Joint **IMEKO TC-1 & XXXIV MKM Conference 2002**
Wroclaw, 8 - 12 September 2002

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NEW INFORMATION TECHNOLOGIES IN MEASURING SYSTEMS DESIGNING

The paper presents an influence of new information technologies upon measuring systems designing and proposes a new course that covers new trends in measuring systems designing. Distributed structure of modern measuring systems requires the use of special software technologies for design software of such systems. Possibilities of applying some modern information technologies for these purposes are considered. In the second part of the paper a program of a new course, concerned measuring system software designing, is presented. An example of student project, designed in the frame of the course, is presented.

Key words: Measuring systems, information technologies

1. INTRODUCTION

Fast development of communication technologies wire-based (e.g. Internet network) and wireless-based (e.g. GSM, GPRS, WAP, UMTS, Bluetooth, WLAN, etc), and software technologies such as: integrated software environments (e.g. LabVIEW, Measurement Studio, Agilent VEE), Java, C+SCPI, Data Socket, ActiveX, HTML, XML, WML, Flash, etc, requires a new approach to measurement systems designing. Distributed structure of modern measuring systems requires the use of special technologies for design such systems. This paper concerns to application of novel information and wire-based communication technologies in measuring systems designing. At first, a review of these technologies, which can be used for design of distributed measuring systems (DMS), is presented. Then, a new course, which covers new trends in measuring system designing is proposed. An example of student project, designed in the frame of the course, is described.

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2. DISTRIBUTED MEASURING SYSTEMS

Distributed measuring systems usually were designed using dedicated industrial networks, such as CAN, Profibus [12] and others. Main advantages of these systems are infallibility and very short time delay of data transfer. Main disadvantages - limited range and necessity of building of network infrastructure. Thanks to a great develop-ment of computer networks, there is a possibility of linking computers with instruments via these networks. General concept of network-based distributed measuring systems, its advantages and disadvantages, is well described in [3], [4], and [5].

2.1. ARCHITECTURES OF DISTRIBUTED MEASURING SYSTEMS

Network-based distributed measuring systems (NDMS) are designed based on network architecture. There are three main network architectures: *mainframe*, *client–server* and *three-layers*. The most popular architecture used in distributed measuring systems is *client–server* architecture [1]. Basis element in this structure is a server of a measurement system (called a Measurement Server - MS). It is usually IBM-PC-type computer with embedded driver of a measurement local bus. MS software allows to remote control a measurement procedure and to make available a measurement result. MS usually contains also a server of client application, which enable client to take remotely the application. Very popular method for this purpose is applying a simple WWW server. As a measurement local bus, the IEC-625-bus or a serial bus is use the most frequently. Many measurement devices are produced in a form of a card, which can be inserted directly into a PC computer; these devices are usually based on a data acquisition board. Measurement instruments can be plugged into a local (LAN) or wide area (WAN) computer network using appropriate converters.

2.2. COMMUNICATION TECHNOLOGIES IN DISTRIBUTED MEASURING SYSTEMS.

Communication protocol is a kind of language, which enables communication between various processes. These processes can perform in one computer or in many distributed computers. Basic task of a communication protocol is enabling one or many applications to acquire the services of another application. Usually an application, which shares services, called *Server*, is waiting for asking for data by an application called *Client*. To perform such a communication, the type of data and the method of transmission must be established. The most popular protocols used in distributed measuring systems are as follow:

- **TCP/IP** - (*Transmission Control Protocol/Internet Protocol*), available on all platforms,
- **ActiveX** – available only on MS Windows platforms,

- **DataSocket** - based on TCP/IP standard, designed by National Instruments,
- **DDE** – (*Dynamic Data Exchange*) - available only in MS Windows environment,
- **UDP** – (*User Datagram Protocol*) – available on UNIX, Macintosh, Windows platforms,
- **AppleEvents** – available only in Macintosh computers,
- **PPC** – available only in Macintosh computers.

2.3. SOFTWARE TOOLS FOR DISTRIBUTED MEASURING SYSTEMS DESIGNING

2.3.1. INTEGRATED SOFTWARE ENVIRONMENTS

A great development of computer-aided design tools for measuring systems design started together with appearance of personal computers. Firmware, specialised, software packages enable us to design measuring systems in a simple way. Such integrated software environments, as LabVIEW, LabWindows, VEE or TestPoint, radically changed methods of measuring systems software designing [14, 15].

Development of computer networks (Internet) caused introduction of network mechanisms into the integrated software environments, enabling us to build distributed applications. Furthermore, these environments have embedded mechanisms of designing WWW pages to display a system state and measurement results, mechanisms of sending messages via an electronic mail (e.g.. to signal dangerous states of the system) and libraries, which enable one to communicate with database (e.g. SQL). Most of the projects of NDMS is designed using the integrated software environments TCP/IP-based mechanism, netDDE, ActiveX and DataSocket (NI) [2, 4, 5, 10, 11].

2.3.2. INTERNET TECHNOLOGIES

Internet technologies consist of software tools, which enable data transfer via Internet. There are many Internet technologies. The most known are presented below:

- **HTML** – primary language for design of WWW pages, it allows formatting texts, drawing lines, linking graphics, sounds and animation and storing the whole in ASCII files, which are readable for all computers,
- **CGI Script** (Common Gateway Interface) – software program, which allows to data transfer between World-Wide Web server and Internet user,
- **JavaScript** - language designed by *SUN* and *Netscape*. It allows placing active elements on WWW pages. Active elements change their face, when you pass a mouse over it,
- **Java** – language introduced by *SUN* in1991,
- **Servlets** [9] - designed by *SUN* extended implementation of **CGI**.

Each of these solutions has some advantages and disadvantages. Construction and operation principles of static software environment **CGI**, **HTML**, **JavaScript**, **DDE**, or **Servlets** are similar. Flexibility, simplicity and a little size – what is important in small applications – are their great advantages. Lack of communication mechanisms between measurement server measuring instruments is a slight their disadvantage. They are very useful in designing homogeneous, dedicated applications [7, 13], but they are not appropriate for designing libraries of graphical controls, which are necessary to design graphic user interfaces. Language **Java** is another tool that can be used in network-based distributed measuring systems designing. The most important feature of **Java** is its platform independence. Java application can be performed in all computers supported by V*irtual Java Machine* without a necessity of change and recompilation of program code. The second feature of Java is a possibility of use of aplets. Aplets are software programs in **Java**, which are embedded in a document in the same way as graphical objects. Java has become very popular language, because enables user to design simple and infallible programs; to build application on various hardware platforms and to perform these programs on other platforms without a necessity of recompilation the code, and also to transfer applications over computer networks with safely [8, 9].

3. NEW COURSE "DESIGN OF DMS"

After an analysis of possibilities of applying some novel software and communication technologies in measuring systems designing, a new course for students of electronics faculties was proposed.

The course is dedicated to distributed measuring systems and is focused on network-based DMS (NDMS). In introduction, a definition and a classification of measuring systems are proposed. Main structures of DMS are described: multiplex, network and mixed. Then, wire-based and wireless-based DMS are presented. Special attention is focused on NDMS.

In the group of wire-based DMS, industrial systems using serial interfaces such as RS-485, RS-422A, RS-423A and dedicated industrial networks such as DeviceNet, CANopen, FieldBus, PROFIBUS, are described. Then, systems with bus extenders, systems with modems and computer-network-based systems are shortly presented.

The next part of the course concerned to wireless distributed measuring systems. Various wireless communication media that can be applied in DMS are discussed. Architectures of DMS with data transmission using infrared links, radiomodems and cellular telephony GSM are shown. An example of DMS using cellular telephony GSM with WAP and ASP technology is described. Possibilities of applying of UMTS telephony, Bluetooth standard and WLAN (Wireless Ethernet) network to DMS are considered.

The main part of the course is devote to detail presentation of computer-network-based DMS (NDMS). General structure of NDMS is shown. Main architectures of computer networks are presented: *mainframe, client–server* and *three-layers*. Their advantages and disadvantages, and usefulness in NDMS are discussed. The architecture *client–server* is described in details: its features, operation model and various kinds of client applications and server applications. The structure NDMS using client–server architecture is presented. Network mechanisms (data transfer protocols, internet technologies) are presented. Special attention is focused on TCP/IP (Transmission Control Protocol/Internet Protocol), ActiveX, DataSocket and DDE (Dynamic Data Exchange) mechanisms. Then, computer-aided design (CAD) tools for NDMS are presented. Internet technologies, such as: HTML, script languages (CGI, PHP, JavaScript, ASP), Java, are described. An example of NDSM, designed with the use of Java, is shown Possibilities of using commercial, specialised environments (integrated software environments) to design NDMS are discussed. Applying of integrated software environments (such as: LabWindows/CVI, LabVIEW, VEE) is presented. Network technologies, used in these environments, are presented. Network mechanisms and appropriate libraries and functions, applied by each of these environments, are described in details. Special attention is paid for designing NDMS with client-server architecture using TCP/IP, DataSocket, ActiveX and netDDE. Examples of using these technologies are shown.

The proposed course presents information, which is necessary to design modern, distributed measuring systems with the use of novel information and communication technologies". Knowledge acquired by students in lectures is verified by designing project tasks of NDMS. An example of a student project is presented below.

4. AN EXAMPLE OF NDMS PROJECT

There are two group of projects: the first – projects based on VXI modules and C language or VEE environment, and the second – NDMS projects, based on DAQ cards, IEC-625 instruments and LabVIEW, LabWindows, or VEE environment. Two or four students work out each project task. Below, a project from the second group is presented. This project was realised by 4 students.

Project formulation:

- Using LabVIEW, design a server application and a client application, which allow to control HP33120A function generator and HP34401A multimeter over Internet (TCP/IP protocol or DataSocket protocol),

Assumptions:

- The measurement server (MS) has to allow to start remotely a measurement procedure of amplitude and frequency characteristics of DUT and to collect measurement results,

- The MS has to make available its status information (is a measurement performed or not, are there clients connected with and how many - or not, fault information, etc.) on the WWW page,
- The MS has to send system faults information using e-mail to the address indicated by the client,
- The client has to receive the measurement parameters (the range of amplitude and frequency changes, the number of measurement points, etc.) from MySQL database server,
- The client has to receive the measurement data and send them to a database table,
- The client has to show a state of measurement process on-line on the screen,
- The client has to show historical data placed in the database,
- You have to choose a data transfer protocol between a clients and a server.

The block diagram of the system, proposed by the students, is presented on Fig. 1. The MS is the main block of the system. This server consists of PC computer with IEC-625 card controller, two instruments (generator HP33120A and multimeter HP34401A) and software program, which makes available system services. Database system (MySQL) and simple WWW server are connected with the MS via local network (LAN). Database system allows archiving measurement data; these data can be send at request to the client. WWW server makes available pages with generated by the MS; these pages show temporary measurement results and a state of the system.

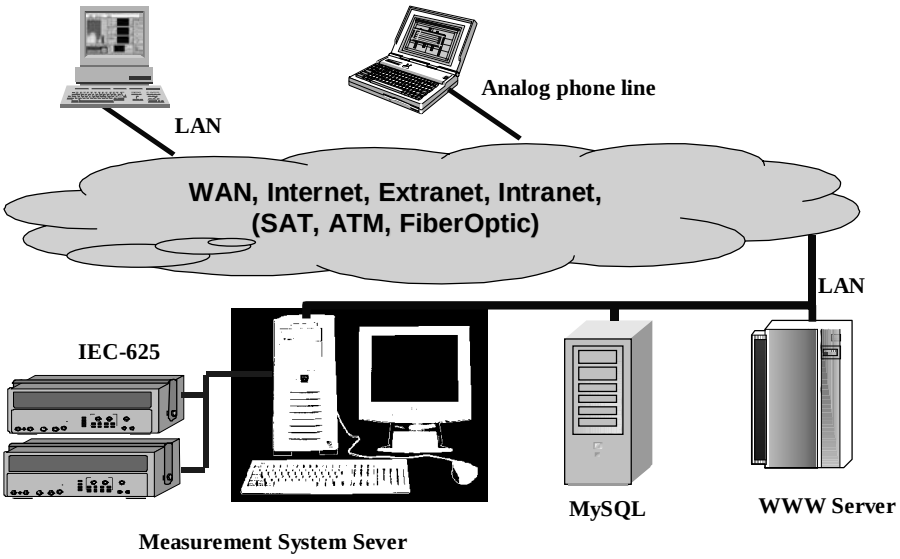

Fig. 1. The block diagram of the system

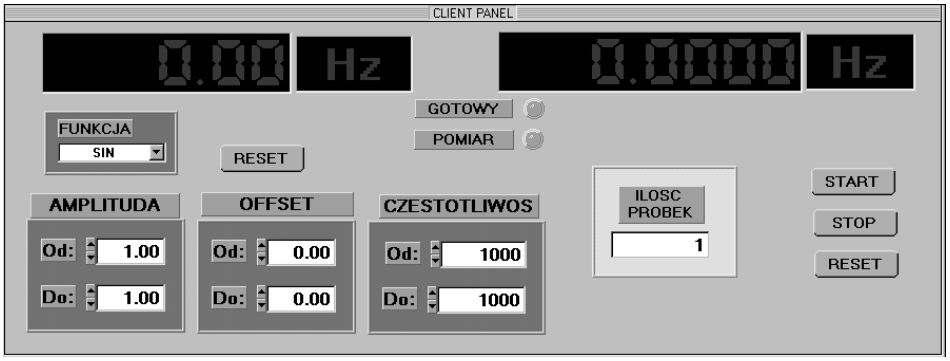

Fig. 2. The panels of the client (measurement parameters)

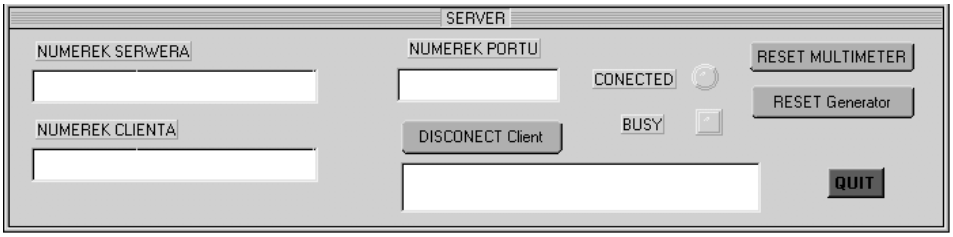

Fig. 3. The panels of the server

Communication between the client and the server is based on TCP/IP protocol. The panels of the client and the server are shown on Fig. 2 and Fig. 3.

Measurement results are available on-line in the client panel in a form of a chart. Additionally, there is a possibility of review of historical data from the database. Beside it, there is possible to look at last measured characteristic on the WWW page, which is automatically generated by the MS. The last function of the system is sending e-mail to the system operator; e.g. information about system faults, database faults, TCP/IP communication, instruments states.

Other projects have the same level of complication. Main differences consists in using various software environments, (LabVIEW, VEE, LabWindows, VisualStudio), measurement devices (DAQ cards, FieldPoint modules, etc.) and various protocols and network communication technologies (DataSocket, TCP/IP, netDDE, ActiveX).

5. SUMMARY

An influence of new information technologies upon measuring systems designing and proposes a new course which covers new trends in distributed measuring system designing is presented. Distributed structure of modern measuring systems requires the use of special software technologies for design software of such systems.

A program of a new course, concerns distributed measuring system software desig n-ing, is described. Some examples of student project, designed in the frame of the course, are presented. Some realisations of this course allow finding that the course is very attractive for students. Especially valuable are experience and capacity acquired during realisation the projects of distributed measuring systems.

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