

# Implementation of a remote access laboratory using computer networks via a Web based system

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**Abstract**—Internet plays a vital role in day to life. As application of internet in day to day life a Web system for managing a remote access laboratory support for the practical classes of subjects involving computer networks and telecommunications, which includes the organization of the physical structure and development of a management system is constructed. With the implementation, it is possible to maximize the use of equipment among all professors of disciplines and equipment were accessed remotely by students / professors. This document will state the importance of a supporting system for classes to improve the usage of laboratory effectively. The application was developed in PHP platform, allowing access via any Internet browser, allowing reservation and use of the equipment remotely. At the end of the development process, the goal in this work is the construction of a Web system for managing and using a remote laboratory networks.

**Index Terms** — Computer networks, network design, networks laboratory, remote access laboratory.

## I. INTRODUCTION

Since the beginning of human history, people have the need to process and transmit information. With this purpose we have developed the computer as a science in charge of developing and studying such systems and machines [2]. With the growing use of computers in educational institutions, in the commercial and residential, became important interconnection of such equipment, forming an effective means of communication network that allows you to share information anytime, anywhere in the world [7]. Currently, the company interacts daily with information systems, when using ATM banking transactions, scanners reading prices in supermarket cashiers, online shopping systems with credit card. These are just some examples of how to use systems to facilitate everyday life, saving time and automating tasks [7]. Based on these concepts, a design was developed that can be accessed via a Web system to a remote access laboratory for use of the disciplines that involve computer networks and telecommunications at Federal University of Technology - Paraná (UTFPR). With the need for practical classes in the disciplines of computer networks, it is necessary a physical laboratory for learning.

With the increasing number of classes and disciplines, this creates a difficulty in organizing the resources used in practical classes. There are cases where professors take the equipment to be used in class. This leads to a waste of time for assembly class and physical configuration of the equipment until it can be used. The project aimed to facilitate the organization of classes through a management system, with reservations of access to equipment and remote configuration of the laboratory.

## II. METHODOLOGY

The context diagram shows the relationships between the system and the environment (users) in a single diagram. The goal is to show graphically what happens generally in a system, no matter how and when such events occur [6]. Figure: Context diagram represents all processes in the system.

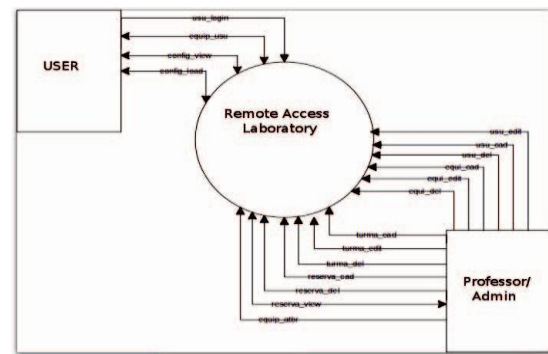


Figure 1. Context diagram

## Tools / technologies used to develop the system

**Operating System:** the main server, called the server console, is the device that makes the communication between the network equipment and computer center. The choice of operating system used in the project was Linux, which is open source and developed under the GNU General Public License (GPL). Many programmers can read, change, and in turn distribute your code to the community, usually through the Internet, making the system more mature as possible [3]. Linux was an appropriate choice to build the Web server as well as being a low-cost system, has high stability and safety. The services that can be used on a Linux server are: Apache, Samba, DHCP, FTP. There are also other types of applications such as firewalls and proxy [4].

**Database:** the database used in the project was MySQL. Database is basically a system that serves to maintain records capable of storing information and allow your users to search and update this data when requested. It is common to refer to the data saved in these systems as "persistent", suggesting a difference between the source data more transient, such as: data from user input, data control software [1]. MySQL started in 1979 and today is used for both Web applications and for desktop applications. Mounted on a client-server structure, its main features are: high-performance, multi-threaded, multi-user and be available for various platforms. One of the bank management systems (DBMS) most popular free to use that currently exists, MySQL has had its evolution focused on three principles : speed, reliability and ease of use. A system developed based on a license that allows a large part of its source code is open, causing the evolution of software faster through the wide range of users; DBMS uses this language Structured Query Language (SQL) to perform queries [8].

**PHP:** PHP stands for Hypertext Preprocessor. It is a programming language focused on Internet and can use multiple operating systems based server. Access the applications developed by this tool can be done by any operating system available today. Figure 2 shows the basic operation of a PHP application.

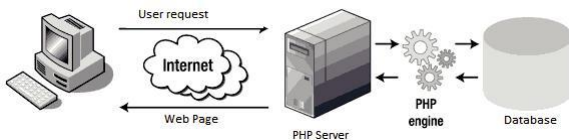


Figure 2. Running a PHP Application [5]

PHP does not require any specific tool for the use of language, because the pages are written in the text only, however the majority of existing software for programming in PHP is open source, free or facilitating the expansion and development of language and PHP applications. [5]

**System access and user profiles**

Access to the system is designed to be used by a browser to Internet. As long as the server that will provide the services of the remote access laboratory has a true IP and connect to the Internet, the system can be accessed remotely from anywhere in the world. The requirements for the system is a connection to the Internet (ADSL, Cable Modem, 3G) and a compatible browser with javascript in order that the system uses this feature.

In the system there are three user profiles. They play different roles in the system, which are:

**Administrators:** user profile that manages system resources.

Roles:

- View, register and edit users (any profile);
- View, register and edit equipment;

- View, register and edit classes;
- View, schedule and cancel use of equipment;
- View logs of all system users.

**Professors:** manages the activities of the students. Roles:

- View and edit only users who are in classes under their responsibility;
- Create users like "student";
- View and edit classes;
- Create new groups;
- View the agenda;
- Perform new reservations;
- View equipment reserved;
- View logs of students.

**Students:** use the network infrastructure provided by the Laboratory of Remote Access. Execute commands on the equipment and may be evaluated from the logs. Roles:

- Use the equipment provided by the Laboratory of Remote Access;
- Show your own log in system.

**Registration of users and groups**

The functionality classes, the system displays the screen. The options available are to register new groups (1) editing (2) or delete (3) existing classes. It offers a search option where the system will search in all fields displayed on the screen. Featuring quick buttons (4) to show future reserves of the class in question and show that students enrolled in each class.

Code	Professor	Course	Classes	Condition	Reservations	Students
T71	Diego	Sistemas para Internet	Redes 1	Active	00	00
T91	Lucas	Sistemas para Internet	Redes 22	Active	00	00
T88	Professor 1	Sistemas para Internet	Redes 22	Active	03	03
T99	Professor 1	Sistemas de Informação	BDD 2	Active	02	02

Figure 3. Functionality classes

The master classes can be done by professors and administrators. A class consists of a name identifier and a responsible professor and possess as optional fields and field course for better identification of the class.

Functionality students, the system displays a screen that can be seen in Figure 4. This screen allows the ability to create, edit and delete users.

Code	Name	Email	#Type
1	Diego	diegolaperuta@gmail.com	Administrador
2	Lucas	lucas@tuxon.com.br	Administrador
3	Gustavo Ely Krug	gukrug@gmail.com	Administrador
9	Rene Mikami	rene0907@gmail.com	Administrador

Figure 4. Functionality students

The user registration can be performed by users like professor and administrator. A user consists of a name, an email is also used to access the system, a profile (type), a password and if users type student a class, users still have a lock field that frees or restricts access to the system.

### Records of equipment

Functionality devices, the system displays the screen which can be seen in Figure 5. This function allows the ability to create, edit, and delete devices.



Figure 5. Functionality devices

### Reservation and use of laboratory

In the reservation functionality system displays the screen which can be seen in Figure 6. The figure displays an interface similar to a calendar where the days indicated in red are days that have passed and it is not possible to make reservations. The blank squares are available to book equipment. Clicking on one of these squares the system displays a new screen, shown in Figure 9, where the user can check the reservations made for the day in question and also can make the booking laboratory.

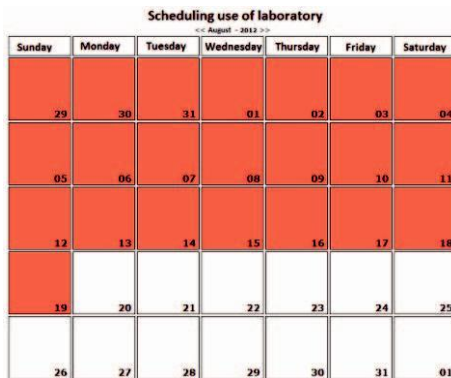


Figure 6. Scheduling lab

The use of equipment is only possible by users like students who belong to the class in which the reservation is made. During the reserves there are two modes of access equipment: an automatic mode, where students can access any equipment and the way in which the classroom professor must associate the equipment for their pupils, as shown in Figure 7. The equipment cannot be used by more than one user simultaneously.

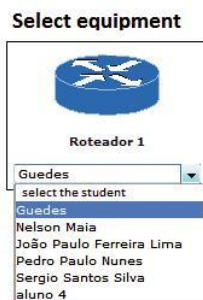


Figure 7. Assign equipment to students

After the student access the device presents an interface similar to the interface of an application conversations, where you can see the screen of "conversations" between

The reservation can be performed by users like administrators and professors. Administrators can make reservation for any class as may cancel any existing reservation. Already professors can only create and delete reservations for groups of their responsibility. All reservations can be viewed by both user profiles.

The register of equipment can be performed only by users profile administrator. Equipment requires a field name that identifies the equipment in all other system screens, and also requires the field device. The type field serves only to change the image displayed on the screen to use the equipment, and the administrator registering the router / switch in this system must perform a very important task that is allowed to change the use of the device by the server using the chmod command.

user equipment-at the top of the screen, and an input for input on the bottom. The use of this interface approaches the IOS CLI interface, operating system from Cisco Systems. You can use the commands to send messages ENTER, TAB to autocomplete commands? SPACE to help and to run the text when the equipment has long messages. Figure 13 shows an example of the use of these commands on the system administrators. While administrators can view logs of any student, the professors can only see logs of students who are in classes of their responsibility and students can view logs only come from their own settings.

### Difficulties and problems encountered

During development it was found that technical problems are reported below:

Connection between the console server and equipment: the connection between the computer and router is made by a cable-type serial. As the server console only had 1 serial input, was required the use of a USB-SERIAL which allowed the connection. Architecture REQUEST-RESPONSE PHP: during the development of the core system, the functionality of the Web application that exchanges information with the devices via serial port, it was discovered that PHP, because it is an architecture of type REQUEST-RESPONSE, has a facility to deal with messages to the virtual port.

To send a command to the router is made a request, and to request the data written by the router is made another request. Because these are distinct requests needed to connect with the equipment several times which caused the loss of information. This problem was solved by using a single service, made in PHP, which is all the time connected to the equipment. When there is a message to the user equipment, the service stores all exchanges of information in the router's database, so that the Web system can then capture this information and show users. Thus become two separate processes that work together.

### III. CONCLUSION

For matters related to computer networks and telecommunications, as well as theoretical concepts is the need for demonstration and practical applications. The visualization of these concepts often require eye contact and manual applications in equipment for learning to become more efficient. In many of the explanations of experts in this area, there are several representations of diagrams such as physical and virtual connections to various equipment. These diagrams just abstracting much of reality making use of real equipment even more essential for a better understanding of the student. Supplying this need for practical applications, professors perceive the need to bring the student to the equipment, giving them the freedom to be able to connect them to each other and perform various settings that a network administrator can do. For this, it was noted that the efficiency of classes networks eventually diminish because of the equipment are not easily accessible to the classroom. If there is a physical environment prepared with the equipment, there is the discomfort of professors around these devices, which often are not small. In addition locomotion, in some cases, some difficulties arise in preparing the environment such as technical problems in equipment, cabling fault, lack of physical space. To aid in the teaching of subjects related to networks, which use various equipment of varying sizes, a system was developed to run a Web system for managing a remote access laboratory that facilitates both the student and the professor, the use of real networking equipment. This system contemplates identically viewing the administrative interface of a network device. Given that these devices require serial connections to access the administrative interface, it was essential to use USB to Serial converters, which were being used several switches and routers.

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### Assembling the Physical Laboratory

For mounting the physical laboratory equipment was used in the Department of Academic Computing (DAINF) at Federal University of Technology - Paraná (UTFPR). We used one computer (server console), 10 Switches Layer 2, 1 Layer 3 Switches 3, 8 routers, 20 USB-Serial Adapters and 21 cables console.

### System logs

This section shows all actions made by students in the equipment. It is shown both entries made by the user as the messages that are returned by the equipment. All messages between equipment and student are saved recording the student's name, what equipment was used, date and time, and message content. On this screen there is a search field to filter any term. This filter is available only to professors and for connection of equipment with the server console was used four hubs USB connection, as the number of devices exceeds the number of USB connections on the server console.

The choice of connecting devices to the server console through the serial port instead of using the Fast Ethernet port with Telnet / SSH, was to be used because the network interface, any reboot the router / switch or exchange of these IP equipment would result in the loss of communication with the equipment. On the server console was used Linux operating system and installed the SSH services, PHP and MySQL.

When connecting the device to the console server, each device is associated with a device by which one can access them, the association performed by the equipment can be seen in Table 1:

TABLE 1  
Association of Devices

Equipament	USB Port
Router A	ttyUSB11
Router B	ttyUSB12
Router C	ttyUSB13
Router D	ttyUSB15
Router E	ttyUSB14
Router F	ttyUSB16
Router G	ttyUSB17
Router H	ttyUSB18
Switch A	ttyUSB2
Switch B	ttyUSB1
Switch C	ttyUSB0
Switch D	ttyUSB3
Switch E	ttyUSB4
Switch F	ttyUSB5
Switch G	ttyUSB6
Switch H	ttyUSB7
Switch I	ttyUSB8
Switch J	ttyUSB9
S8500A	ttyUSB10
S8500B	ttyS0
Switch 2948G	ttyUSB19