European Remote Radio Laboratory - ERRL

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Keywords

«Remote laboratory», «RF», «Experiments»

Abstract

The European Remote Radio Laboratory (ERRL) initiative aims to develop a remote access platform for a set of radio communications experiments which exploits high-tech high frequency equipments. Being a pilot project under Leonardo da Vinci Programme, its scope includes development of the remote access laboratory platform via Internet, which will provide hands-on radio communications training along with the theoretical supplements to students, technicians, and engineers in radio communications field of ICT. Target groups are students from electrical, electronics, telecommunications or related departments at polytechnics and vocational schools; and engineers, particularly the new graduates, in the fields of electrical, electronics, telecommunications or computer, and those who require the hands-on experience/training in telecom/radio related topics. The expected results of the ERRL would include the following outcomes: (1) Teaching material for the use of high frequency test and measurement elements such as oscilloscopes, signal generators, spectrum analyzers, network analyzers, (2) Radio-lab training modules with up-to-date course contents, (3) Test system which will evaluate the user's degree of success in completing ERRL courses, (4) Complete remote experiment modules (in the languages EN, TR, DE, FR, RO) that can be accessed through Internet.

Introduction

The paper presents an EU funded project called European Remote Radio Laboratory (ERRL). The basic background information and target groups are presented and the software architecture is discussed. The paper ends with the personal opinions concerning enhancing engineering education through EU funded projects.

The contributors of the project are:
1. Atılım University, TR, promoter
2. Groupe ESIEE Paris, FR
3. EVTEK University of Applied Sciences, FI
4. Institute of Communication and Computer Systems, National Technical University of Athens, EL

5. Institute of Vocational Education, Work and Technology at University of Flensburg, DE
6. Balıkesir University, TR
7. The Norwegian University of Science and Technology, NO
8. Transilvania University of Brasov, RO

The project web site is located at http://errl.evtek.fi

Objective and Scope

The European Remote Radio Laboratory (ERRL) initiative aims to develop a remote access platform for a set of radio communications experiments which exploits high-tech high frequency equipments. Being a pilot project under Leonardo da Vinci Programme, its scope includes development of the remote access laboratory platform via Internet, which will provide hands-on radio communications training along with the theoretical supplements to students, technicians, and engineers in radio communications field of ICT. The duration of the project is two years starting from 1 October 2006. The project budget is approximately 517K Euro in total, approximately 388K Euro of which is granted from Leonardo da Vinci Programme.

Target Groups

There are recognized three direct target groups, which are:

1. Students from electrical, electronics, telecommunications or related courses of engineering educational/training organizations (such as universities and institutes).
2. Engineers, particularly the new graduates, in the fields of electrical, electronics, telecommunications or computer, and those who require the hands-on experience/training in telecom/radio related topics.
3. Students or graduates (technicians) of vocational schools/colleges serving for the electrical, electronics, telecommunications, computers fields, or their equivalents.

Indirectly the instructors and teachers benefit of new pedagogical approaches while course content and practical experiments laboratory assignments are available and accessible easily. The project will also produce theoretical content (instruction) about the experiments and produce interactive instructional material to support this content in the form of animations, games, and videos.

A profound analysis of needs of the different target groups were carried out in the beginning of the project. It was noticed that the needs differ between the countries and between the target groups.

Project Aims

The major and minor aims of the project can be listed as:

- Providing remote training and experimentation, via a remote radio lab, on high-cost and high-tech equipment that are not available in most of the educational and training organizations in radio communications field of ICT.
- Providing compatible training in radio communications related fields among the partner countries, by exchange of technical materials and feedbacks. Hence, establishing an international network in the targeted field.
- Improving the quality of education in the targeted field by enabling access of more of the related groups to the high-tech equipment and training.
- Encouraging the targeted groups to spend more time with practical training by removing the need for being present in the lab physically, and at restricted time zones.
- Encouraging vocational schools/colleges and other training institutions with limited financial resources to canalize their investments to establish a remote access facility which develops self learning skills of the students.

- Supporting the distance education programs in the field and providing the flexibility for the trainees to get laboratory experience in distance.
- Providing remote access to the laboratory equipment for different groups of learners such as disabled and women who have no chance otherwise.

Expected Outcomes

The expected results of the ERRL would include the followings:

- Radio-lab training experiment modules along with up-to-date course contents which better suit the changing needs of telecommunications industry.
- Web-based software tools including user interface, web-server software and web to workbench communication tools, to access experiment modules and some radio test equipments remotely.
- Test system supporting European Qualification Framework (EQF)
- Teaching materials for the use of high frequency test and measurement equipments such as oscilloscopes signal generators, spectrum analyzers, network analyzers etc.
- EPSS (Electronic Performance Support System) content on the use of test and measurement equipments.
- A software and infrastructure design that will make it easier and cheaper to make a lab remotely accessible.
- A project web site facilitating collaboration and discussion on radio systems education, among partners and in European level.
- Survey studies (needs analysis, didactical outcomes) on target groups chosen from partner organizations, as well as those accessed ERRL training facilities.

Impacts

- Harmonized and compatible technical materials among partners first, and then among the partner countries (particularly in radio communications of ICT), as a result of the collaboration and continuous exchange.
- Diffusion of high quality education material among target groups in participating countries.
- Financial savings for training organizations/schools by enabling their access to ERRL, by avoiding investment on extensive training units with high cost equipment.
- In the long run, less financial investment and reinforcement of compatibility due to resource sharing among the network members.
- The project results will be updated continuously in accordance with the feedback from target groups such as industry and schools. That indirect relation between the industry and schools will help schools see the major skills required by the industry and update their curriculum accordingly.

ERRL Software Architecture

The main architecture of the ERRL software system can be summarized as in Figure 1. Mainly there are two server architectures in the ERRL system: Workbench and Web servers.

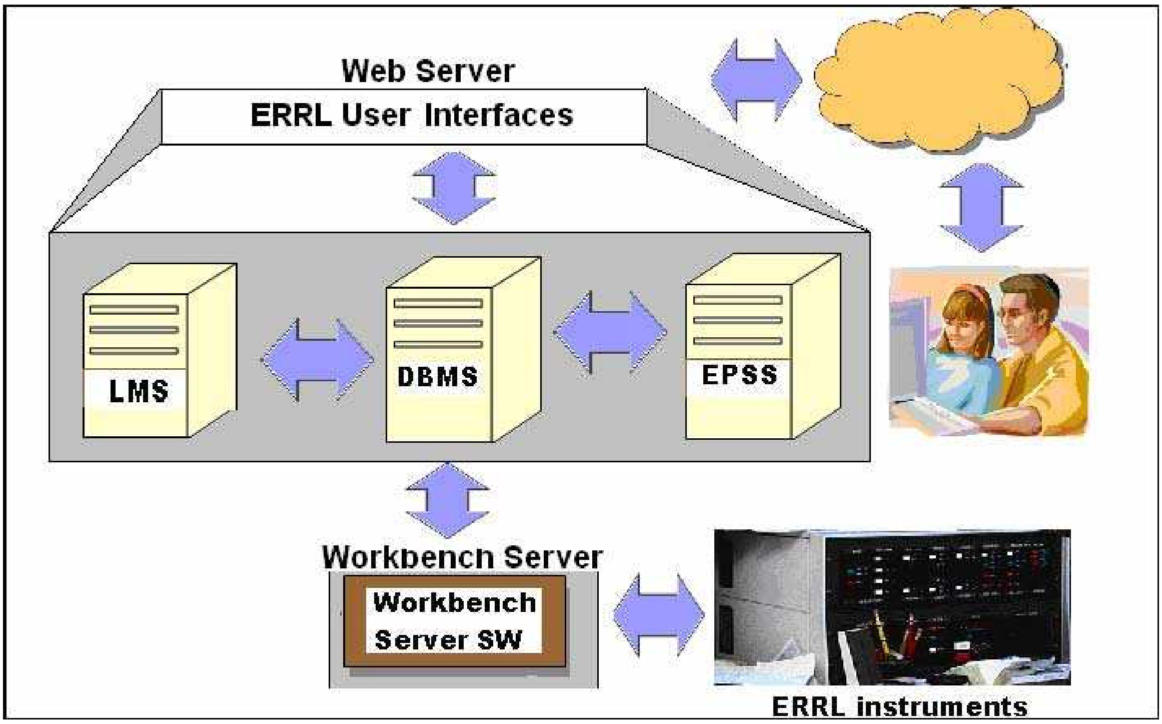

Fig. 1: General Architecture of the ERRL

A. Workbench Server Software Architecture

Workbench server is one of the tiers in ERRL software architecture. It carries out experiment-specific operations related to running experiments. Workbench server software architecture is illustrated in Figure.2. Since most of the RF equipments that will be used in the project are manufactured by Agilent, Agilent's Test & Measurement Toolkit for Microsoft Visual Studio is to be used, assuming that it will provide better and easier control. The web-server will be implemented mainly in Java using open source development environments (such as Eclipse). One reason for this choice is the availability of software developers experienced in these environments. The interoperability problem (which is likely to appear in any remote laboratory application) will be solved by adopting the web services infrastructure.

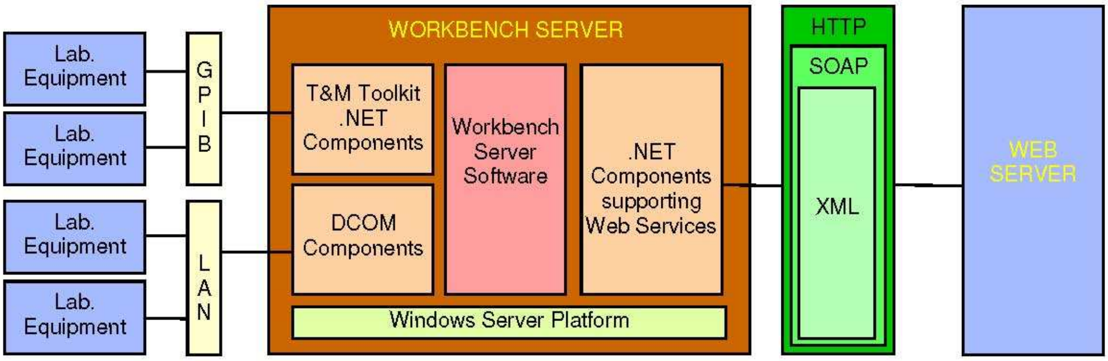

Fig. 2: Workbench Server Software Architecture

Job Scheduling

The experiment requests will be queued by the workbench server and executed in a first-in-first-out fashion. The experiments will be designed as batch jobs that can be completely defined in XML format.

Interoperability of applications

Although not necessarily in the ERRL scope, a web-server application will be able to access many workbench servers possibly in different remote locations. The workbench server software structure is being planned accordingly. Also a workbench server will be able to serve many web servers. Using UDDI and WSDL, a user will be able to explore the facilities provided by a workbench server and figure out how to use them in a programmatically way. The use of web services as the communication infrastructure will assure the interoperability of applications implemented using different technologies. For example a workbench server implemented entirely in LabView will be able to interoperate with the system provided that it implements the well-defined web services interface. Web services is based on XML, SOAP, HTTP, WSDL and UDDI technologies and is regarded as the most promising architecture for enabling the interoperability of diverse software platforms.

B. Web Server Architecture

Three fundamental parts of the system exist on the web server: Learning Management System (LMS), EPSS and ERRL user interfaces. One or more Data Base Management Systems will support all of these systems. Two servers have been configured for supporting this structure as described below

- Operating System :
  -Fedora Core-6-x86_64
- Database :
  -Mysql 5.0.27 version for LMS and EPSS
  -Oracle 8i for storing experimental results and clients' records
- Web Server :
  -Apache 2.0 version and Tomcat 5.0 version

In this server the following programming technologies will be used:

- Jsp, Servlets and EJB, JavaScript for storing experimental results and clients' records
- PHP for LMS and EPSS

System Architecture of the Web Server

During the development of ERRL system at web server side, the model view architecture will be used. Under the protection of them, the system and software will have a high quality and efficiency in the current technology.

- Model: Model domain contains the business logics and functions that manipulate the business data. It provides updated information to view domain and also gives response to a query. The controller can access the functionality which is encapsulated in the model.
- View: View is responsible for presentation aspect of application according to the model data and also responsible to forward query response to the controller.
- Controller: Controller accepts and intercepts user requests and controls the business objects to fulfil these requests. An application has one controller for related functionality. Controller can also be depends on the type of clients.

According to the architecture, we will use enterprise java beans (EJB) for Model domain, java server pages (JSP) for View domain and servlets for Controller domain.

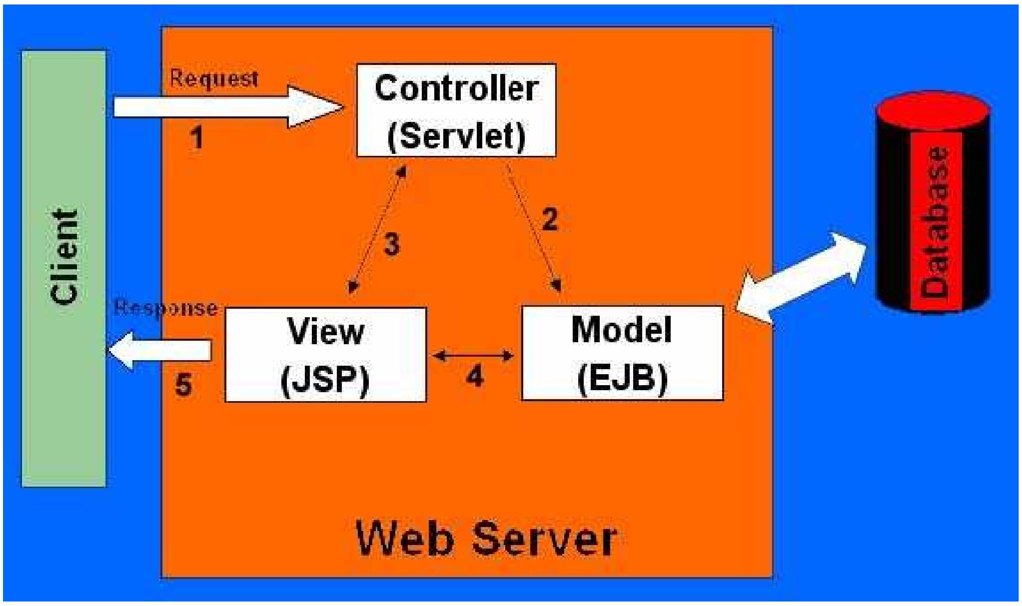

Fig. 3: Model View Architecture of the System

C. Communication between Workbench server and web-server

Workbench server will communicate with the web-server through its web services interface. Using HTTP and SOAP protocols, web server will submit an XML-based request to the workbench server describing the experimental procedure and the results demanded. The workbench server will execute the experiment and return an XML-based response to the web-server describing the experimental results obtained. Possibility of using the emerging IEEE standard, ATML (Automatic Test Mark-up Language), for this communication will be explored. The steps of this process can be summarized as:

Step1 -Experimental parameters are taken from the user and an XML file, which is about the test, is created by the system.
Step2 -This file sends to the work bench server through http by calling web service based on XML.
Step3 -Test results file again based on XML will be came on the web server and so according to the required format, result will be represent to the user as a graphical format or text format by java applet or XML file.

In the development of the web server application Visual Studio .NET 2005 is going to be used. The .NET frame work provides extensive support for XML processing and communication using SOAP and HTTP protocols.

For handling the communication of the Workbench Server with the laboratory equipment, third-party toolkits exist for the Visual Studio .NET 2005 environment, namely Test & Measurement Toolkit provided by Agilent and Measurement Studio provided by National Instruments. These toolkits also allow the integration of the applications developed using VEE or LabView with the code that is developed using the Visual Studio development environment. In ERRL project we plan to use Test & Measurement Toolkit.

In the development of the pilot experiment software, the DCOM server present on the Vector Network Analyser is going to be used. The native DCOM support in Visual Studio provides an efficient high-level programming facility. Communication over GPIB is also supported in Visual Studio with the Measurement Toolkit and forms an alternative to DCOM-based control of the Vector Network Analyser.

Samples from the experiments list

There is a list of planned experiments to be implemented, the available devices available and pedagogical subject.

- Measurement of scattering parameters of short, open load, matched load (Device: VNA)
  - concepts of reflection and transmission (return loss, Standing Wave Ratio, reflection coefficient)
- Spectrum Analysis and Fourier Series (Device: Spectrum analyzer, signal generator)
  - frequency-domain representation of sine, triangle and square waves
- FSK, ASK and PSK modulation (Device: Spectrum analyzer, Modulation generator, oscilloscope)
  - digital modulation techniques
- Measurement of scattering parameters of wave guide, bandpass/lowpass filter, amplifier, phase shifter, directional coupler (Device: VNA)
  - transmission, phase shift, attenuation, directivity, filtering and amplification Equipment: Vector network analyzer
- Impulse Response and Multipath (Device: VNA)
  - relation between time and frequency domain response of a radio channel
- Frequency Modulation (Device: Spectrum analyzer, Modulation generator, oscilloscope)

Lessons learned in enhancing engineering education through EU funded projects

The forming of a productive consortium is many times difficult. It is formed often in a very random way meaning the partners do not know each other, the procedures and working methods are different. It takes time to learn to know each partner. The sources of the motivation of the partners differ, which leads easily to a shortage of commitment. Universities sign easily the “letter of intent” without a meaning of a real engagement. In the application process only the applicant knows the real objectives, which much meet the requirements of the EU Commission.

To be successful, the partners must agree the idea of working together with universities on a joint (research) project. The administrational practices and procedures might not support such external or commercial project work concerning the reports of working hours and financial issues.

The joint projects promote easily and in a realistic way to identify good learning management tools to facilitate learning and management of course materials developed.

One important aspect of this kind of collaboration is the exchange of ideas, the transfer of technology and practices, and pedagogical approaches between partners. The consortium is an important platform to promote the European dimension among the partners.

If the courses and contents are not in the syllabus of degree programme, it makes difficult to persuade the students and teachers to seriously go through them.

Conclusion

It can be justified that the efforts and funds used in developing joint courses and laboratory experiments are very important from many aspects: quality, harmonization, finance. According to many examples and attempts in many countries this kind of development seems to be very difficult and the results are not always sustainable. On the other hand, some private companies have spend huge efforts in establishing IT Academies (e.g. Cisco Systems, Microsoft, Oracle) offering partnerships to universities and institutions. They have produced good teaching material, as well. Should there be more co-operations with companies while preparing course material and laboratory experiments? However, education over the Internet is going to be the next big killer application of the Internet.