Online Practical Telecommunications Training – The VITELS Project[*]

Ulrich Ultes-Nitsche, Aurelius Baier, Michael Mäder

Department of Computer Science
University of Fribourg, Chemin du Musée 3, CH-1700 Fribourg, Switzerland
{uun,aurelius.baier,michael.maeder}@unifr.ch

Torsten Braun, Marc-Alain Steinemann, Attila Weyland

Institute of Computer Science and Applied Mathematics
University of Bern, Neubrückstrasse 10, CH-3012 Bern, Switzerland
{braun,steine,weyland}@iam.unibe.ch

Philippe Joye, Rudolf Scheurer

Department of Information and Communications Technologies
University of Applied Sciences of Fribourg
Boulevard de Pérolles 80, CH-1705 Fribourg, Switzerland
{philippe.joye,rudolf.scheurer}@eif.ch

Abstract—**We report in this paper on the project VITELS (Virtual Internet and Telecommunications Laboratory of Switzerland), funded by the Swiss government in the SVC (Swiss Virtual Campus) programme. VITELS provides an extensible practical telecommunications course. It uses WebCT to prepare the content of each module and provides web interfaces to the various practical exercises. To date, there are 7 core modules completed, with several others under development. The core modules are: "Simulation of IP Network Configuration", "Client/Server Concepts", "IP Security", "Firewall Management", "Sockets and Remote Procedure Calls", "Remote Method Invocation", "Application Server".**

Keywords—on-line practical telecommunications teaching; configuration of real hardware components; balance of theory and practice; course-wide consistent teaching style

1. INTRODUCTION

Gaining practical experience with the configuration of computer-networks plays an important role in the telecommunications education of computer science, computer engineering, and telecommunications engineering students. However, the physical presence of the network components at the student's site is not necessary for their adequate configuration. This observation leads to the simple conclusion that practical course units can be integrated into Internet-based distance learning without the need for physical meetings. Such an on-line practical telecommunications course is being developed in the project VITELS (Virtual Internet and Telecommunications Laboratory for Switzerland), which is funded by the Swiss government's SVC (Swiss Virtual Campus) programme.

VITELS provides an extensible practical telecommunications course. It uses WebCT to prepare the content of each module and provides web interfaces to the various practical exercises. To date, there are 7 core modules completed, with several others under development. The core modules are: "Simulation of IP Network Configuration", "Client/Server Concepts", "IP Security", "Firewall Management", "Sockets and Remote Procedure Calls", "Remote Method Invocation", and "Application Server". The access to the individual practical sessions is controlled by an LDAP-based scheduling system (LDAP = Lightweight Directory Access Protocol), in which students must book timeslots for accessing the practical part of each module [5].

All modules follow specific guidelines, which were determined in co-operation with the pedagogical department of the University of Geneva. This so-called "VITELS guide" [4] determines the general layout of VITELS modules, including aspects like learning milestones, student feedback, balance of theory and practical work, quizzes and essays, etc. Besides a common look and feel to all modules, the VITELS guide guarantees pedagogically well-structured student guidance through each module. Each student can, for instance, evaluate his/her progress at multiple stages and decide whether to continue or repeat some sections of the course unit.

Behind the scenes, the VITELS system provides information about student progress to the instructor, who will, for instance, evaluate essays and see quiz results and evaluations of practical sessions. The instructor can provide feedback to students at multiple stages and finally evaluate and mark the work done by individual students. The instructor's evaluation is supported by programmed scripts, which test settings created in the practical sessions.

Recently, VITELS has been integrated into an Authentication and Authorisation Infrastructure (AAI) [3]. Students registered at AAI-enabled organizations are granted unified access through the AAI. At the universities in Berne and Fribourg, VITELS modules have been used successfully in telecommunications courses, and the number of requests from other institutions to use VITELS is constantly increasing. For more information, please visit the VITELS webpage at http://www.vitels.ch.

2. THE STRUCTURE OF VITELS

2.1. The VITELS Modules

When logging into the VITELS systems the students are presented a selection of course units, including a general overview and access to the scheduling system. The opening page of VITELS is presented in Figure 1. There the core modules can be seen and by clicking on any of these, the corresponding course unit is opened. The core modules and their content are [1]:

1. "Simulation of IP Network Configuration": In this unit, the students learn how to set up and configure a simple IP network and routers.

2. "Client/Server Concepts": This module introduces the client/server concept, using the hypertext transfer protocol HTTP as an example.

3. "IP Security": Here, students learn to secure the IP protocol and to set up virtual private networks VPN.

4. "Firewall Management": In this course unit, the students exercise the configuration of packet-filtering firewalls.

5. "Sockets and Remote Procedure Calls": Students learn the basics of network programming using sockets in this module.

6. "Remote Method Invocation". This is a module on how to use Java programming constructs in network programming.

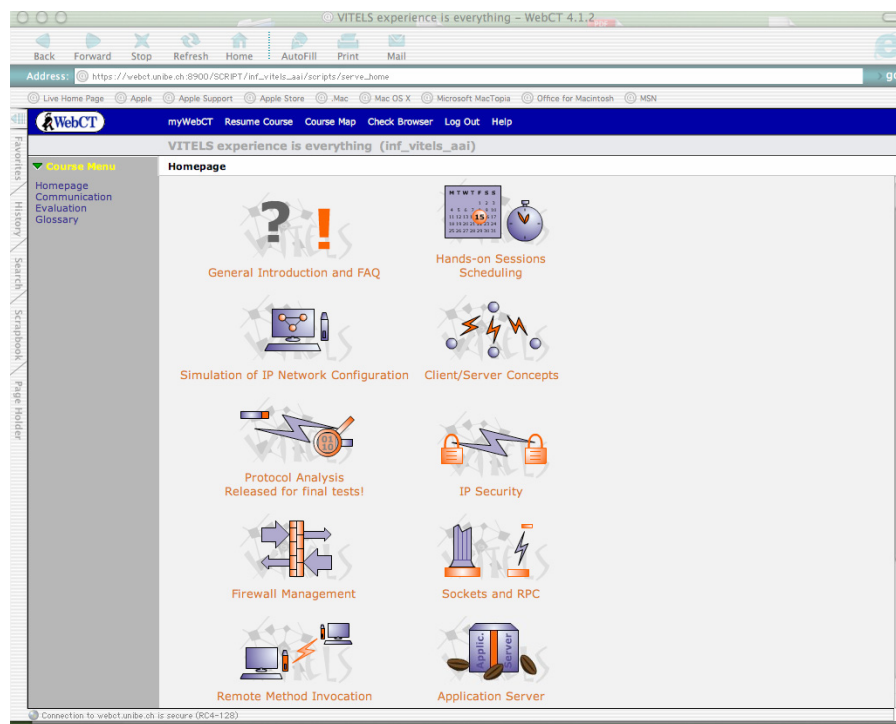7. "Application Server" This module explains the concept of Java application servers in business environments.

Figure 1. Screenshot of the initial page.

2.2. The General Structure of each Module

In each module, the students are guided through four main sections: "Introduction", "Theory", "Knowledge Application/Exploration", and "Prove Your Knowledge and Skills". Subsequently, we discuss the module structure briefly. In the next section, where the "Firewall Management" module is discussed, more details of the modules' structure will be made explicit.

The "Introduction" section welcomes the students and provides them with some general information regarding the particular VITELS module. The students learn about the goals of the module and also have to set their own goals for the module. In addition, they learn about the relation of the actual module to other modules.

The "Theory" section introduces the students to the theoretical background of the actual module. The gained knowledge will be necessary later on to perform the practical parts of the module successfully. Between some modules, the "Theory"

sections overlap content-wise. This is seen as beneficial redundancy to intensify the gained knowledge.

"Knowledge Application/Exploration" is the main practical part of each module. It introduces the given tasks the students are required to do, including description of the hardware used and the interfaces to the hardware. Using this hardware, the students do the so-called "hands-on" sessions. The hands-on sessions are the specific practical exercises in the actual module.

In the "Prove Your Knowledge and Skills" section, the students are asked to write a short essay on the content of the actual module, to do a quiz in which they have to prove the knowledge they have gained, and a final survey which will mainly used to improve the actual course unit's content.

2.3. Course Evaluation

Each module is evaluated separately. The students are mainly assessed based on the practical work they have done in the "hands-on" sessions. However, the results of quizzes, two essays, posting of messages to a message board, specifying the initial goals of the students, and the final survey are also evaluated.

3. EXAMPLE MODULE USE-CASE: THE FIREWALL MODULE

We will use the term "firewall module" here as a shorthand for *"Firewall Management" module*. The firewall module is accessed by clicking on the correspondingly named icon on the initial webpage (cf. Figure 1).

In the "Introduction", students learn that configuring a packet-filtering firewall [2] will be the main task in the module. In addition, the relation of the firewall module to other VITELS modules is sketched, and a mind map [4] presents some first thoughts about firewall management.

In the section on firewall "Theory", the students learn which information in an IP packet is used to decide whether to let pass or drop the packet (IP addresses, TCP ports, and higher-level protocols). In addition, the possibility of translating local addresses into global ones using network address translation (NAT) is discussed in that section.

In the third section, students are guided towards two hands-on sessions, in which a hardware firewall (Netscreen 5XP[1]) must be configured for two different scenarios (one using the transparent mode of the firewall, another applying NAT). As an example, the web-interface of the firewall (see Figure 2) is discussed in that section, describing all possible settings and how they influence the behaviour of the firewall. This information will be required in the hands-on session.

The first hands-on session requires the students to configure the firewall in transparent mode, i.e. in such a way that the presence of the firewall is invisible as long as data packets comply with the firewall rules and can pass. In the second scenario, the firewall will be configured using local IP addresses and NAT to access the external network. The configuration scenarios are explained in detail to the students, both textually and graphically.

---

[1] NetScreen is now part of Juniper Networks http://www.juniper.net/netscreen_com.html
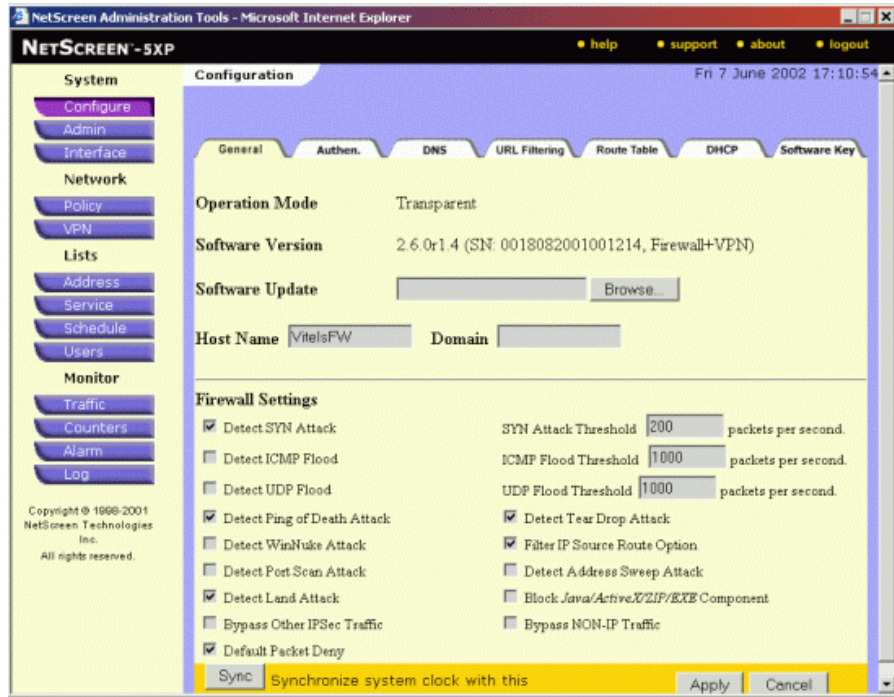
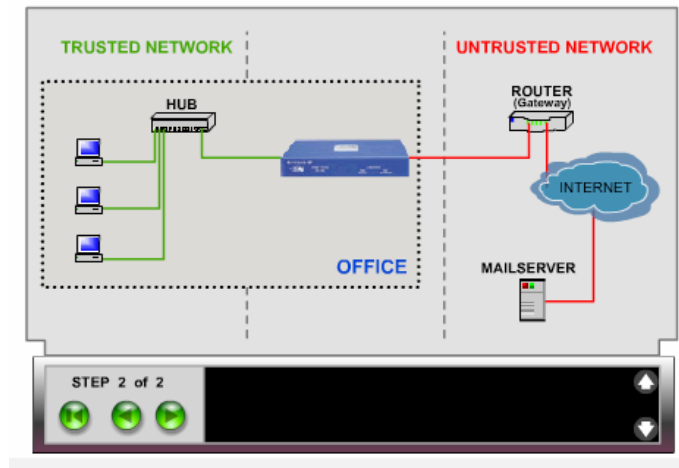Figure 2.   The administration window of the Netscreen 5XP firewall.

Figure 3.   The simplest configuration scenario.

The simplest scenario, for instance, is presented to the students as in Figure 3. Here an office setting is simulated consisting of the trusted office network and the

untrusted external Internet. Then the students are asked to configure the firewall in such a way that the settings for different protocols are met as presented in Figure 4. When the students have completed the configuration, they can start test scripts, which test automatically the correctness of the configuration. Then the system provides automatically generated feedback, telling the students whether or not they succeeded. If they have not succeeded, they receive information about the underlying conceptual problem that made their configuration fail.

#	Source	Destination	Service	Action
1	Inside any	Outside Mailserver	Mail	Permit
2	Inside any	Outside any	WWW	Permit
3	Outside any	Inside any	all	Deny
4	Inside any	Outside any	all	Deny

Figure 4.   The configuration settings of the simplest scenario.

4. CONCLUSIONS

We have discussed the VITELS practical on-line telecommunications course in this paper, using the module on "Firewall Management" as a simplified use case. As presented, VITELS allows students to gain experience with configuring and testing real telecommunications hardware without being present at the hardware's site. The course has already been used successfully at the universities of Bern and Fribourg.

As this paper could not discuss all aspects of VITELS, the interested reader is invited to visit *http://www.vitels.ch* for more information, including a demo session of the VITELS course.

REFERENCES

[1]   Andrew S. Tanenbaum: *Computer Networks*, 4th Edition, Upper Saddle River: Prentice Hall, 2003.

[2]   Simson Garfinkel and Gene Spafford: *Practical UNIX Security*, Sebastopol, CA: O'Reilly, 1991.

[3]   Marc-Alain Steinemann, Thomas Spreng, Aljoscha Bachmayer, Torsten Braun, Christoph Graf. Martin Guggisberg: *Authentication and Authorization Infrastructure: Portal Architecture and Prototype Implementation*, Technical Report, IAM-03-012, December 2003.

[4]   Marc-Alain Steinemann, Attila Weyland, Jacques Viens, Torsten Braun: *VITELS, Didactics and Design Guide Version 1*, Technical Report, IAM-03-002, April 2003.

[5]   Marc-Alain Steinemann, Stefan Zimmerli, Thomas Jampen, and Torsten Braun: *Global Architecture and Partial Prototype Implementation for Enhanced Remote Courses*, Computers and Advanced Technology in Education (CATE 2002), Cancun, Mexico, May 20-22, 2002, pp. 441-446.