Products Used:
- LabVIEW®
- DAQ
- SCXI

The Challenge:
Develop an open and user configurable system to perform continuous monitoring of exhaust gases produced by boilers and industrial furnaces on a paper and pulp factory.

The Solution:
A client-server system running LabVIEW under Windows NT and 95: three clients with DAQ and SCXI connected to the sensors and one server application linked to a Microsoft Access database and Microsoft Excel via OLE.

Figure 1. EcoMonitor architecture
Introduction
Due to the latest legislation about environment, the major companies releasing gases to the atmosphere must have a continuous monitoring system to measure emitted gases and execute periodic reports to the authorities.

Portucel is one of the major Paper & Pulp companies in Portugal, and the unit where the system is installed is one of the oldest in the country. Therefore, the main goal was to install a completely new system to acquire, transmit, process, archive and visualize the measured signals, and also to build automatic reports. This new system should be independent of the existing ones.

The sensors needed to measure the physical phenomena were already installed and the measured values were available as voltage or current signals. The emission sources were three: two boilers and one furnace, and were located around the factory with distances up to 200 meters from each other and 400 meters from the main building.

The customer wanted a central computer, inside the main building, to monitor the signals measured in every source, to implement a database and produce the periodic reports to the authorities.

The major requirements of the customer were that all the software and hardware should be based on an open standard, easily expanded and in-house autonomy to manage the system. Another requirements were the ability to watch and control the several sensor calibrations, the existence of security levels and to implement data transfer between the new system and the IBM AS/400 mainframe already installed.

The EcoMonitor System
To better address the customer needs, a client/server approach was chosen (see Figure 1.). The EcoMonitor system consists of two levels of hierarchy. The EcoMonitor Remote acquires data from the sensors 24 hours/day, and watches and actuates the calibrations on the sensors. The Server manages the communications to the clients, processes and archives data in a database, gives the user a "real-time" graphical view of the system, and automatically generates reports on Microsoft Excel.

LabVIEW was chosen as the development software because of its unique capabilities to acquire, process and visualize data. Also because it has the required data transfer capabilities (TCP/IP, SQL, OLE), programming and debugging simplicity, and concurrency between processes.

Voltages and currents are measured from the sensors with a SCXI+DAQ system, connected to the computer parallel port. This way all the signal conditioning and conversion is made inside the SCXI rack, avoiding interference from the industrial environment.
Technical Details
One of the major problems encountered in this application, both in the Server and in the Remote station, was the need to execute parallel tasks, such as communications, data transfer, data visualization, user requests, and others. LabVIEW help us to overcome this due to the simple way of doing concurrent programming. This way, background services may run concurrently with the user interface without loss of performance.

The computer running EcoMonitor Remote is a Pentium 100 with 32 MB of Ram, with Windows 95. The software application is an executable built with Application Builder.

The EcoMonitor Remote has two main tasks to execute: continuos data acquisition and a calibration watch/actuate service. Besides these main tasks, it performs data averages and transmission to the Server, DAQ system configuration if ordered by the Server, and UPS management in case of power down. Data acquired is always saved to the disk to prevent loss during power down. A floppy disk transfer allows data transfer during a communications network malfunction. The front panel of the Remote application is shown in Figure 2.

The SCXI+DAQ system is composed by an SCXI rack, an SCXI-1200 DAQ board, an SCXI-1122 board for analog signal conditioning, an SCXI-1162HV to watch for sensors calibration and an SCXI-1163R to actuate the manual calibrations. All SCXI modules are electrically isolated (optical connection) to prevent damages caused by electrical discharges.
The flexibility of the SCXI along with the ease of programming data acquisition routines inside LabVIEW allowed us to build a powerful monitoring system, but also easy to understand and even to be improved by the end user.

A photo of one of the installed Remote systems (sensors + DAQ/SCXI) is shown in Figure 3.

The Server computer is a Pentium 166 with 48 MB of Ram under Windows NT Server 4.0. In this case, the application runs inside LabVIEW without the diagrams.

The main task of the Server is to run several services available to Remote applications and to the user interface. The services are the communications (measurements and calibrations, receive and archive), the database access, the alarms server (receive, display and archive), time server (watch for changes in day, month, year) and UPS management. All communications are based on standard TCP/IP under Windows.

Automatic reports are generated in Microsoft Excel, through the OLE Automation Server VIs. This way, we are able to provide the end user final reports according to the legislation, as well as the flexibility of Excel for customized data processing. The database is implemented with Microsoft Access, interfaced through the SQL toolkit. This way we provide a consistent use of Microsoft applications cutting down the overall costs.
Several administration functions as configuration of remote unit channels, alarm definition, user management, backup copies control, and others, are also available.

The Server supplies continuous information on alarms (measured signal greater/lower than a configured value) and status of the entire system.

Data transfer between the application and the AS/400 mainframe can be done manually or automatically.

The data visualization panel is an easy-to-use user interface, which performs several complex operations to provide valuable information about the emitted gases. The limits for each signal may be observed and values higher than limits are plotted in different color. The user may also choose to see data automatically updated.

This panel, data visualization, and the alarm management panel are certainly the most used by the user and they both run in parallel with the Server application. Both are shown in Figure 4.

Figure 4. Data visualization and alarm management panels
Conclusions
This application was technically challenging in many ways. Every function, client and server, are implemented using LabVIEW, with a small exception to a Code Interface Node used in the Server.

LabVIEW proved to be excellent due to short development time, ease of debugging and ease of code reuse and maintenance, thus increasing productivity. The simplicity of building the user interface allowed us to discuss functionality details early in the project development and provide the customer with the solution he asked for.

It also proved to be suitable for the development of large applications. The EcoMonitor Remote has 39 VIs (1.71MB of code) plus 36 from the vi.lib, using 13895 wires and 101+85 controls/indicators. The Server has 185 VIs (19.4 MB of code) plus 28 from the vi.lib, using 66669 wires and 677+348 controls/indicators and has 28 front panels. These metrics were obtained with the Professional Developers Toolkit.

After the final setup, a team from Portucel attended a one-week course about the general system operation, the administration procedures and also the LabVIEW Basics. This way, the customer has full capabilities to manage and even to add new functionality to the system.

This system can easily be expanded to monitor more signals and more sources. The remote units can be placed far away from the server and communicate through modems, RS-485, or other standards, with no significant changes to software, because all the communications are based on the Windows network standard.

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