Open-source Infrastructure for the Remote Delivery of Synchronous and Highly Interactive Sessions

Jose Quiroga[1][a], Miguel Garcia[1][b] and Francisco Ortin[1][c]
[1]*Computer Science Department, University of Oviedo, c/Federico Garcia Lorca 18, 33007, Oviedo, Spain*
{quirogajose, garciarmiguel, ortin}@uniovi.es

Abstract: Ever since the COVID-19 pandemic, there has been an increase in the use of Web conferring tools such as Zoom, Abobe Connect, and Google Meet. Besides online meetings, these tools have been used to deliver online lectures over the Internet. Teamwork communication platforms (e.g., Microsoft Teams, Slack, and Webex Teams), provide additional features, such as persistent chat rooms, channels, third-party application integration, direct messaging, and private groups. Finally, Virtual classroom packages (e.g., BigBlueButton, Adobe Connect, and Blackboard Collaborate) are customizations of the previous tools for online learning. Although these systems are used for the synchronous delivery of lectures, they lack an important requirement for those labs and seminars where strong lecturer–student interaction is required: instructors cannot see the students' work in real-time, so immediate feedback cannot be given while they are working. In common face-to-face scenarios, instructors analyze the work of each student, correct their mistakes, give particular explanations for that student, and even propose improvements and extensions for their solutions. To this aim, we created an open-source infrastructure that supports this kind of online synchronous sessions.

Our open-source distributed infrastructure consists of the following elements. First, a modification of the Veyon open-source monitoring system to see all the students' screens in a distributed session. We added the support of recording sessions and some features to comply with the EU regulation 2016/679. To allow students to connect to the sessions from home, we deployed a customized instance of the SoftEther open-source VPN server. We also implemented a collection of Windows and Linux scripts to install, start, stop, and create the remote sessions for both instructors and students. The BigBlueButton open-source software is used for the delivery of lessons, audio and chat interaction, and document sharing.

We used our infrastructure for the remote labs of a programming course. After answering an anonymous Likert-scale questionnaire, the students showed a high level of satisfaction (4.28 out of 5) regarding the simplicity, performance, privacy, security, intrusiveness, and utility of the infrastructure. In the final evaluation of the course, no significant difference with the previous years was detected (p-value < 0.05), for the student's grades, pass and fail rates, and the number of students taking the exam. The student configuration consumes 784 MBs of RAM, 2.56% CPU (3.6 GHz i7, 16 GB, Windows 10), and 504.7 Kbps (download) / 161 Kbps (upload) bandwidth. These values for the instructor were 963 MBs, 3.35% CPU, and 1360/514 Kbps. The bandwidth requirements for the instructor depend on the number of students connected: 90.8/0.37 Kbps per student. Therefore, for a session with 100 students, a 9.08/0.037 Mbps bandwidth connection is required, showing good scalability.

Therefore, our open-source infrastructure provides the synchronous remote delivery of sessions, following the traditional face-to-face approach. Its features make it appropriate to deliver synchronous classes where strong lecturer–student interaction is required, and all the student work can be done with a computer. It provides an easy installation and

[a] https://orcid.org/0000-0002-1646-4796
[b] https://orcid.org/0000-0002-3150-2826
[c] https://orcid.org/0000-0003-1199-8649

configuration, and shows affordable resource consumption. Our infrastructure can be freely downloaded from https://www.reflection.uniovi.es/download/2020/tlt/

Keywords: Web conferencing, synchronous sessions, open-source software, resource consumption.

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