Chapter 4.18
Project Smart Remote Classroom:
Providing Novel Real-Time Interactive Distance Learning Technologies

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ABSTRACT

Real-time interactive virtual classrooms play an important role in distance learning. However currently available systems are insufficient in supporting large-scale user access, and they cannot efficiently support accessing with heterogeneous devices and networks. Furthermore, these systems are usually desktop-based, until the result that the teacher's experience is completely different from teaching in a real physical classroom. This chapter discusses the Smart Remote Classroom project that deals with these difficulties using the following novel technologies: (1) A hybrid transport layer multicast protocol called TORM and an adaptive content delivery scheme called AMTM, which work together to enable large-scale users to access a virtual classroom with different devices and networks synchronously. (2) A dedicated software called SameView, which takes use of the proposed TORM and AMTM technology, and provides a rich set of functions for teachers and students to efficiently carry out the real-time

interactive tele-education. (3) The Classroom augmented by Smart Space technology called Smart Classroom where the user interfaces of the SameView are incorporated in the classroom space. Thus the teacher can instruct the remote students just like teaching face to face in a conventional classroom. All these technologies have been successfully integrated and demonstrated in the prototype system at Tsinghua University.

INTRODUCTION

Motivation

In recent years , distance learning has increasingly become one of the most important applications on the internet and is being discussed and studied by various universities, institutes and companies. The Web/Internet provides relatively easy ways to publish hyper-linked multimedia content for more audiences. Yet, we find that most of the courseware are simply shifted from textbook to HTML files. However, in most cases the teacher's live instruction is very important for catching the attention and interest of the students. That's why Real-Time Interactive Virtual Classroom (RTIVC) always plays an indispensable role in distance learning, where teachers and students located in different places can take part in the class synchronously through certain multimedia communication systems and obtain real-time and media-rich interactions. However, to provide this type of distance learning in large scale, there still remain some barriers:

1. Lack of adequate technologies to cope with large-scale access. Most tele-education schools simply adopted commercial videoconference products (usually they are H.32X-based systems) as the operating platform for RTIVC, where all clients should connect to a centered MCU (Multi-Point Controlling Unit) and data initiated from one client is replicated (sometime maybe mixed) and forwarded to all other clients by MCU. However these systems are not scalable, since the maximum user number (usually 10 or more) is rigidly limited by the capacity of the MCU. Moreover, the cost of communication service is very expensive or there is no guarantee for the quality of service. Thereby nowadays most tele-education schools can only operate RTIVC classes including a small number of students. A possible approach to address this scalability issue is leveraged by the IP Multicast technology, where no central data-replicating node like MCU is required. However, the current state of the IP Multicast technology is not full-fledged yet. First, the IP Multicast service provided by the network layer is a best-effort service. This is not tolerable for applications like RTIVC that are sensitive to the loss of messages. For example, the dropping of a single packet at one client will make the state of the whiteboard in a RTIVC system at this client lose consistency with others. Secondly, IP Multicast is not fully supported by many currently deployed routers of the Internet. Today's Internet can be viewed as many Multicast islands that fully support IP Multicast being separated by the Unicast zones which are not capable of IP Multicast. As a result, we can see many applications which directly rely on the network layer. IP Multicast cannot be successfully deployed on current Internet infrastructure.
2. Lack of adequate technologies to accommodate students with different network connecting and terminal device conditions in one session. Most current RTIVC systems have rigid requirements for the network and device settings of the clients. Clients with inferior device capability or network bandwidth could not join the session and get smooth service quality. On the other hand, clients with superior conditions could not