

# An Approach for Development of Measurement Laboratories for Remote Experiments

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**Abstract** – The advance of the information and telecommunication technologies, based on multimedia and global networks, causes innovations in the field of measurement. The model of measurement laboratory for remote experiments is presented in this paper. Clients can access measuring system, i.e. instruments, via Internet and directly carry out real experiments.

**Keywords** – Virtual laboratory, client/server architecture, client application, remote experiments

## I. INTRODUCTION

Nowadays, in order to control and run technological processes, a number of process' parameters should be measured. Measuring is carrying out at different measurement places, with bigger or smaller distance between them. All measurement resources, which are used in that purpose, are connected in one functional entirety – measurement system. Low price of microprocessor's components and systems, made possible the realisation of the systems with distributed data processing.

The development of information technologies has opened new possibilities in realisation of measurement data acquisition systems. The idea of remotely accessible laboratories via Internet became true [1]. The laboratory heart consists of a group of specialised and/or general instruments, connected to the Internet through the PC. Within a remote measurement laboratory, clients can cooperate to each other, even they are on geographically distant places.

## II. DISTRIBUTED ARCHITECTURE

As it's known, the distributed measurement systems are the systems where it is possible to realise the network by linking a great number of remote subsystems, and where it is possible to change their's software. If access to these systems is allowed via Internet, we have remote laboratory, i.e. distributed measurement system based on client-server architecture. This systems are also called virtual laboratories.

A virtual laboratory for measurement and instrumentation must aim to realise an integrated environment for creation and distribution of virtual instruments and systems through a computer network [2].

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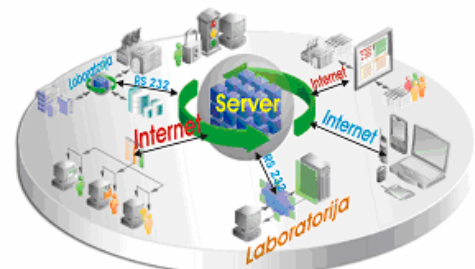


Fig. 1. Virtual laboratory.

The system architecture comprises a hierarchical structure on few levels (Fig. 1) [1]. Clients can access only to the first level via a simple Web browser. The base of this system is measurement system, which is connected to a computer (server) via standard communication interface (RS-232 protocol). It (allows) makes possible distribution of data and measured results via Internet to a client. System is based on standard protocols and features, and it can be easily expand.

Basic parts of the system are:

- main server,
- connection with measurement systems (laboratories),
- measurement instruments which perform the laboratory.

Main server manages the whole system. It allows access to the laboratory and the experiments, on one side, and forwards the tasks (assignment) to the features which are in the environment, on the other side. The instruments in the laboratory are connected to the main server over standard interface RS-232, which routes the instructions and results of the experiment.

## III. MEASUREMENT LABORATORY REALISATION – SOFTWARE SOLUTION

Virtual instruments for measurement characteristics test of sensor module ADAM 4011 [3] are realised in order to develop the remote laboratory. These instruments are realised by program language LabVIEW [4]. They allows complete setup and control of the intelligent measurement module ADAM 4011, and measurement in all input bands.

Fig. 2 shows the hardware connection scheme of the virtual instrument. ADAM modules are connected to PC through RS-232/RS-485 convertor, ADAM 4520. Standard values of electric signals, generated by calibrator METRAtop 53, are attached to inputs of intelligent measurement module [5].

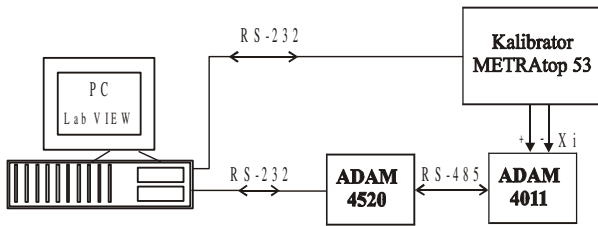


Fig. 2. Hardware connection scheme of the virtual instrument.

Tools and technologies, which are used for development of this virtual laboratory, are IIS, ASP, SQL Server, Visual C++, Java, VB and CGI scripts (Fig. 3). Every mentioned technology and tool has a specific role in the laboratory work.

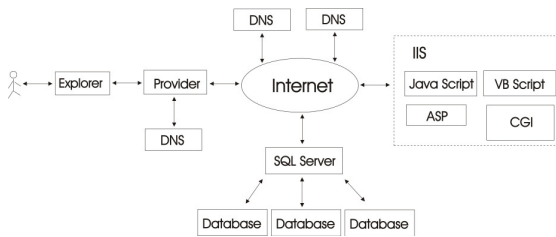


Fig. 3. Client application architecture.

In concrete system architecture, the Internet Information Server (IIS) is used as a web server. Client accesses the laboratory by standard browser and web address of the virtual laboratory. Browser forwards symbolic address to a local DNS server, where the pares of symbolic addresses and IP (Internet Protocol) addresses are hosted. If there are no errors, the page will be opened in the browser. Client requires the laboratory access by identifying itself through Login and Password. After that, browser forwards the requirement to the virtual laboratory server. Web pages are written in ASP (Active Server Pages) program language.

The confirmation of the client is implemented at the beginning of the next web page. The server checks added personal data and allows the client to access the system if the client exists in data base. If the client doesn't exist in data base, server refuses that client with a note to try again.

After registration, new page appears. The client has to choose a measuring experiment and requires the access. At the next page, the client has to enter specific set of data (range, sample rate, number of measurements...), which is necessary for laboratory setup. Based on this set of data, the input file of virtual instrument has been created.

By pressing the OK button, the proper LabVIEW application runs up. LabVIEW application carries out measurements with given pharameters, and the acheived results puts into output data file. Based on these data file, web page with the measurement results has been generated and the results are shown to the client.

The client receives report in the form of HTML page. In this case, the measurement results are given tabelary, thus the client can perform the required calculations. Calculations can

be also performed using the equations given at the current page. Also, the client can graphically present results of the measurement.

Of course, the concurrence of more measuring requirements on the same measuring system at the same time has appeared. This problem can be solved in two ways. The first is not to allow any new client login while the laboratory is occupied by the client who is already logged and performs measuring. The second way is to put all logged clients in a queue. When a single measuring is done, the next client from the queue gets the laboratory for use (first-in first-out concept). The second solution is more practical because the laboratory occupation is splitted between all logged clients. In this way, increase of clients number increases the waiting time in the queue, but it is equal for everyone who is in order to login.

#### IV. CONCLUSION

The information technologies advancement causes new possibilities for the realisation of data aquisition measurement systems. Suggested system is based on client-server architecture, it is easy to expand and it makes possibilities for distant clients to access the instruments. System expanding can be shown with the increasing number of laboratories, which are connected to the system. It will be necessary to develop a virtual instrument in the program language LabVIEW for each laboratory. Also, it will be necessary to make the program, which will enable the selection of available laboratory and prevent of client's concurrence, if the number of laboratories incresases. Equipment needed for the very next laboratory is certainly specific for every task and overload of a PC with a connected equipment is the only limit. It can be overcome by adding a new PC and connecting it to the established laboratory network. At the same time, the application has good bases for further development, which is related to easy handling and to the possibility of easy upgrading and interface changing. Thus, this lab shown possibility to make standards in communication between modules, which role with devices are connected to the server, and internet applications which serve the users. If they would be created, widening of the system with new modules would become very simple and fast. It would bring up ability to develop system distributive by many developers from long distance places.

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