Innovation of laboratory exercises in course Distributed systems and computer networks

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Abstract. This paper is focused on innovation of laboratory exercises in course Distributed Systems and Computer Networks. These exercises were introduced in November of 2012 and replaced older exercises in order to reflect real life applications.

1. Introduction
Exercises wireless network coverage prediction and TCP/IP network analysis are part of Distributed Systems and Computer Networks course. These lessons are compulsory for students Sensors and Instrumentation and optional for other students.

Distributed Systems and Computer Networks lessons are successor of long time taught course Information Transfer. This course is focused on basic principles used in order to transfer information in area of electrical engineering. It covers area from serial line to USB and TCP/IP networks.
The main purpose of this course is to show main approaches used in way data are transferred and to compare their advantages and disadvantages. Through this course students become familiar with basic ways to transfer data, from physical principles, for example difference between twisted and flat cable, to the ways of securing data delivery on higher layers of OSI model, like CRC.
This knowledge will help students in following lectures, so they can faster get to solving specialized problems and don’t get stuck at basics of data communication, like how serial communication works.

2. Wireless network coverage
Laboratory exercise Wireless Network Coverage is extension of former version, which employed only wireless modems working on 868 MHz frequency and I-Prop software (figure 1) used for simulation of signal coverage. The main problem of original exercise was, that it was too theoretical and students had problems understanding the connection between measured data and real life application.
The main task is to simulate coverage of wireless signal in real environment and to demonstrate how the signal distribution is affected by obstacles and type of antenna used on both sides of connection.
After simulation students evaluate predicted signal coverage with real devices – 868 MHz modems, wi-fi access point Mikrotik RouterBoard and notebook. One of modems and RouterBoard serve as base station (figure 2), the other one with notebook serve as mobile client, which students use to measure real signal strength in several points of their choosing. The main advantage of hardware used in this exercise is its versatility and robustness. Both modems and Mikrotik RouterBoard are practically indestructible and can be easily reconfigured after reset, in case of misconfiguration made by students. To determine the signal strength they use special query command in case of 868 MHz modems and visualization in inSSIDer program in case of wifi signal (figure 3).
Another innovation is usage of several antennas, which help students to understand basic aspects of signal transmission like polarization. Students have one antenna with known gain and they have to determine the gain of the others (figure 4).

When students gather all the data they need they compare measured and simulated data. The last part of exercise is focused on change in wi-fi signal strength depending on antenna used on side of base station. For this part we prepared three types of antenna. Using these antennas we can easily demonstrate the difference between them and with piece of dry and wet cloth we can demonstrate problems that wi-fi has with air humidity in real life.

3. TCP/IP network analysis
TCP/IP Network Analysis is brand new laboratory exercise focused on basic principles used in TCP/IP networks including OSI model and basic protocols. In this laboratory exercise students will find out how TCP/IP networks work. They will gain understanding of principles used in networks. In simplified form they will acquire knowledge from routing, through DHCP and DNS system, to basics of network monitoring and analysis. For network monitoring students use simple tools, which are part of operating system (both Windows and Linux) or are licensed under GNU/GPL. With these tools students are able to discover network topology and use this knowledge for localization of problems in this network. Of course these tools can be used to gain illegal access to network resources, but they can be also used to detect such attack or prevent it.

In first part of this laboratory exercise students have to find out how they are connected to into the internet and from publicly accessible databases they find out how DNS system works. In second part of this laboratory exercise they are monitoring network communication using packet sniffer Wireshark (figure 5). Than students analyze collected data in order to solve problem defined in following parts of exercise. Among other tasks they have to capture DHCP request and lease and to find out lease time or to analyze how web page is composed from several servers. Last but not least is capture of unsecured message transmission like smtp or Facebook chat.
One of advantages of this laboratory exercise is that every part of it reflects real world conditions. As a method of line interception for we chose port mirroring, which can be easily set up on better switches.

4. Comparison

It is not surprising, that exactly same laboratory exercises don’t exist. In case of Wireless network coverage similar exercise is taught at KTH Royal Institute of Technology [3]. The main difference is that they employ GSM base station and don’t simulate signal coverage, only measure signal strength in defined distances.

Better situation is in case of TCP/IP network analysis where we can easily find very similar laboratory exercises, which often use Wireshark. These exercises are usually taught on Computer science departments and in many cases they reveal the subject more deeply [4], but that exceeds intention for this course, which is mainly to show possibilities and trends.

5. Conclusion

Innovation of two laboratory exercises in Distributed systems and computer networks course led to significant modernization and made the course more interesting. The course reflects real life application of principles demonstrated in course.

References
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