

# Chapter XVI

## Teaching TCP/IP Networking Using Practical Laboratory Exercises

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### ABSTRACT

*Motivating students to learn TCP/IP network fundamentals is often difficult because students find the subject rather technical when it is presented using a lecture format. To overcome this problem we have prepared some hands-on exercises (practicals) that give students a practical learning experience in TCP/IP networking. The practicals are designed around a multi-user, multi-tasking operating system and are suitable for classroom use in undergraduate TCP/IP networking courses. The effectiveness of these practicals has been evaluated both formally by students and informally in discussion within the teaching team. The implementation of the practicals was judged to be successful because of the positive student feedback and that students improved their test results. This chapter describes the practicals and their impact on student learning and comprehension, based on the author's experiences in undergraduate computer networking courses.*

### INTRODUCTION

Almost any computer science, engineering, and business curriculum includes some basic courses on transmission control protocol/Internet protocol (TCP/IP) networking. Unfortunately, motivating students to learn TCP/IP network fundamentals

can be difficult not only because students find the subject rather abstract when it is presented using a lecture format, but also because of very limited resources designed to supplement the teaching of TCP/IP networking is publicly available. Research has shown that students learn TCP/IP networking better, and feel more engaged with their courses,

if they are given practicals that illustrate theoretical TCP/IP networking concepts (Midkiff, 2005; Richards & Waisbrot, 2002; Sarkar, 2006; Sarkar & Craig, 2006). Students gain first-hand experiences in TCP/IP networking by hands-on practical work, for example, setting up a TCP/IP network, installing and configuring a server, IP sub-netting, TCP/IP connectivity, Telnet, and anonymous file transfer protocol (FTP). Therefore, we have prepared some practicals that facilitate an interactive, hands-on learning experience in TCP/IP networking. These practicals are designed around Linux, and can be used either in the classroom as a demonstration to enhance the lecture environments, or in the computer laboratory to provide hands-on learning experience at an introductory level (either first year or second year undergraduate courses).

The basic concept of TCP/IP networking is described in many textbooks (Forouzan, 2003; Kurose & Ross, 2005; Mansfield, 2003; Raymond, 2005; Stallings, 2007), and TCP/IP network performance is discussed extensively in the networking literature (Gotsis, Goudos, & Sahalos, 2005; Hassan & Jain, 2004; Man, Hasegawa, & Murata, 2006; Xin & Jamalipour, 2006; Zeng & Trajkovic, 2005). Sloan (2004) describes TCP/IP lab materials which may be suitable for practical work in the computer laboratory. However, these lab materials are still in work-in-progress. A number of sophisticated network simulators exist for building a variety of TCP/IP network models (Fall & Varadhan, 2007; *OPNET Technologies*, 2007; Zeng, Bagrodia, & Gerla, 1998). Nevertheless, by setting up and configuring actual TCP/IP networks the students gain first-hand experience that cannot be gained through computer simulation and modeling, and which plays a crucial role in motivating them to learn about TCP/IP networking. To date, we have focused on developing practicals to support teaching and learning traditional TCP/IP networking courses at undergraduate level (second year). The hands-on learning approach to teaching TCP/IP networking

has been successfully applied for two years now in the networking and telecommunications course (undergraduate computer science/IT curriculum) at AUT University. The course covers the main aspects of TCP/IP networking, including client-server networking, local-area network (LAN) administration and management. The practicals and other materials are revised annually based on student feedback, and the use of the latest version is discussed in this chapter.

The main contribution and strength of this chapter is the emphasis on practicals as a means to achieve effective student learning at undergraduate level. The most innovative aspect of this chapter is the structuring of the laboratories and crafting of the specific exercises to be effective in complementing the lecture content of the course. The course context in which the practicals are presented is described next.

## **COURSE CONTEXT AND LEARNING OUTCOMES**

The networking and telecommunications in which the aforementioned practicals are introduced has a total of 56 contact hours assigned. These courses are at Level 6, or second-year degree level at AUT University (Sarkar & Clear, 2000; Sarkar & Petrova, 2001). The Level 5 'hardware and software infrastructure' is the prerequisite for this course. The course goal is to produce graduates who will be able to work for networking and telecommunication companies worldwide.

The first half of the course covers networking fundamentals, while the second half focuses on TCP/IP networking. On completion of this course students will be able to:

- Discuss the relative advantages and disadvantages of various data transmission media, topology, data encoding, and protocols employed in telecommunication networks,

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