VIRTUAL INSTRUMENTATION

João Paiva dos Santos

joao.santos@ipbeja.pt

Lab SPEPSI

Instituto Politécnico de Beja

Beja, 15th May, 2014

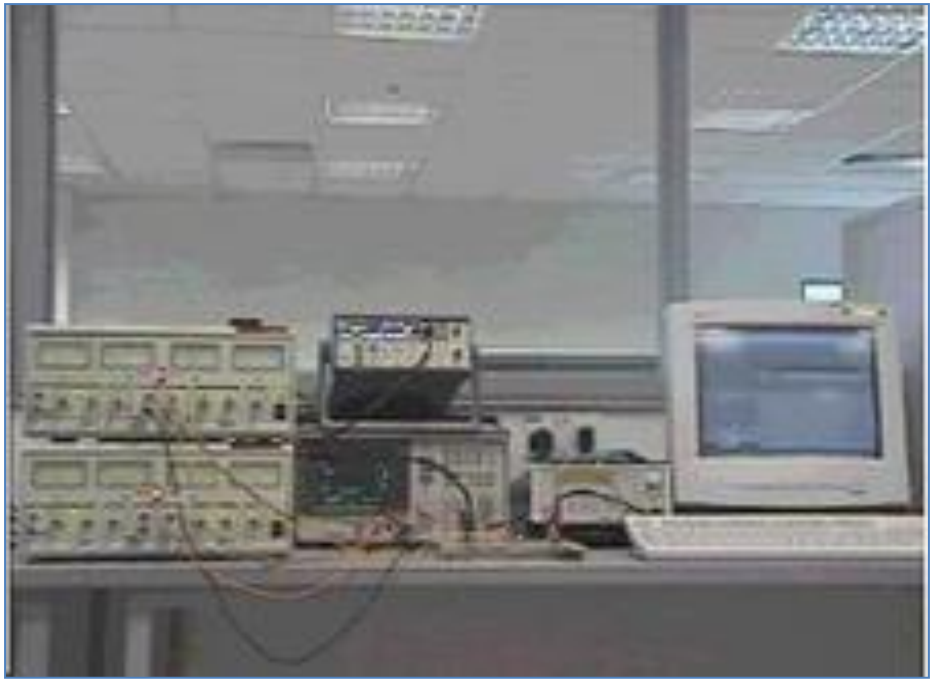
Overview

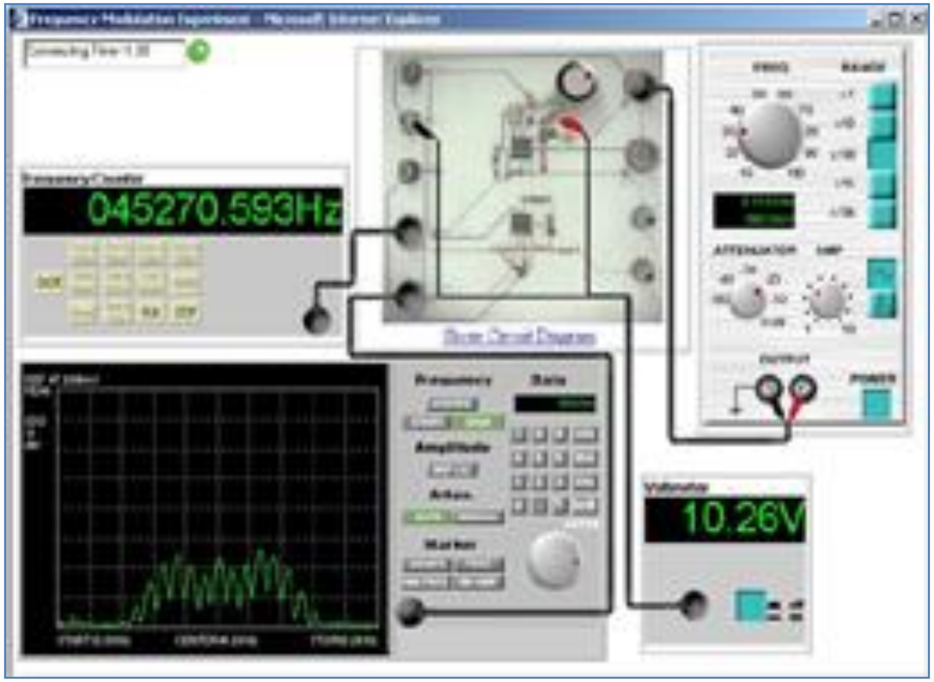
- What and why
- Hardware
- Software
- Some standards
- Remote use
- Example

Virtual Instrumentation: What?

- Computer software with connected measurement hardware used to create user-defined measurement systems.
- The measurement system is controlled by instrument like panels on a computer screen.
- The measurement data is digitized and available for further processing and visualization.

Virtual Instrumentation: What?





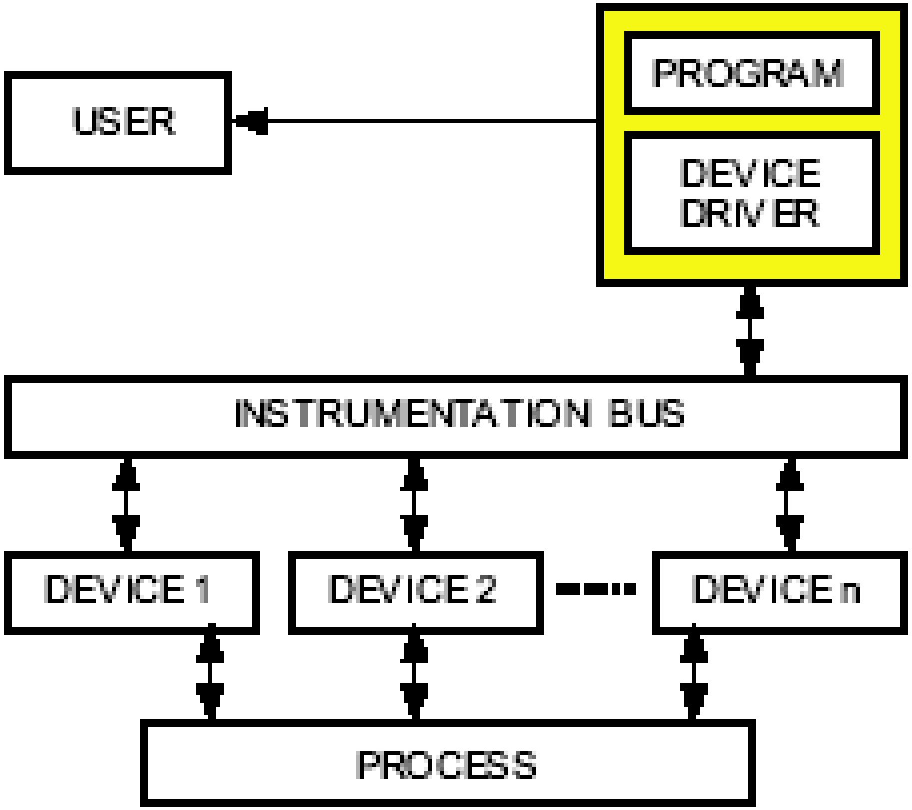
Virtual Instrumentation: What?

- Computer and Display
- Software
    - Driver level software
    - Register Level Software
    - High-level tool software
- Interconnection Buses
- Instrument Hardware

Virtual Instrumentation: What?

Early Virtual Instrumentation

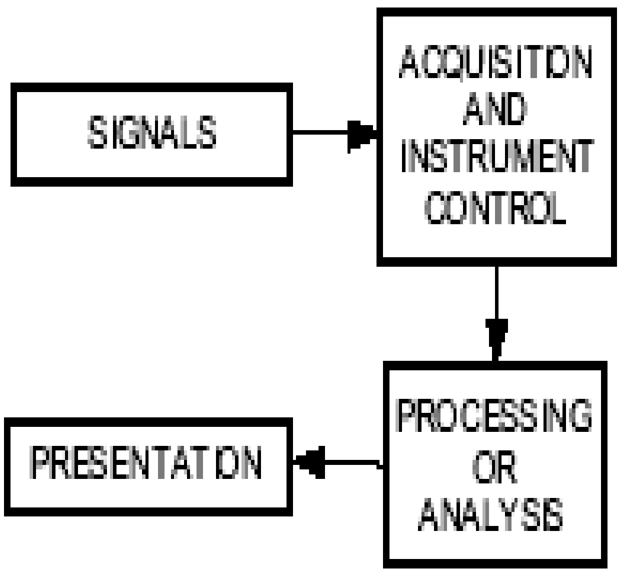
Conceptual model

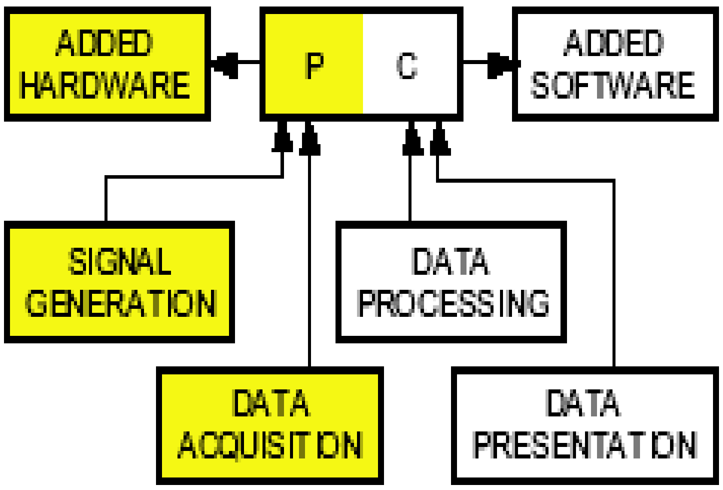


Virtual Instrumentation: What?

Virtual Instrumentation

General Model

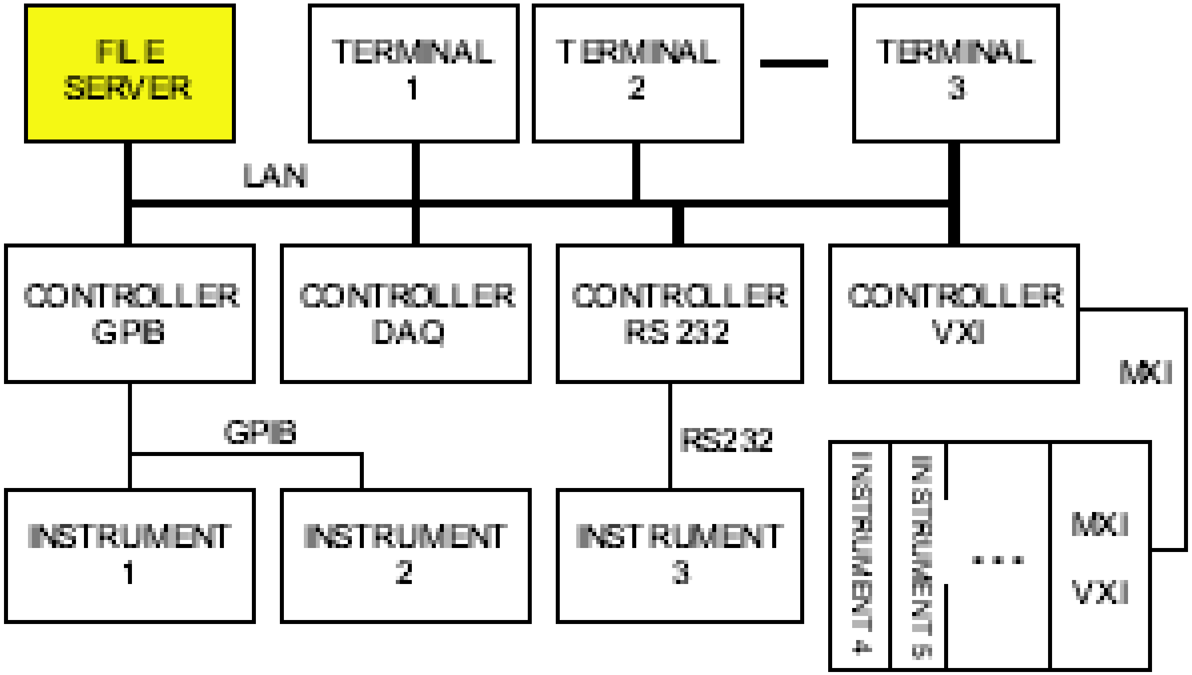




Virtual Instrumentation: What?

Virtual Instrumentation

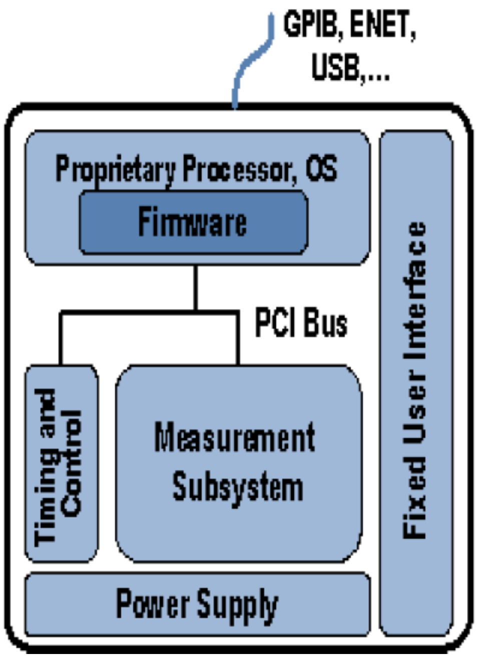
Distributed Measurement Systems

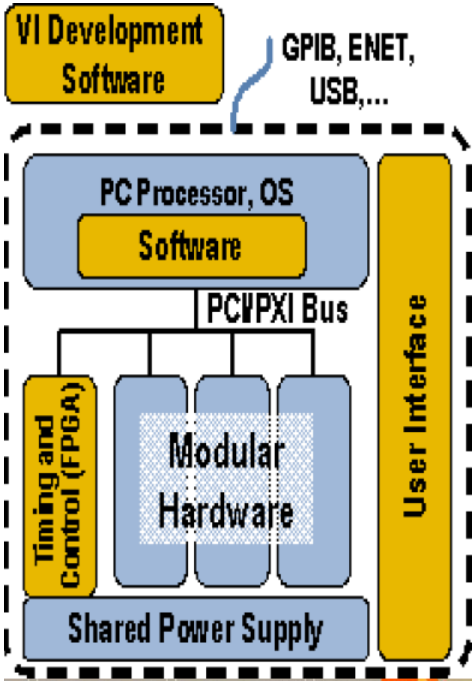


Virtual Instrumentation: What?

Traditional and Virtual Instrumentation:

- a similar architecture
- very different philosophies





Virtual Instrumentation: Why?

Automation of the measurement process:

- more reliable and cheaper

Lower costs of overall system:

- implementation
- reuse
- expansion

Virtual Instrumentation: Why?

- Portability between various computer platforms
- Easy-to-use graphical user interface
- Graphical representation of program structures
- Connectivity (TCP/IP, …)

Virtual Instrumentation: Why?

Remote based measurements:

In research/industrial environment:

- operators do not need to be continuously in the laboratory to control their tasks
- this might be crucial in hazardous environments

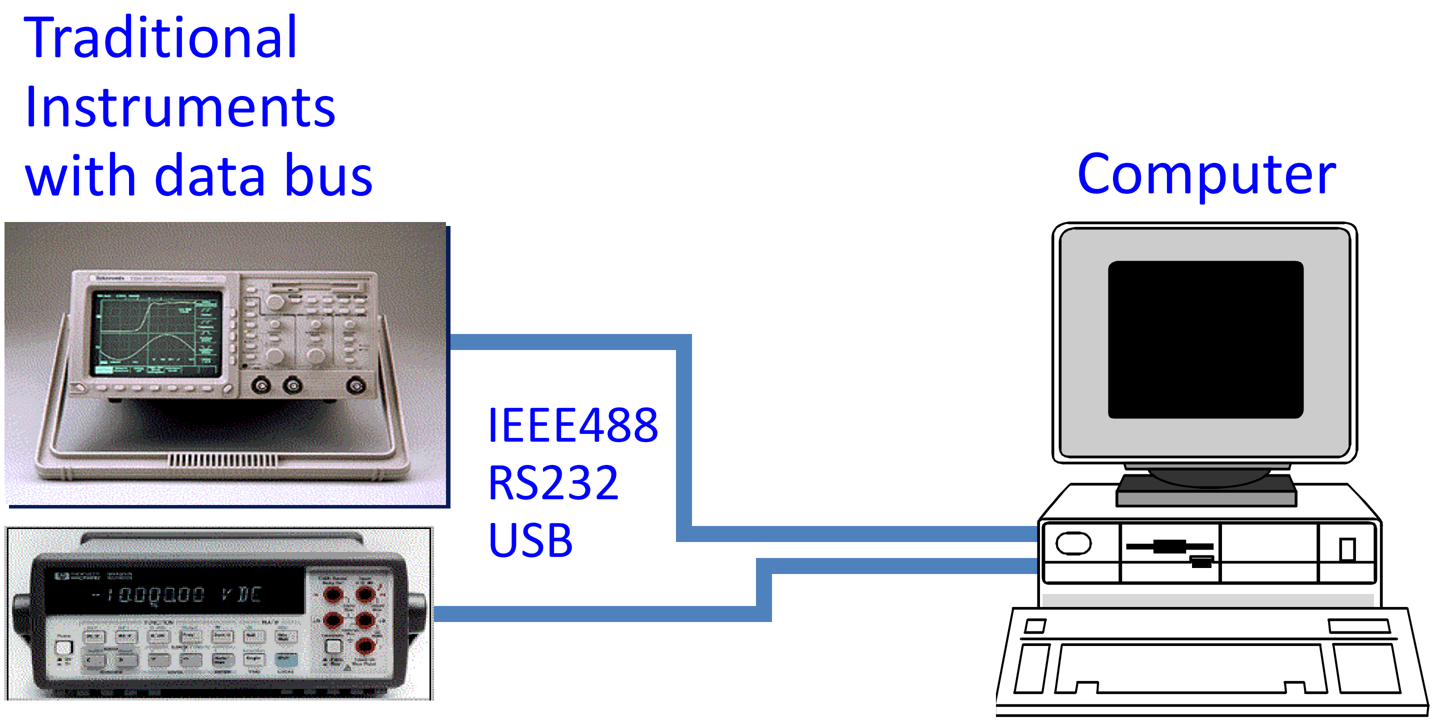
Virtual Instrumentation: Why?

Remote based measurements:

In teaching environment:

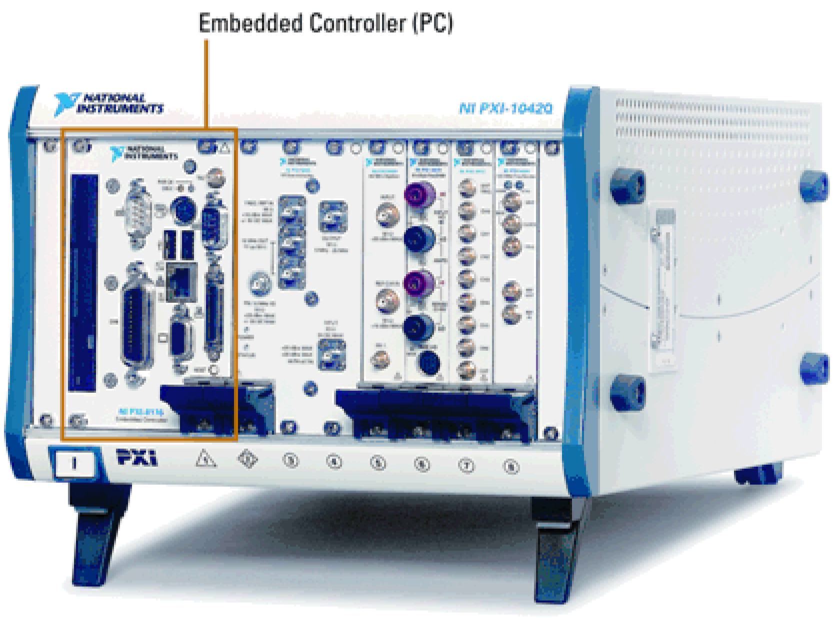
- the same equipment, sometimes scarce, may be shared by a greater number of students
- students may access the equipment with less restrictions in time

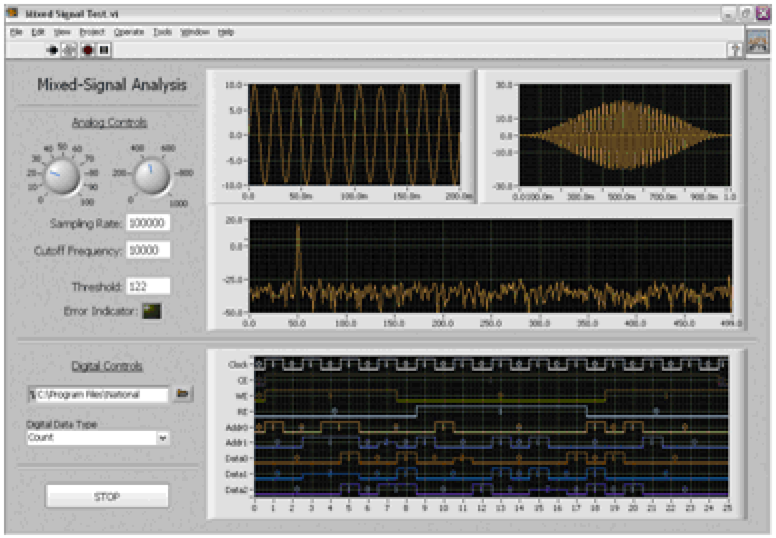
Virtual Instrumentation: Hardware



Virtual Instrumentation: Hardware

Modular Instruments

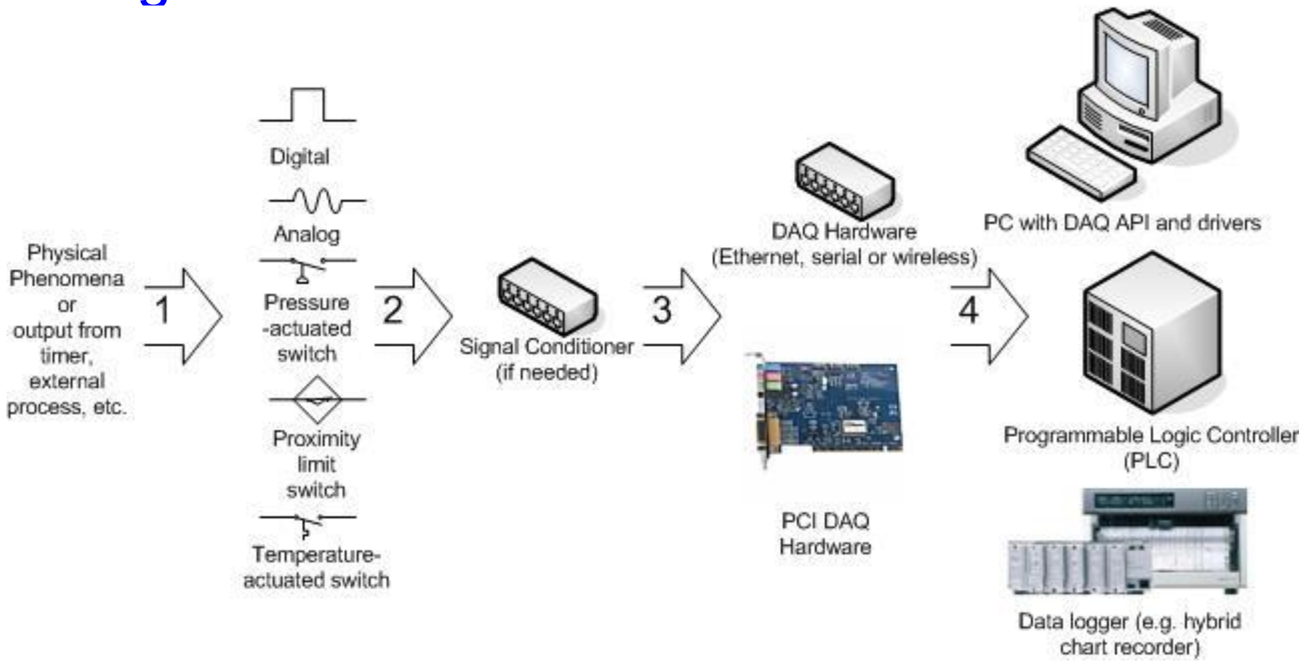




Virtual Instrumentation: Hardware

Data Acquisition (DAQ) system

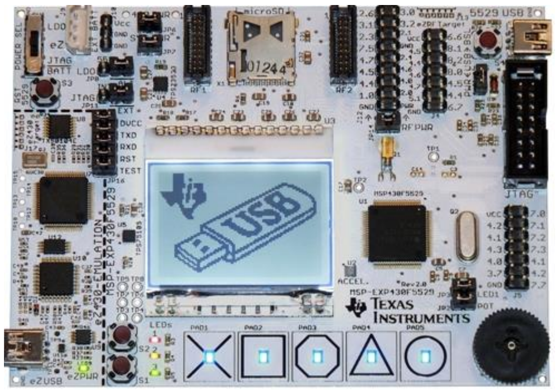
- Transducers
- Signal Conditioning
- DAQ device
- Driver
- Software

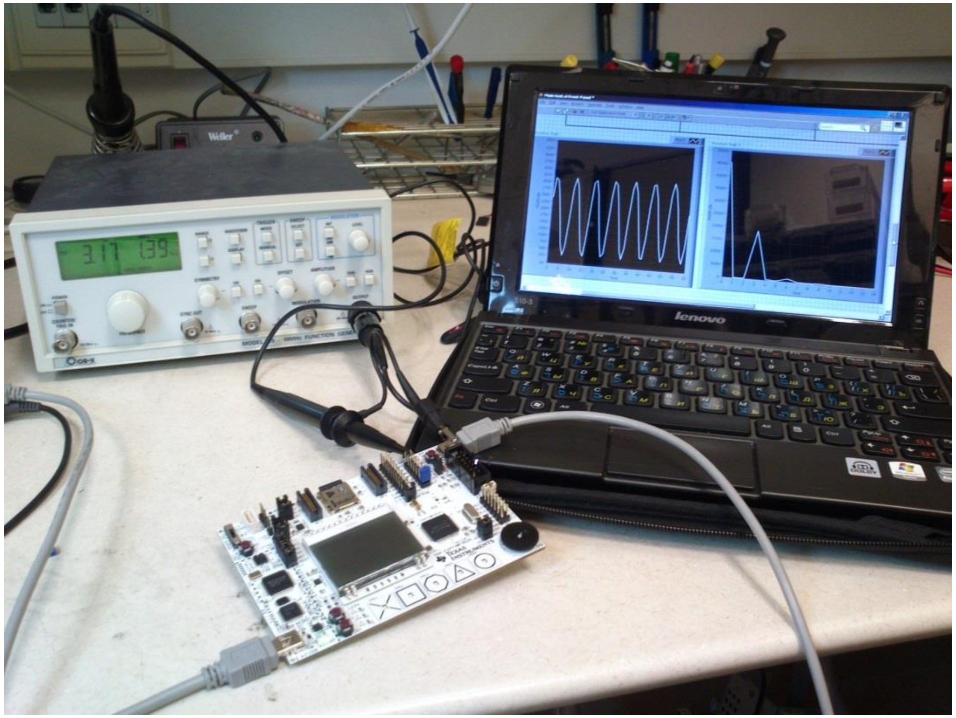


Virtual Instrumentation: Hardware

Low cost Embedded Systems

MSP430F5529 USB





Virtual Instrumentation: Software

Commercial off-the-shelf software:

- National Instruments: LabVIEW, LabWindows/CVI, NIDAQ,…
- Mathworks: MATLAB/Simulink
- Agilent: VEE,…

Virtual Instrumentation: Software

Other options?

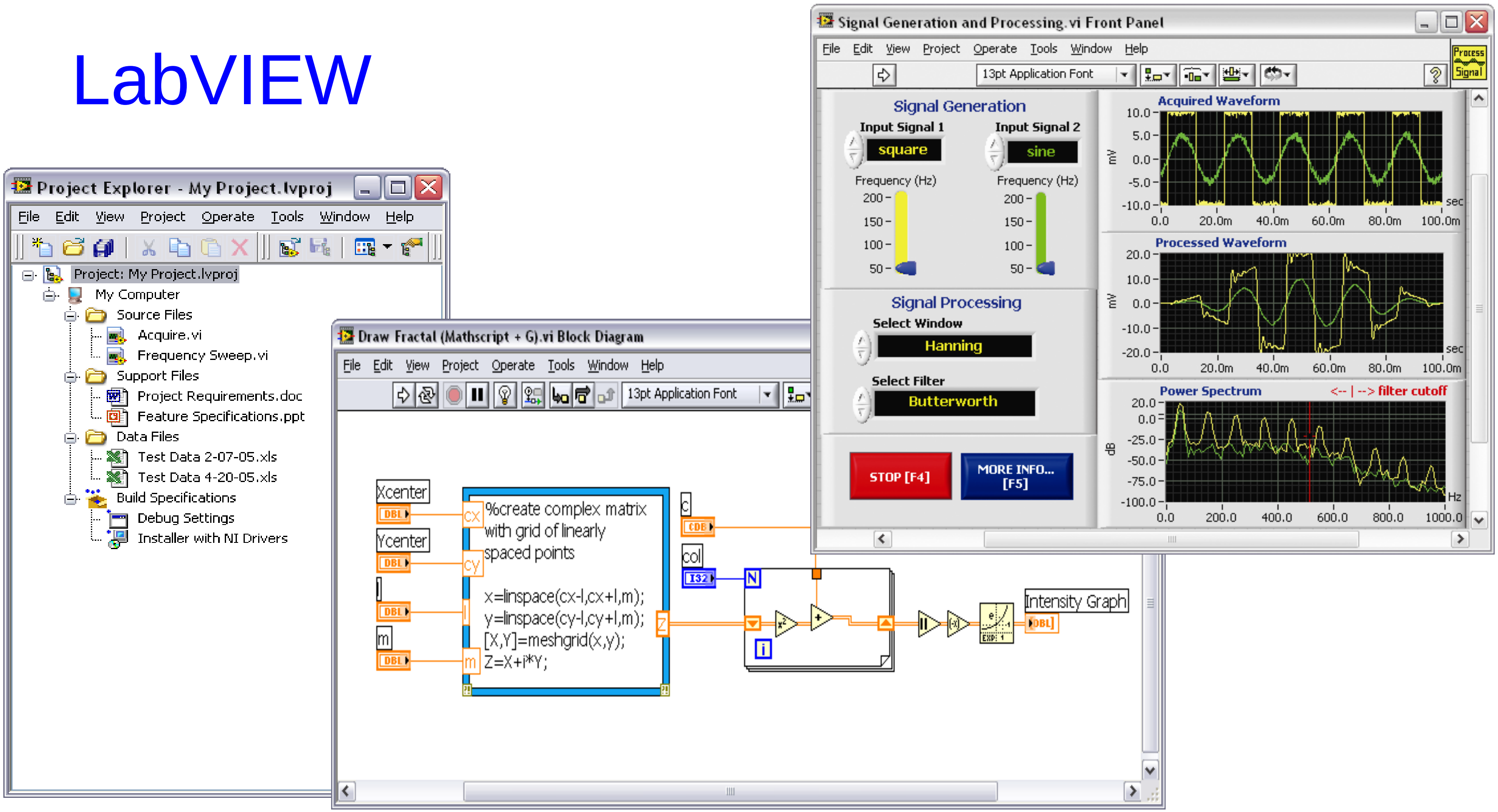
- Standard programming languages
- Specific libraries
- Commercial IDEs: MS Visual Studio,…
- Free/Open Source IDEs: DevC++,…

but

Scarce general use tools…

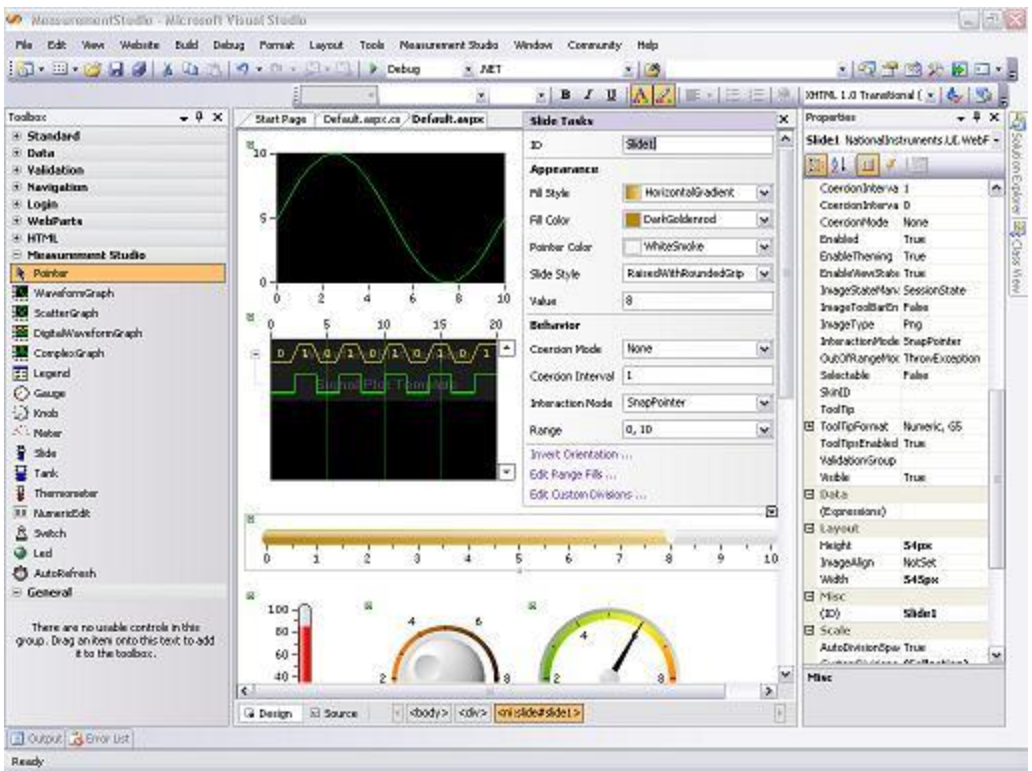
Virtual Instrumentation: Software

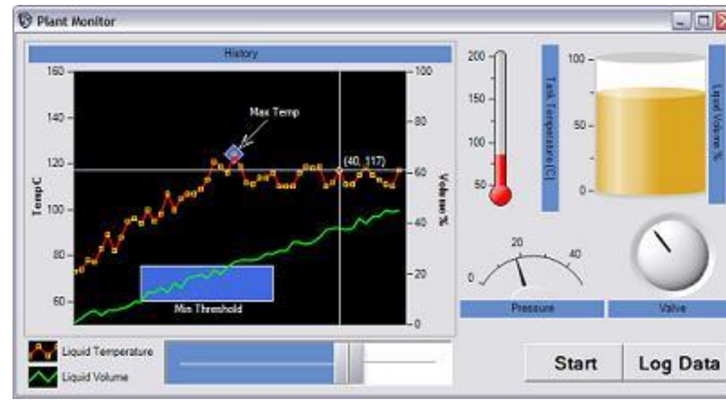
LabVIEW

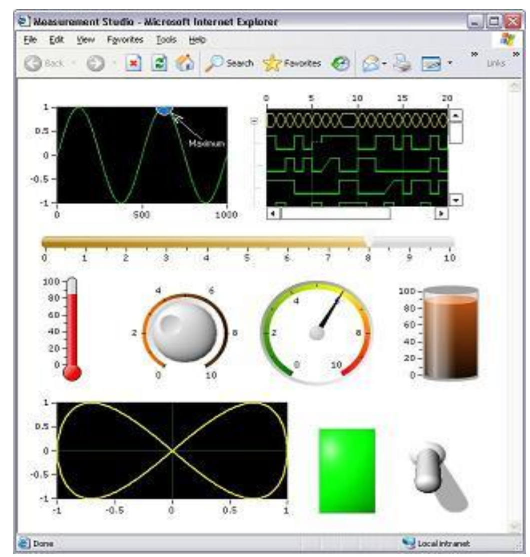


Virtual Instrumentation: Software

Measurement Studio



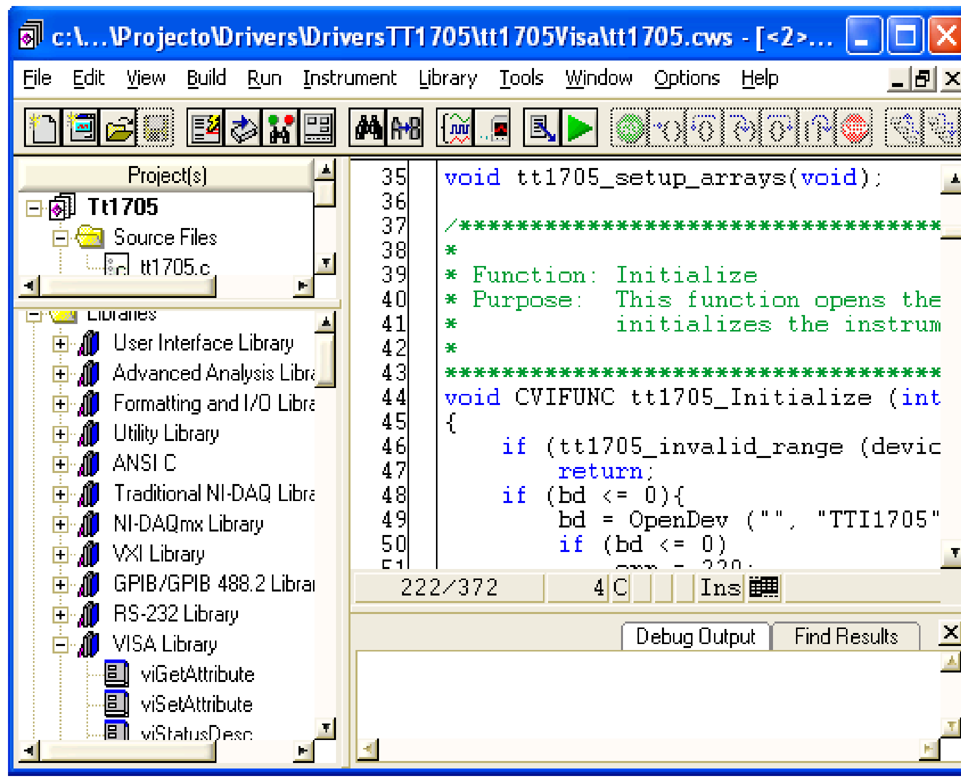




Virtual Instrumentation: Software

LabWindows/CVI

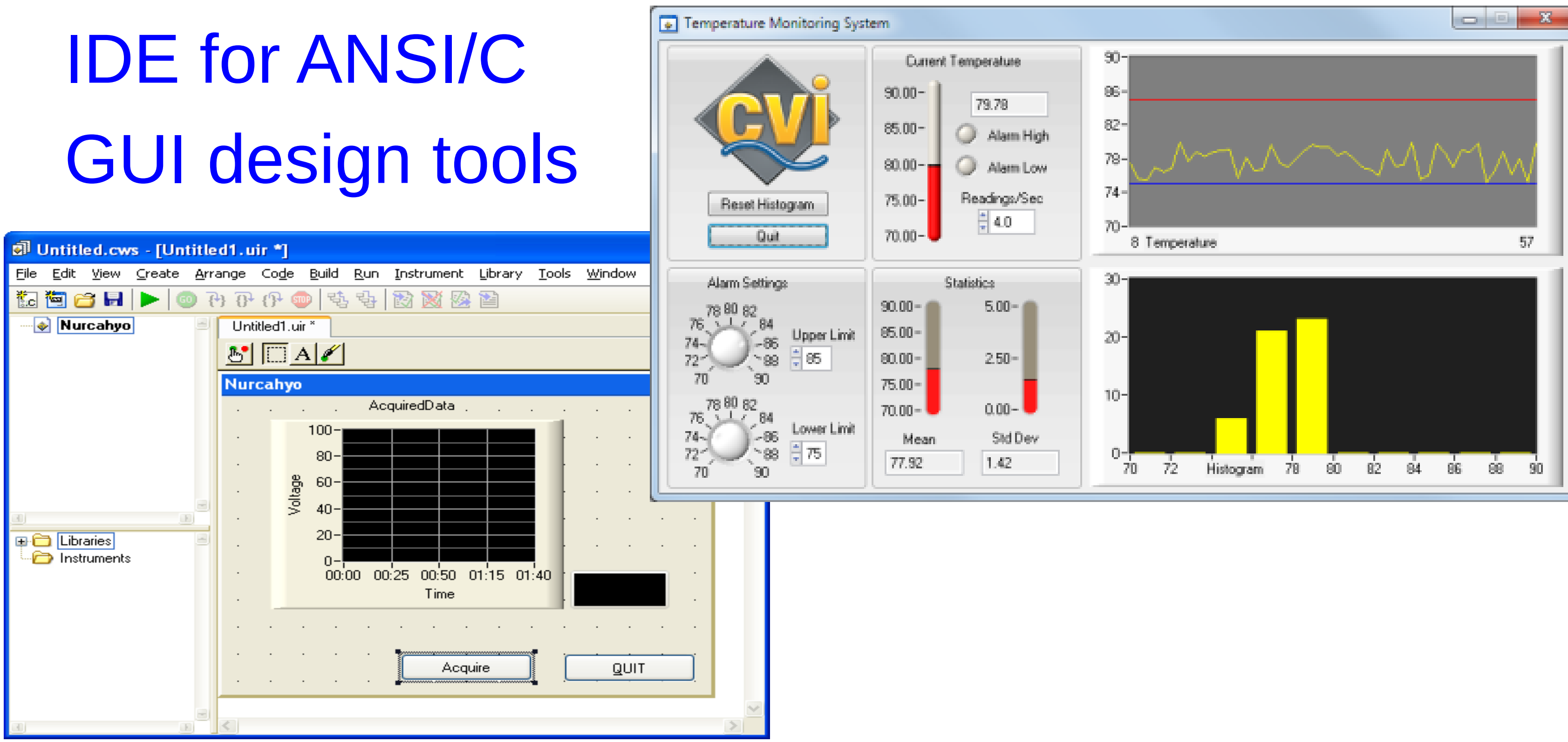
- IDE for ANSI/C
- Libraries:
  - Standard
    - GPIB
    - RS232
  - Comunicação TCP/IP
  - VISA
  - …



Virtual Instrumentation: Software

LabWindows/CVI

- IDE for ANSI/C
- GUI design tools



Virtual Instrumentation: Software Standards

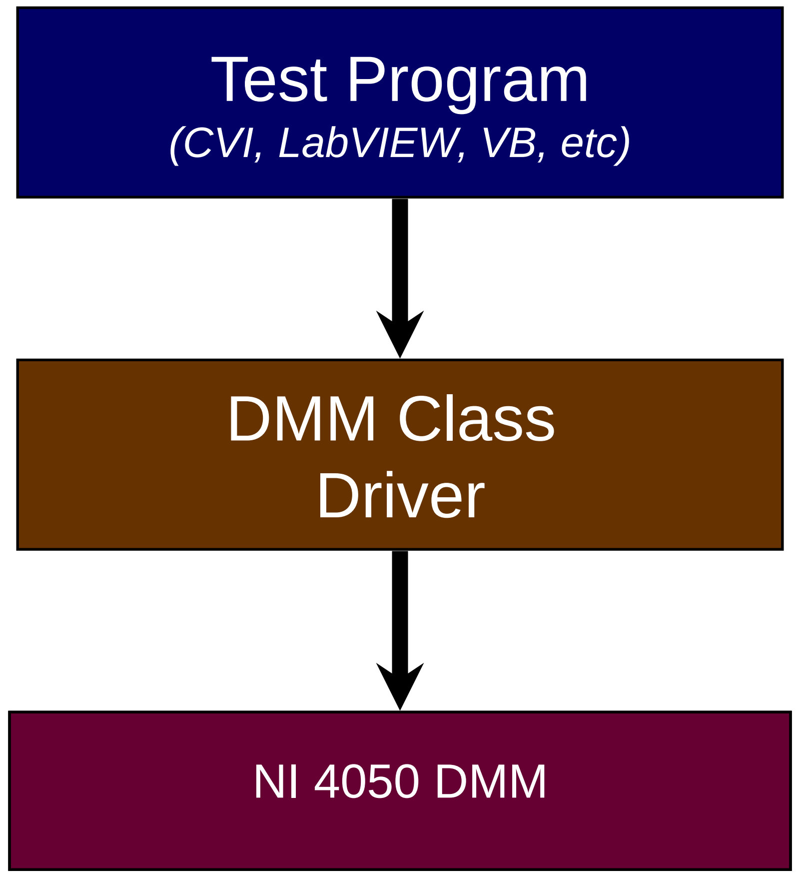
Some software standards:

- VISA: Virtual Instrument Software Architecture
- VXI plug&play
- SCPI: Standard Commands for Programmable Instruments
- IVI: Interchangeable Virtual Instrumentation

Virtual Instrumentation: Software Standards

Hardware-Independent Test Systems

- Swap instruments under generic class drivers
  - No source code change
- Five classes defined
  - scope
  - dmm
  - arbitrary wfm generator
  - switch
  - power supply



Virtual Instrumentation: Remote Use

Standard approaches…

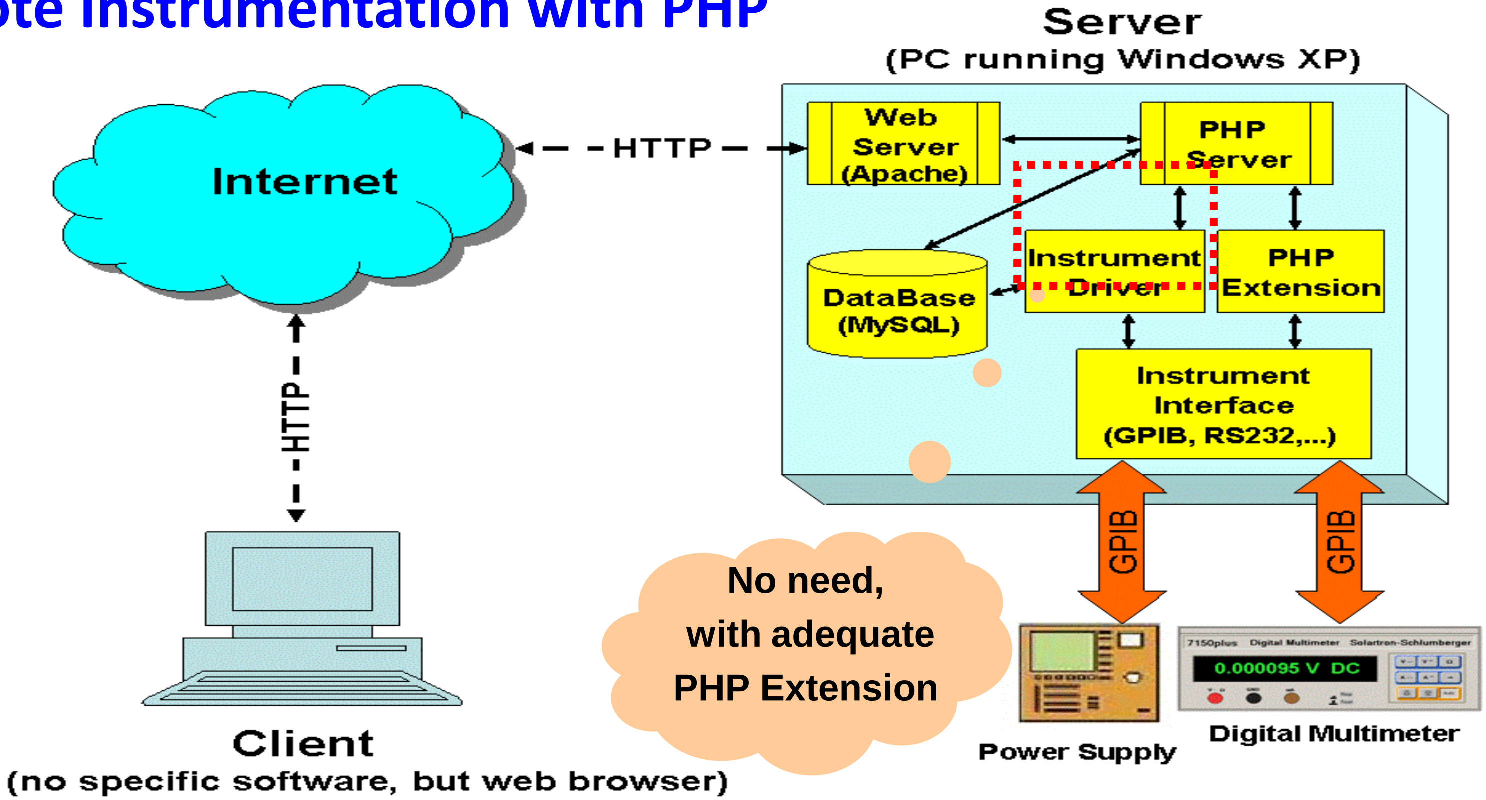
- VXI-11 protocol + VISA API:

  Labview, LabWindows/CVI, VEE, Generic IDEs
- LabVIEW technology with embedded Internet functions
- Java applets
- TCP/IP socket connection

Virtual Instrumentation: Remote Use

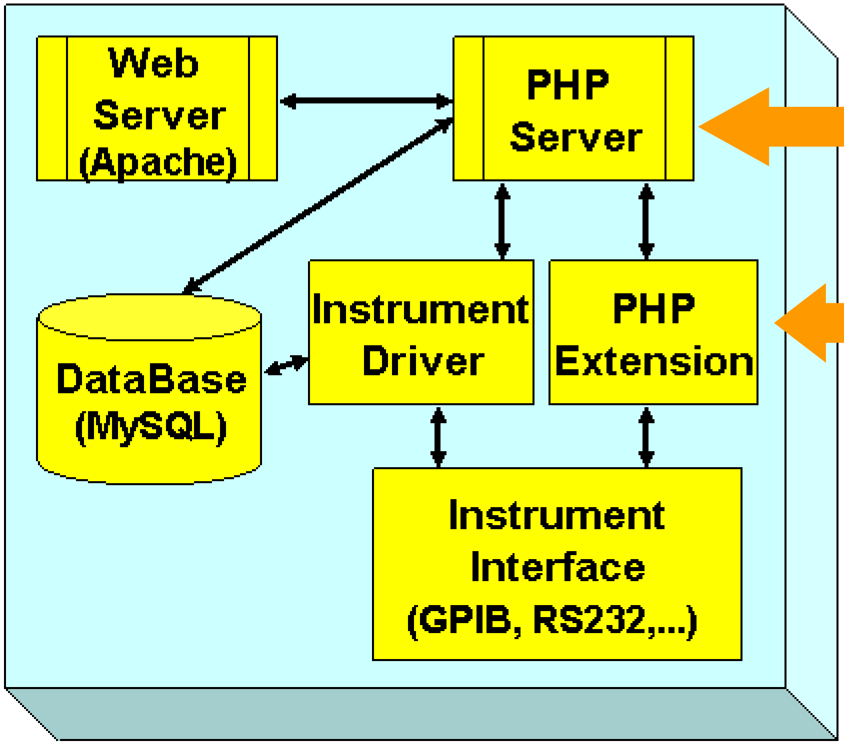
A different approach:

Remote Instrumentation with PHP



Virtual Instrumentation: Remote Use

Server



PHP tools for Virtual Instruments

PHP Classes for Virtual Instruments

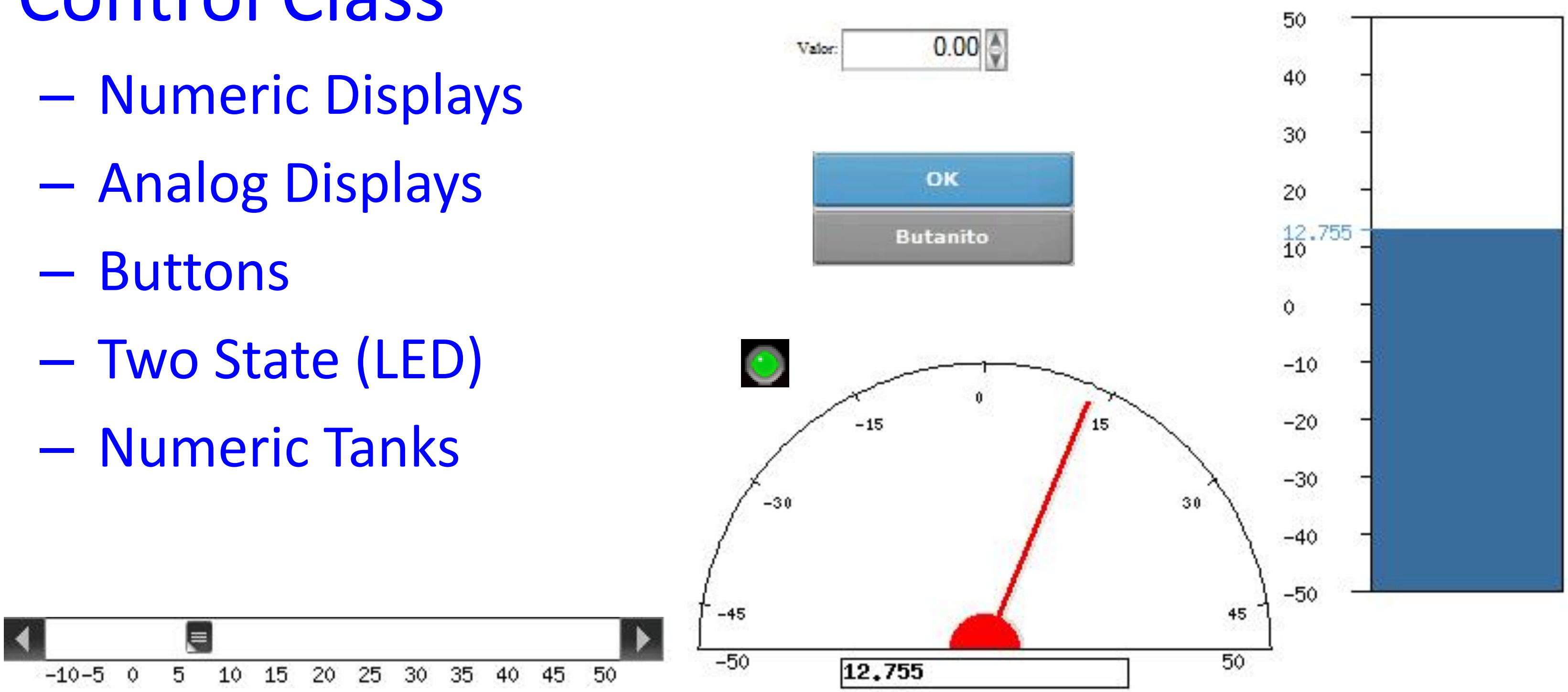
PHP Extensions for interface control

GPIB/IEEE488

Virtual Instrumentation: Remote Use

PHP tools for Virtual Instruments

- Control Class
  - Numeric Displays
  - Analog Displays
  - Buttons
  - Two State (LED)
  - Numeric Tanks



PHP tools for Virtual Instruments

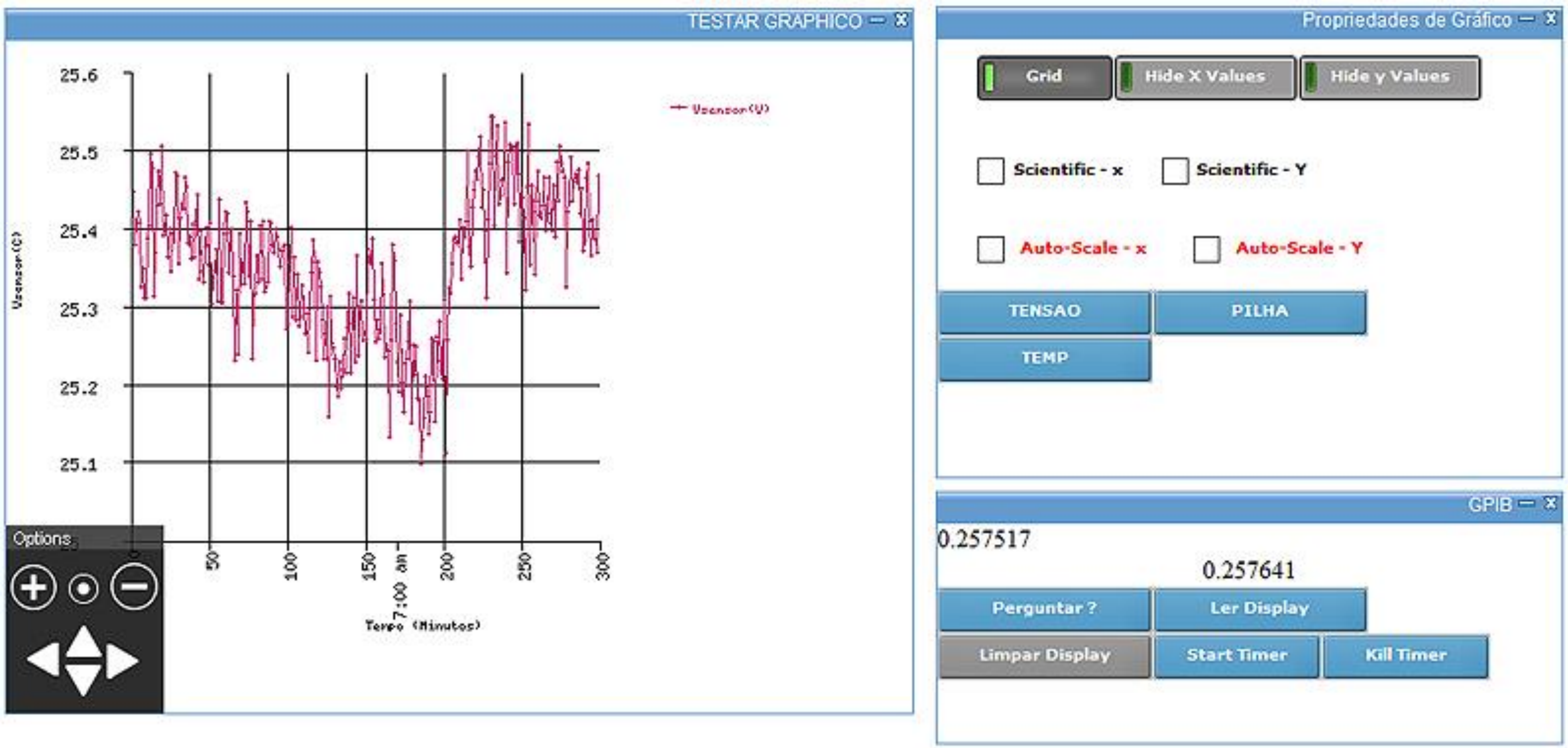
Example:

A digital multimeter (HP 3478A) to be used as an AC Voltmeter and makes a measurement:

```
<? PHP
/* The HP 3478A DMM does not comply with IEEE 488.2 specific commands. To
   configure this device, one needs to use its specific commands. The first
   value in the function call is the device handle, obtained in the call of ibdev.
   The second value, “F2”, is the command to the device, which in this case
   changes the measurement mode to AC VOLT. The last value is the size of the
   string carrying the command, 2 bytes, in this case. */
ibwrt($dmm , “F2”, 2);
/* The measurement value is stored in the buffer $result. 100 specifies the
   maximum number of bytes to read.*/
ibrd( $dmm, , 100);
?>
```

Virtual Instrumentation: Remote Use

PHP tools for Virtual Instruments



Virtual Instrumentation: Remote Use

Remote Laboratory Architecture with PHP

- Proved to be simple and robust
- On the server side it may use only non comercial software
- On the client side it does not require any special software, but a ubiquitous web browser

Virtual Instrumentation: Remote Use

Remote Laboratory Architecture with PHP

- As the needs for processing power are mainly on the server side, there's a negligible load in client machines
- The tools developed allow the creation of Web applications for instrument control in a simple and fast way
- New classes and interface drivers to be developed

Virtual Instrumentation:

Thank you for your time!