SameView: A Large-Scale Real-Time Interactive E-learning System Based on TORM and AMTP

Yi Che, Runting Shi, Yuanchun Shi, and Guangyou Xu
Dept. of CS, Tsinghua University, Beijing 100084, China
{cheyi97,shirunting99}@mails.,
{shiyc,xgy-dcs}@tsinghua.edu.cn

Abstract. In this paper, we present the design and development of SameView, a real-time interactive E-learning system. It is designed for large-scale deployment over the Internet and provides a friendly user interface for various pedagogical activities. For efficient scalable multicast over the Internet, SameView is built on top of TORM (Totally Ordered Reliable Multicast), a transport layer multicast infrastructure exploiting a tree-based structure. Between the transport layer and upper level applications is an enhancement layer called AMTP (Adaptive Multimedia Transport Policy), an adaptive multimedia transport strategy to cope with heterogeneous network configurations. To enrich a user’s learning experience, SameView offers a multimodal human-computer interface by incorporating audio/video presentation, as well as a synchronized whiteboard for collaborative web browsing and annotation. Several enhanced features are introduced, including a live record tool which could be used to record a classroom session for later viewing.

1 Introduction

With rapid advances in distributed multimedia technology, the notion of real-time interactive distance learning has received more attention than ever before. Whereas traditional classroom activities are characterized by their inherent geographical limitation, the advent of distant E-learning applications has enabled students to attend classes anywhere with an online computer. Among existent commercial products of media applications, two main categories are readily applicable for remote E-learning. The class of streaming media applications, including RealNetworks[1] and Microsoft Windows Media[2], allow a one-way streaming broadcast of on-demand media or stored contents. On the other hand, video conferencing software such as Microsoft NetMeeting[3], support real-time interactive two-way or multiway communications. Yet they both offer generic services and are not well suited for distance E-learning purposes. Then we witnessed the birth of several RTIVCs(Real-time Interactive Virtual Classroom), as marked by the virtual classroom at University of Washington[5]. Apart from combining these two types of services, RTIVCs have a well-designed user interface for pedagogical activities such as courseware browsing and class recording.
Inspired by the very same notion, we designed and implemented our own version of an RTIVC. Compared with existent RTIVCs, our contribution is highlighted mainly in three aspects:

1) **TORM** (Totally Ordered Reliable Multicast), a transport layer infrastructure for multicast over the Internet;
2) **AMTP** (Adaptive Multimedia Transport Policy), an intermediate layer placed between the transport and application layers, to enable adaptive multimedia transport;
3) SameView’s multimodal user interface specially designed for pedagogical activities, so that interactive communication could be achieved through audio/video presentation and an HTML-capable whiteboard for courseware browsing and remote discussion.

The rest of the paper is organized as follows. In Section 2, we present the overall architecture of SameView and explain the roles of different components. Section 3 and 4 will focus on TORM and AMTP respectively. In Section 5, we introduce SameView’s multimodal user interface, and in Section 6, we report the various tests we have performed with our system. Finally, conclusion and future work will be given.

**Fig. 1. Overall Architecture of SameView**

**Fig. 2. Collective Remote Learning**

### 2 Architecture

There are several issues of concern in the design of a remote E-learning system.

- In order for the instruction to be carried out on a wide basis, the underlying transport layer must provide support for scalable and efficient dissemination of real-time interactive data. To address the problem, we build the application on the basis of a reliable multicast infrastructure named TORM, which is a hybrid approach employing both multicast and unicast to deliver data over a hierarchical tree structure.

- In order to cater to the heterogeneous networks over the WAN, it is necessary to provide differentiated services with regard to local bandwidth conditions. This is