

Chapter I

Synchronous E-Learning Integrating Multicast Applications and Adaptive QoS

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ABSTRACT

A new generation of e-learning development, based on synchronous groupware applications integration, providing improved interactivity and pro-human relations, allows richer training experiences far beyond a virtual classroom. Despite WWW service evolution, e-conferencing multimedia applications remain “killer applications” and insensitive to resources degradation, in fact, 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 design goal at application level becomes crucial for groupware development, enabling QoS proactivity 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 videoconferences, are in the frontline to benefit from QoS adaptation. However, not all include adaptive technology is 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.

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. Next generation e-learning platforms will support cooperative use of geographically distributed educational resources as an aggregated environment, thus enabling a more effective knowledge exchange but facing several challenges, such as flexibility, extensibility, and scalability (Amoretti, Bertolazzi, Reggiani, Zanichelli, & Conte, 2005). Predictable bandwidth availability and capacity solvency imply QoS management to regulate resources in heterogeneous environments. IP multicasting techniques (Deering, 1998; Kosiur, 1998; Moshin, Wong, & Bhutt, 2001; Thaler & Handley, 2000; Ratnasamy, Ermolinskiy, & Shenker, 2006) are attractive solutions for the 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; so 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 condi-

tions 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 (Lubonski, Gay, & Simmonds, 2005; Deusdado, 2002; Li, Xu, Naharstedt, & Liu, 1998).

E-learning, as a component of flexible learning, encompasses a wide set of applications and processes that 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 work 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 is 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.

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