COMPUTER BASED MEASUREMENT SYSTEMS FOR SEMICONDUCTOR DEVICES LABS

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The paper describes the developed software architecture of computer based measurement system for semiconductor devices labs. The architecture is specifically targeted towards Web based Java applications, where the browser becomes the platform for a lightweight hypertext-based user interface. An overview of some data acquisition (DAQ) devices is performed.

Keywords: Instrumentation, data acquisition, computer based laboratory

1. INTRODUCTION

Traditionally, measurements are done on stand alone instruments of various types-oscilloscopes, multi meters, counters etc. However, the need to record the measurements and process the collected data for visualization has become increasingly important. Computers equipped with measurement and control systems have become an accepted and necessary part of physics school laboratories.

There are several ways in which the data can be exchanged between instruments and a computer. Many instruments have a serial port which can exchange data to and from a computer or another instrument. Use of GPIB interface board (General purpose Instrumentation Bus) allows instruments to transfer data in a parallel format and gives each instrument an identity among a network of instruments.

Another way to measure signals and transfer the data into a computer is by using a Data Acquisition (DAQ) board. A typical commercial DAQ card contains ADC and DAC that allows input and output of analog and digital signals in addition to digital input/output channels.

A DAQ board performs the analog to digital conversion with a user selectable sampling rate. A PC-based DAQ system can convert analog signals into a digital output form, which can be manipulated with software. Using software in conjunction with a personal computer, analog data can be displayed, logged, charted, graphed, or stored as needed.

Stored data can later be used and compared with a set of established limits. For a PC system normally PCI or USB boards and for notebook system PCMCIA boards are used. A typical Data Acquisition System is shown on the figure 1.

In order to control all hardware parameters, it is important to have a powerful software package that also includes the driver for the DAQ-boards. The software controls the measurement system by acquiring the raw data, analyzing, presenting the results and store them in suitable Learning Management System (LMS). It is also important to choose a programming language (C++, Java, VB) that enables an easy setup or adaptation of the programs for the experimental paradigm, data acquisition and analysis.

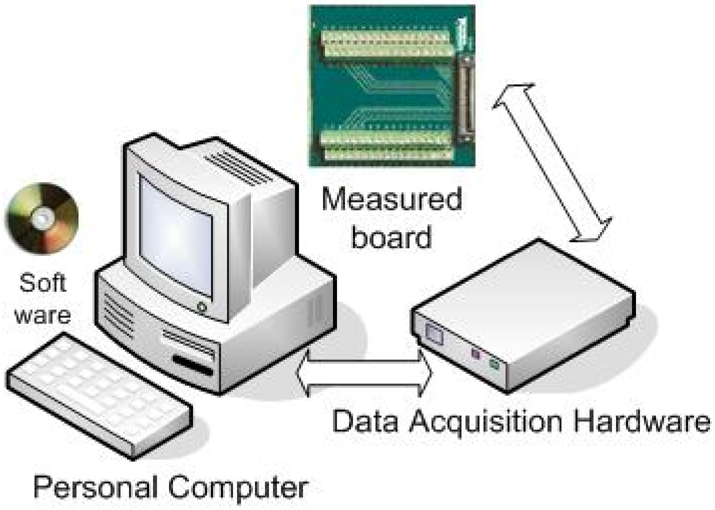

Figure 1. A typical Data Acquisition System.

2. DAQ BOARDS OVERVIEW

Many vendors provide to the market separate measurement devices or complete computer systems for measurement of electrical parameters as current and voltage, but not all of them are suitable for our needs. Technical requirements of the DAQ boards for measurement of semiconductor devices (diodes, zener diodes, bipolar and MOS transistors) parameters and characteristics have been analyzed. Based on them three DAQ boards are selected and evaluated – Lucas Nuelle Unitrain, Measurement Computing USB-1208LS and Visatronic VT7. Features comparison of these DAQ boards is shown in table 1.

	Unitrain	**USB-1208LS**	**VT7**
			
PC Connectivity	USB and serial interfaces	USB interface	USB interface
Provided Software	LabSoft	IO Library LabView	Agilent VEE Pro
External power supply	Yes	No – 5V trough USB	Yes
Ability to control form other software (C++, Java, .NET)	Yes – COM Object in C++	Yes – trough NI IO Library	Yes - Direct ASCI commands

Voltmeter	AC, DC, 9 ranges 100mV to 50V, true RMS, AV	DC, 8 ranges 1V – 20V	DC, 4 ranges 2V - 20V
Ampermeter	With external shunt resistance	With external shunt resistance	DC, 8 ranges: 60µA – 200mA
Signal Generator	0.5 Hz - 1MHz, 0-10 V, sine, square, triangle	Analog output - software controlled 100S/sec, 0-5V	0.1 Hz – 32KHz, 0-5 V, sine, square, triangle, sawtooth with positive and negative slope
Arbitrary signal generator	Yes	Yes	Yes
Oscilloscope	dual-channel, bandwidth 4 MHz, 22 time ranges, 9 ranges 100 mV to 50 V, trigger and pretrigger, XY- and XT modes	Up to 8 channels, bandwidth 8kHz External trigger	dual-channel, bandwidth 2 MHz, 19 time ranges, 9 ranges 10 mV to 5 V, trigger by channel or external
Power Supply	Adjustable DC power supply -20 V - +20 V, 2 A	No	Adjustable DC power supply -12V - 0V, 300m A 0v - +12V, 300m A
3-phase power supply	0-150 Hz, 0-14 Vrms, 2 A	No	No
Logic Analizer	No	No	Yes
Digital I/O	16 x Digital out, 16 x Digital in, 16 x Digital In/Out	16 x Digital out, 16 x Digital in, 16 x Digital In/Out	8 x Digital out, 8 x Digital in

Table 1: DAQ boards comparison

Evaluation of algorithms and protocols for the following tasks has been carried on:

- Control of measurement devices;
- Transfer of the measurements to the host computer;
- Processing and visualization of the measurements with "virtual instruments";
- Storing the data from the measurements in a learning management system (LMS).

Front-end Java based software has been developed for all of them, defining the unified software architecture for usage of different hardware measurement devices through single user application.

3. SYSTEM ARCHITECTURE OF WEB BASED DAQ SYSTEM

Depends on physical location of DAQ device two system architecture has been developed:

- Local DAQ system – DAQ board is attached to every single user PC.
- Distributed DAQ system – DAQ board is attached to centralized server accessible by standard HTTP protocol.

3.1. Local DAQ System

The developed architecture of local DAQ system is shown on figure 2.

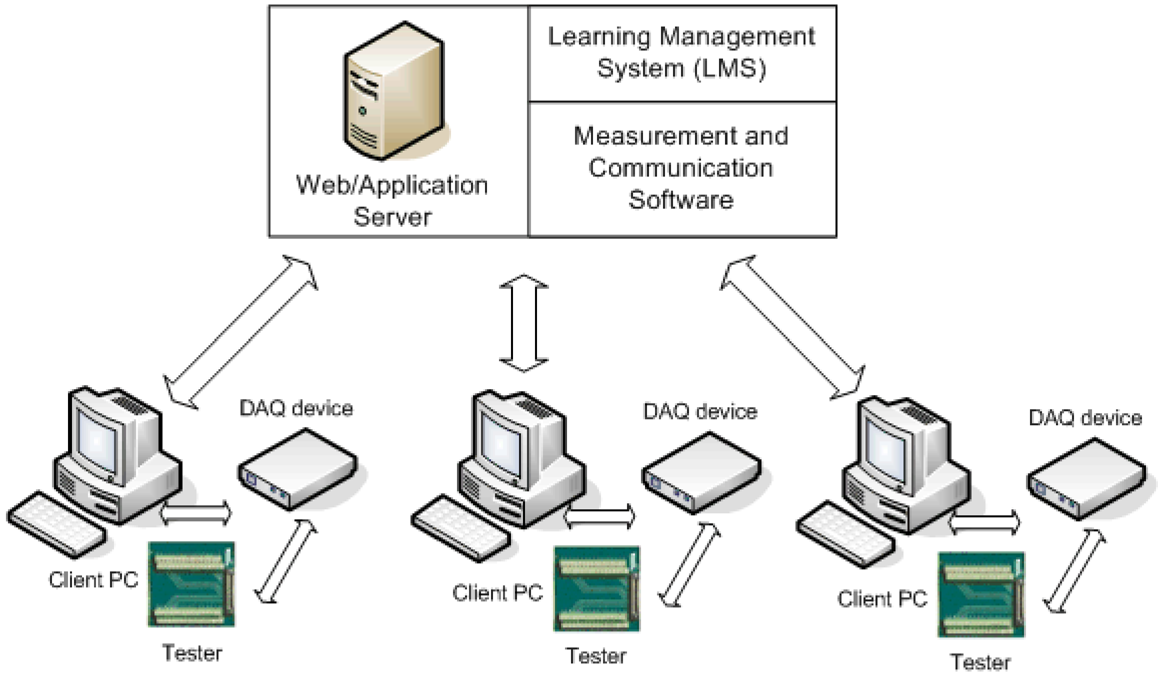

Figure 2. Architecture of local DAQ System

Every client PC is equipped with DAQ device and tester with measured circuit. The measurement software is loaded from the server in a standard Web browser on the clients. It communicates with DAQ device via the device driver installed on every client PC. The measurement results can easily be stored in Learning Management system located on the server for further analysis. Provided architecture has the following advantages:

- Learner has full access to DAQ device and tester board.
- Every learner workstation has its own tester board with different measured circuit.
- There is no need to control the access to the DAQ device, because only one learner is using it.

3.2. Distributed DAQ System

Distributed DAQ system shown on figure 3 is suitable for very expensive DAQ devices, where equipment of all PCs in the laboratory with such devices will cost a lot. The DAQ device is connected to the server. Web server provides an access to the measurement circuit trough standard HTTP protocol. There is no additional hardware or software needed on the clients – only standard Web browser. The most important software module here is the "Access Control" module. When one client takes a full control on the DAQ device (set measurement conditions and parameters) the "Access Control" module allows to other users only possibility to measure the results. In other words only one user has a full control on the experiment at the same time.

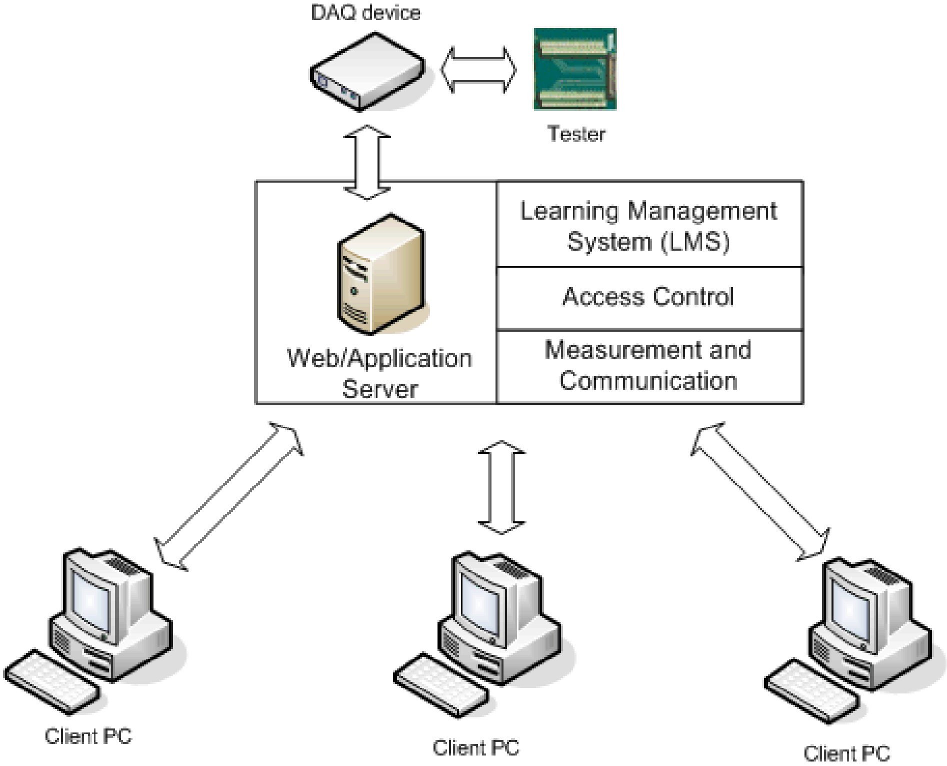

Figure 3. Architecture of distributed DAQ System

The distributed DAQ system frees the experimenter from physical presence in the laboratory. It also allows multiple users all over the world to participate in common experiment with device equipment not necessarily situated in one laboratory.

4. CONCLUSIONS

Teaching and learning experiences may be enhanced by integrating new-technologies in the engineering curriculum, particularly in experimental-type courses. By installing plug-in data acquisition boards (DAQ) and suitable application software, the general-purpose computers become enormously flexible virtual-instruments with data acquisition and analysis capability.

Provided system architecture gives another view for measurement system in educational labs. Using DAQ devices as data acquisition hardware reduces the overall cost for such laboratories, allows every learner to have an access to a real measurement experiment.

5. REFERENCES

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