engagement-learning/2348?camid=4v1a

Instructional Strategy Approaches with Technology
www.igi-global.com/chapter/instructional-strategy-approaches-technology/39458?camid=4v1a
Automating a Massive Online Course with Cluster Computing
Timothy C. Haas (2016). International Journal of Distance Education Technologies (pp. 30-48).
www.igi-global.com/article/automating-a-massive-online-course-with-cluster-computing/151052?camid=4v1a