Virtual Lab versus Remote Lab

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Abstract:

Both virtual and remote labs are very important parts of the curriculum of engineering education. The main task of the project „Remote Electronic Lab (REL)“ is the development of a possibility to do measurements on electronic circuits from anywhere via the Internet. These experiments are carried out by means of remote-controlled real laboratory instruments and are not simulated in order to offer a realistic laboratory situation.

1 Virtual Lab vs. Remote Lab

To work in laboratories is a very important part of the curriculum of engineering education („Learning by doing“).
In a virtual lab each experiment is simulated by using software (e.g. LabVIEW, MATLAB, ORCAD). The remote lab is designed to provide real-time experiments to students via the internet.

For remote labs have the following benefits:

- The students can login and carry out experiments from any place of the world.
- Remote labs provide extended access to expensive and/or highly specialized devices.
- Unlike simulations remote labs provide real lab experience.
- Remote labs give students the opportunity to work in the remote mode,which will eventually become important in engineering jobs.
- Unlike simulations remote labs provide real lab experience.

The Carinthia Tech Institute (CTI) offers an evening study program for working students, setting an increasing demand for computer-based and internet-based training courses.

The system concept of telelearning at the CTI is shown in Figure 1.

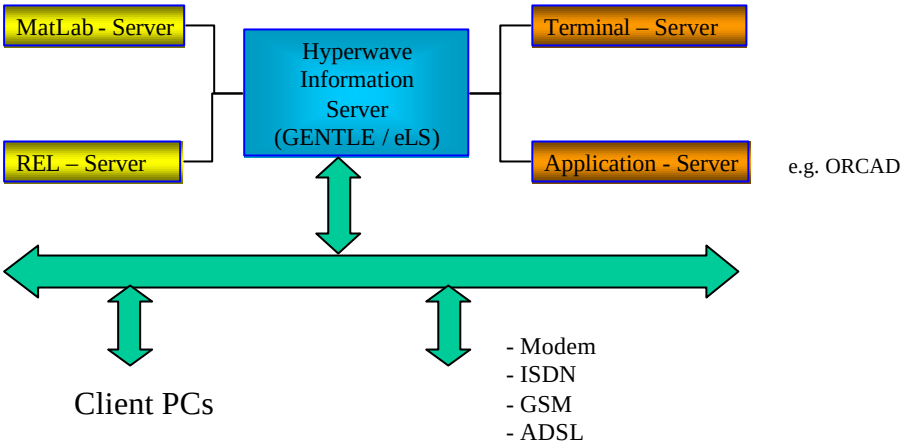

Figure 1 System concept of telelearning at the CTI

Central part is a Hyperwave Information Server, which fulfills the functions of user administration and dynamically design of documents and furthermore works together with other specialized servers [6].

Typical fields of use of remote labs are:

- Telelearning
- Demonstrations in lecture halls (class rooms)
- „Broadcast“ of experiments to groups of students/learners
- Industry, research institutes

Some benefits of industrial use of remote labs are:

- Expensive and complex instruments can be used from different locations of a company.
- Complex experimental systems, including specific media addition such as cooling, inert gas maintained by specialist staff at a specific location, can be directly controlled from the scientists office.
- Team members, working at different locations can take advantage of the same test-run results without extra travelling.
- Long-term trials (reliability, failure performance) can be comfortably supervised from home, e.g. at weekends.

2 The Remote Electronic Lab (REL) of the CTI

2.1 Basic Requirements

- An integration in the existing telelearning system (eLS/GENTLE [2]) should be possible.
- A common Internet browser (Microsoft Internet Explorer 5) should be the only necessary application for the remote user .
- The administrative needs should be minimal at the client-side as well as at the sever .
- The experiment and the necessary environment (hard- and software) should be strictly separated, to reach a high flexibility.

2.2 REL Hard- and Software

The project is carried out in cooperation with National Instruments Austria. The used software-packages are LabVIEW 5.1 and ComponentWorks 2.0.1.
The hardware for the project, apart from the PC, are four laboratory-instruments with GPIB-interface and a GPIB-interface-card for the PC.

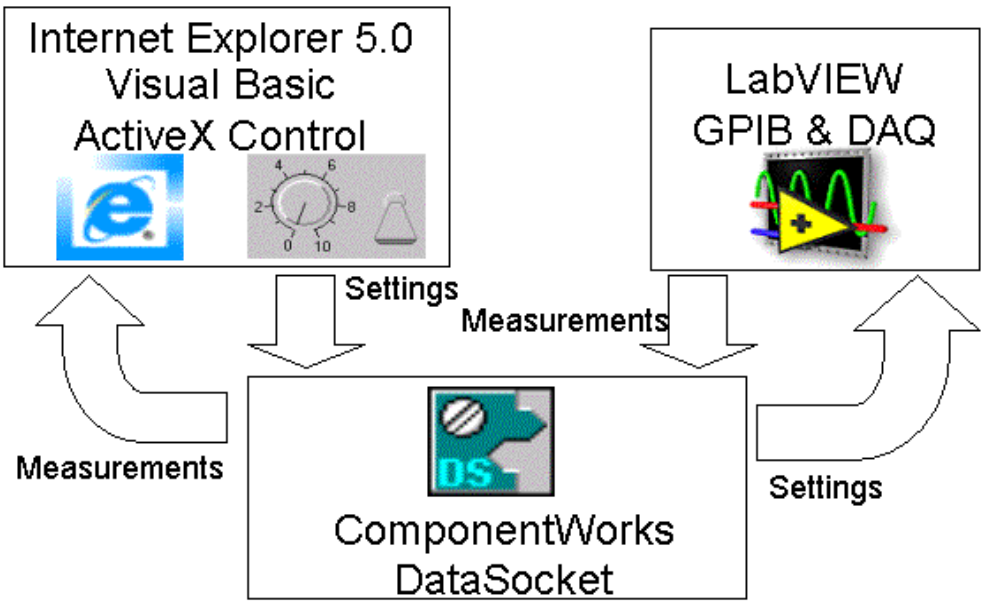

Figure 2 Software of the Remote Electronic Lab

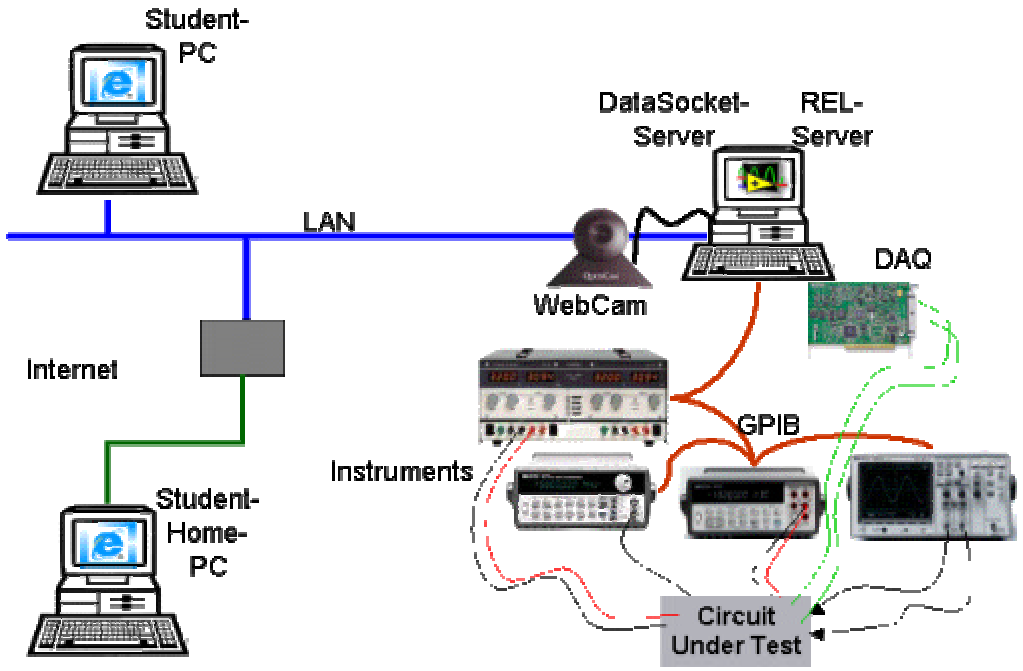

Figure 3 Hardware of the Remote Electronic Lab

2.3 The REL server

The REL server is the PC to which the instruments are connected via GPIB. The essential software running on this Computer is LabVIEW, a graphical programming environment. LabVIEW-GPIB-drivers are available for a large number of laboratory-instruments. With these drivers the corresponding instruments can be controlled. Parameters can be set and measurements can be displayed in the graphic user-interface.
For remote-control, these parameters and measurements have to be distributed to and from the users. A new technology from National Instruments, the so-called "DataSocket" is suitable for that demand. DataSocket offers the possibility to share rawdata among different data-sources and –targets. Rawdata means, that e.g. voltage-curves are distributed as matrices, respectively vectors and not as files in any graphics-format.
For coordinating the exchange of parameters and measurements, a LabVIEW-VI (Virtual Instrument) has been developed. The instrument-drivers are integrated in it as Sub-VIs.

2.4 The user interface of remote clients

The interface to the user at a remote computer are ActiveX-controls. ComponentWorks offers a number of ActiveX-components, which have a similar appearance as controls and indicators in LabVIEW-front panels. These components can be put together to ActiveX-controls, e.g. in Visual Basic. These ActiveX-controls can be embedded in HTML-files and displayed in MS Internet Explorer 5.

These files are integrated in the telelearning-system eLS/GENTLE. Two examples, the power supply and the DAQ board are shown in

Figure 4 and

Figure 5.

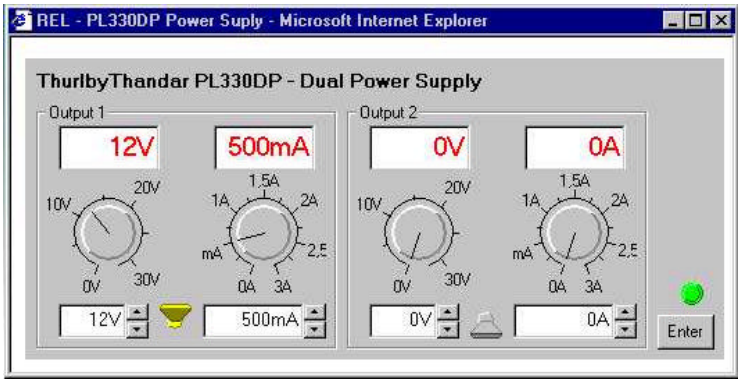

Figure 4 User interface for Power Supply

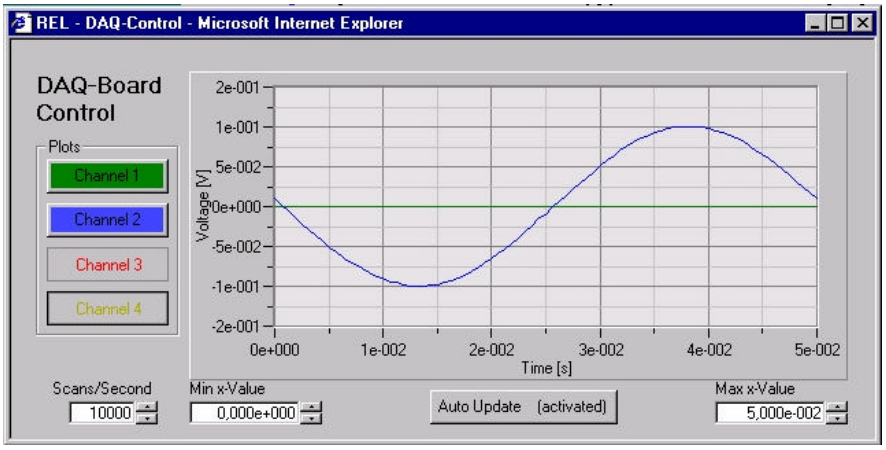

Figure 5 User interface for DAQ Board

2.5 Process of remote-controlling

On loading the ActiveX-controls at any computer, they connect to the DataSocket-Server. Now, the student may set some parameters and click “Enter” in order to transmit the information to the DataSocket-Server, from where the instrument-server can call it. Continuously, the instrument-server checks the DataSocket for updates. If any connected application has put new information on it, it is called and the appropriate instrument-driver is activated. After having finished controlling the instrument, a sort of confirmation is given back to the DataSocket. In case of a measuring instrument, the measurements are put on it. Then, the client recognizes an update and calls the available information from the

DataSocket-Server. This information can be a certain number of single values or, in case of an oscilloscope, a vector with 2000 values.
Now the ActiveX-control displays the information as numeric values in the appropriate indicator, or as a graph.

2.6 Access to the Remote Electronic Lab

It is obvious that multiple simultaneous accesses to the instrument-server would not make sense because different settings from different students to one instrument could not be handled. Therefore it is necessary to do experiments sequent.

Figure 6 shows the appropriate virtual instrument (VI) and Figure 7 shows the REL user access control.

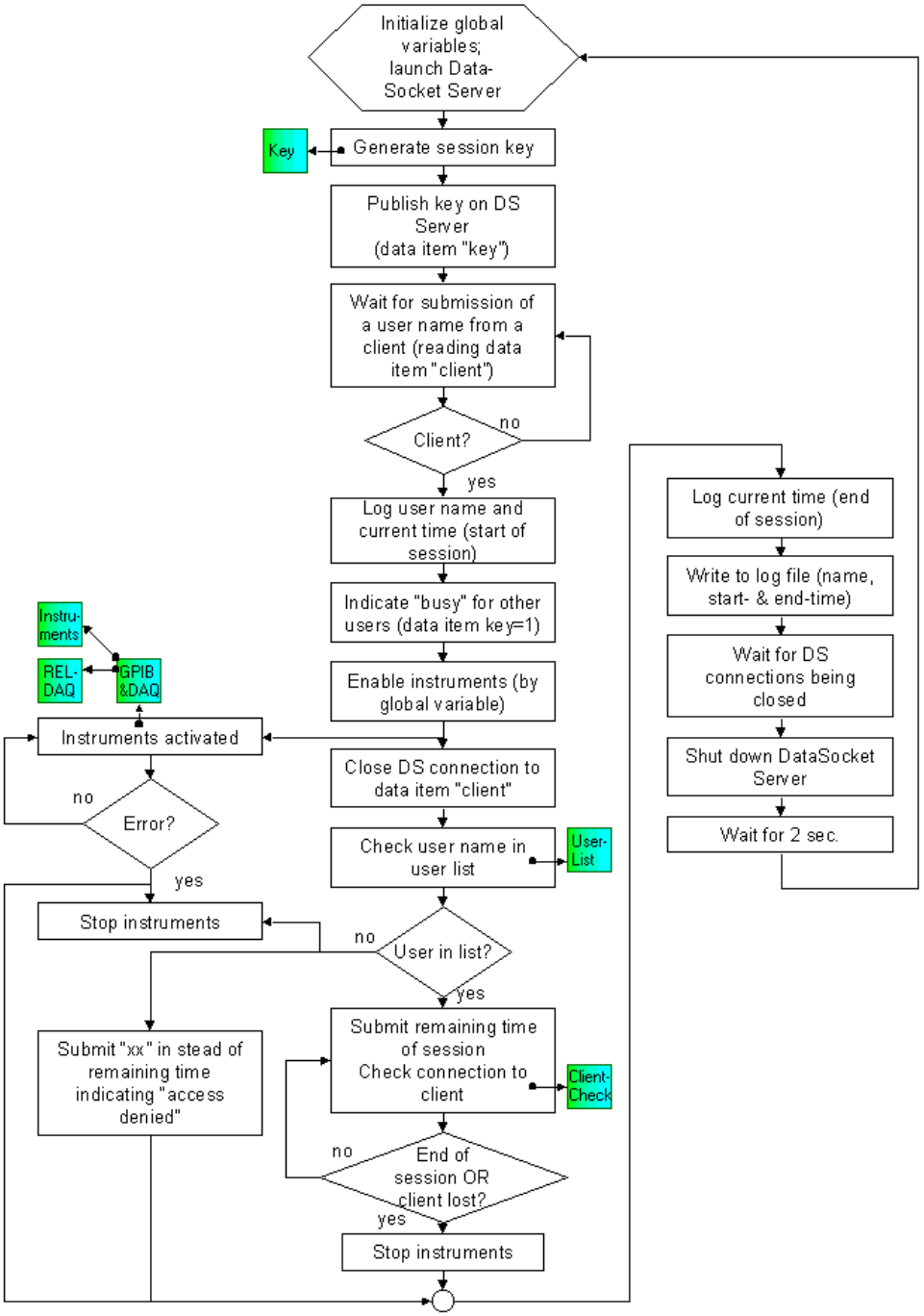

Figure 6 User access VI

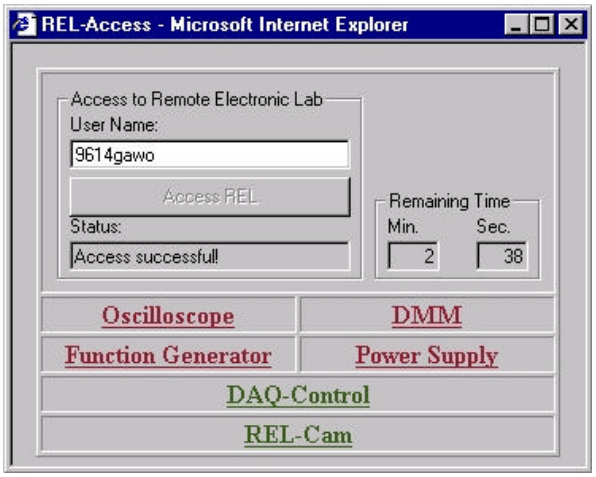

Figure 7 REL user access control

2.7 REL Web Cam

Finally the REL includes a digital camera for the visually observation of the experiment.

Abbildung 1: Snapshot der REL Web Cam

3 Outlook and Future Features

Finally we can summarize, that the goals of the project are reached.
Future extensions will be:

- The integration of a kind of user scheduling for organizing the access according to a time table.
- The substitution of the GPIB drivers by IVI drivers in order to improve the speed of controlling the instruments.
- The usage of a switch matrix board for changing the probes connected to the test-circuit in order to offer a situation which is closer to the real one.

This remote laboratory can be used not only in the field of education, but also for doing any measurement-task with real laboratory instruments.

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