Chapter 23

Network Simulation Tools for Supporting Teaching in Computer Networks

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ABSTRACT

Computer networks have evolved dramatically in recent years and consequently qualified and experienced network administrators are highly sought after, which in turn has led to the development of specialised computer networking courses at many universities. In this chapter, the authors investigate the use of network simulation tools as an alternative to be employed in computer networking laboratories. Network simulation tools provide students with the opportunity to freely experiment with virtual computer networks and equipment without the expensive costs associated with real networking hardware. The results of their research show that students appreciate the use of network simulators and see them as an effective approach to learning computer networking concepts and gaining the relevant experience. This was also confirmed by the actual performance of students who experienced different levels of exposure to networks simulators during their studies. The authors furthermore investigate the use of interactive, electronically assessed lab sessions, where students get immediate and interactive feedback while they are going through lab exercises. Their research shows that this approach not only releases the lecturer from less demanding students to better support weaker students, but that this will also lead to improved student performance and better student retention.
INTRODUCTION

Computer networks have evolved dramatically in recent years. The growing demand in terms of security, mobile computing and voice-over-IP among others, has led to the development of new protocols and algorithms to meet these challenges. Qualified and experienced network administrators are therefore highly sought after, which in turn has led to the development of specialised computer networking courses at many universities. Training for CISCO’s Certified Network Associate Certification (CCNA) is an integral part of the BSc Computer Networks course in the School of Computing at the University of Derby. During their study, students take four Cisco related modules: Network Fundamentals, Routing Protocols and Concepts, LAN Switching and Wireless, and Assessing the WAN. Network Fundamentals and Routing Protocols and Concepts are stage 1 modules, while LAN Switching and Wireless and Accessing the WAN are stage 2 modules.

Computer networking courses clearly need the support of a lab-based approach due to the practical nature of the subject (Sarkar, 2006; Goldstein, et al., 2005; Javidi & Sheybani, 2008; Dixon, et al., 1997). However, the initial costs of the equipment, as well as costs for maintenance and frequent upgrading as demanded by ever changing technologies is extremely high. Due to these costs, students are often provided only with limited network equipment during their studies. In addition, typically only a small number of students can use the equipment at any one time, which puts restrictions on class sizes and teaching resources. The size and location of physical laboratories further restrict the students’ experience. Moreover, some of the functionality (e.g., some WAN technologies) cannot actually be experimented with by the students. Due to these reasons, we have decided to use network simulation programs for lab exercises. This is also backed up by a number of studies reported in the literature (Sarkar, 2006; Goldstein, et al., 2005; Javidi & Sheybani, 2008) which have confirmed the usefulness of network simulation programs.

The remainder of this chapter is organised as follows. The following section compares physical and simulation based network laboratories, while the next section reports our investigation of using network simulation software for teaching computer network concepts. This is followed by a session which provides details on our study of employing e-assessment based laboratories for networking, before the last section concludes the chapter.

PHYSICAL LABORATORIES VS. SIMULATION SOFTWARE

Physical networking laboratories have the following limitations:

1. They are expensive. The cost of network components is high and sometimes beyond the reach of higher education institutions.
2. They are difficult to maintain. Networking equipment and software need to be upgraded regularly.
3. They are hard to secure. The safety of the equipment cannot be guaranteed, and it is difficult to prevent accidental damages to the hardware by inexperienced student.
4. They lack flexibility. Students need to conduct lab session on campus within a certain time limit (2 hours). It is difficult to replicate the same lab without wasting time on initial setup. After the lab, the students have to leave the room to make way for another class. Therefore, if they have not finished their exercises, they will need to wait for the next available timeslot to continue with their lab session. Also, time is wasted in reconfiguring the network equipment to the former network topology.
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