

Architecture Client-Serveur Ouverte  
pour Travaux Pratiques Distants  
24h/24-7j/7 en Electronique  
**Open Architecture for Remote  
Labworks in Electronics**

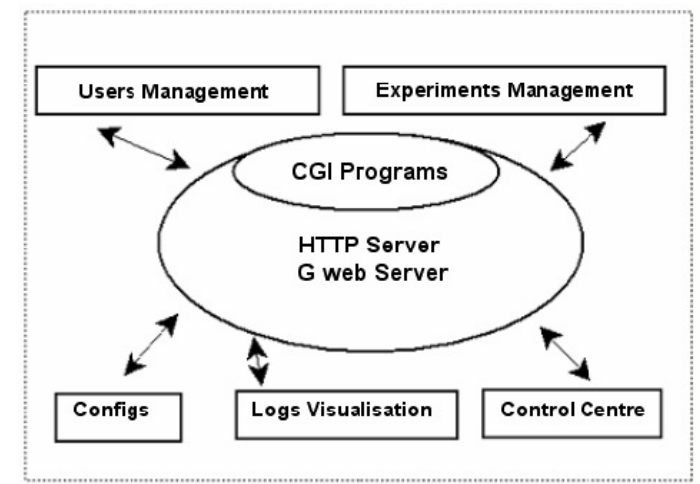
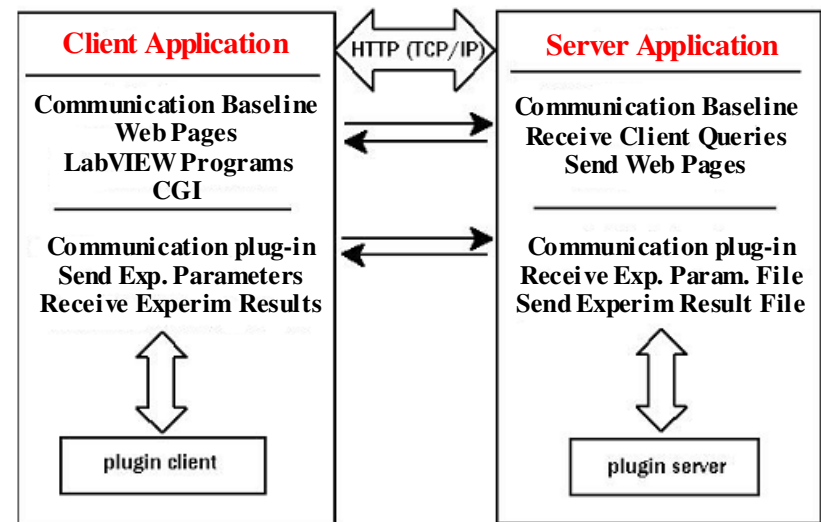
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# Context: Remote Lab Work

- Electronics, automation, signal processing labs:
  - technical & engineering students
  - undergraduate level
- Distant practical learning
  - via Internet TCP/IP
- Real-world experiments and instrumentation:
  - not only simulations and virtual instrumentation
  - physical devices & instruments (analog/digital)
  - PC remote control / monitoring of distant systems

# Client-Server Architecture

- Global architecture
  - software & hardware
  - **open, extensible** (plug-ins)
- HTTP Server:
  - G Web Server, CGI scripts
  - Internet Developer Toolkit
- Client through internet:
  - student at home (with cdrom)
  - upload params & configs
  - run expe., real-time visu of curves
  - download of results & measures, interpretation



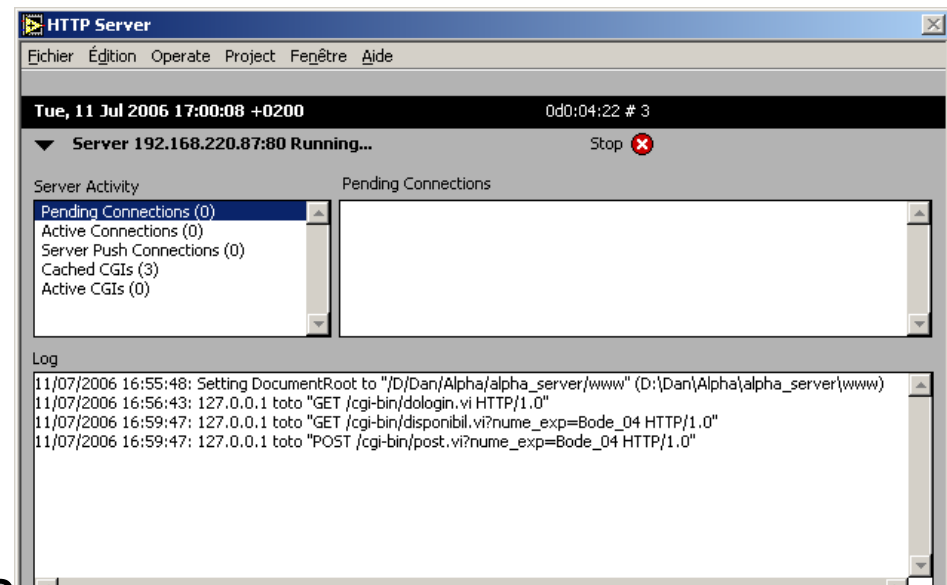
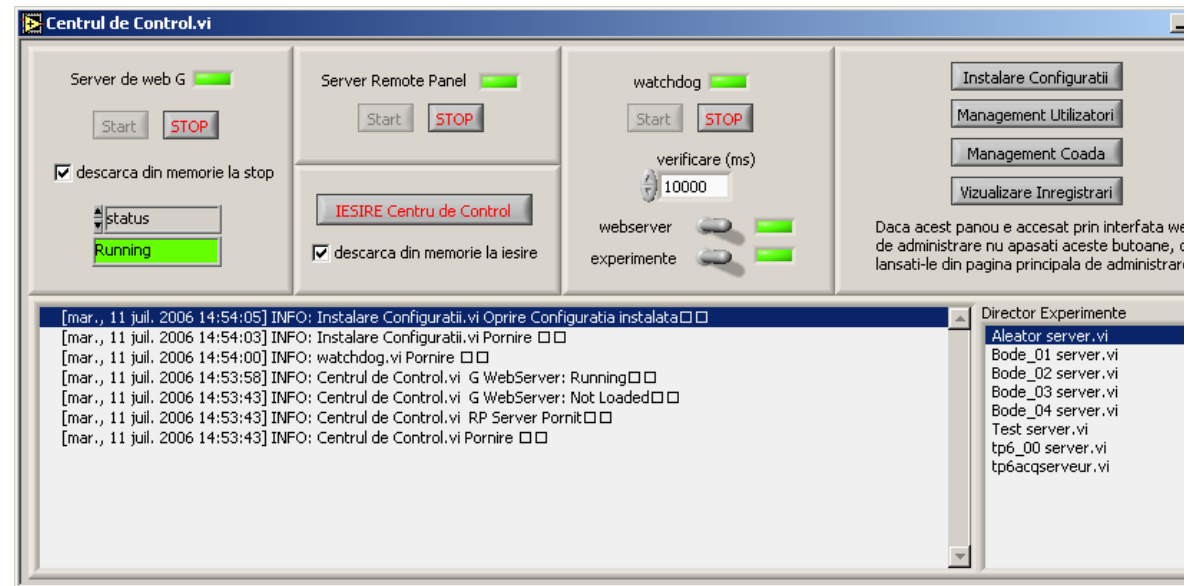
# Control Center

## ■ On server side:

- start web server
- start remote panel
- start watchdog
- CGI scripts

## ■ Management:

- pluggable experiment list
- remote administration
- users login, passwd
- user access, connections
- client queries
- config. experiments
- visu logs, history, statistics

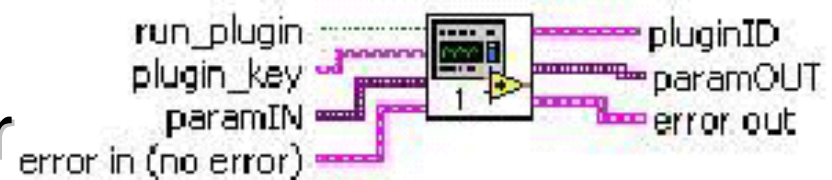


# Plug-ins

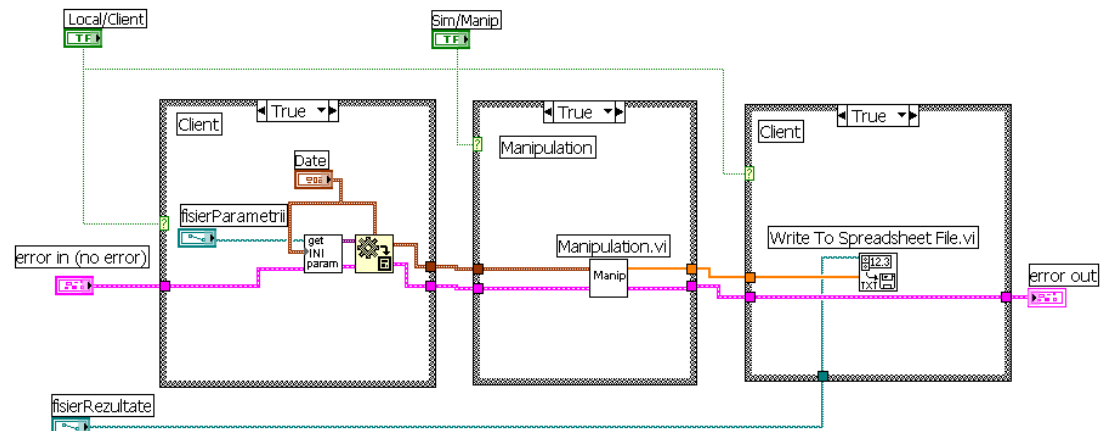
- 5 types of plug-ins:
  - **experiment**: one plug-in per experiment
  - **simulation** (math & physics models)
  - web pages, **demos**, other (reports, visu, quizz...)

- Server plugin:

- **template** available for tutor



- Working mode selection: **Local vs. Client** & **Expe. vs. Simul.**



# Prototype Implementation

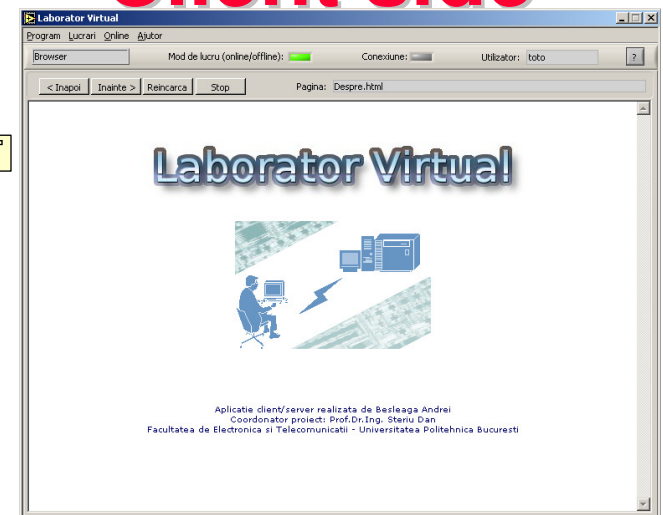
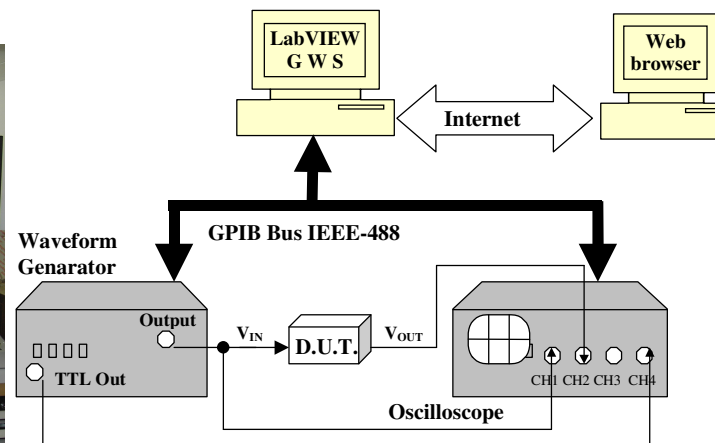
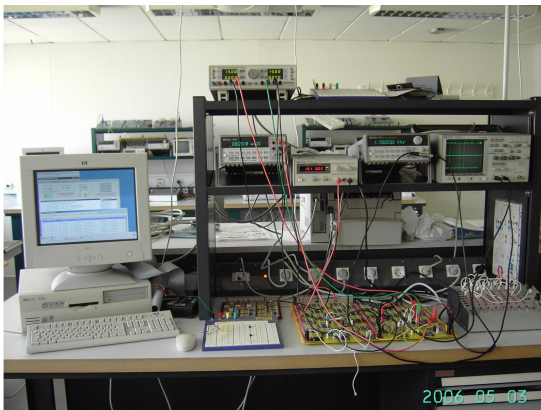
## ■ Server:

- PC Windows, **GPIB** bus (IEEE488), **LabVIEW**
- **measurement devices**: waveform generator, oscilloscope, programmable power supply, DAQ board, multimeter, switch-board (for power on/off)

## ■ Client : graphical interface = control panel

## ■ Server side

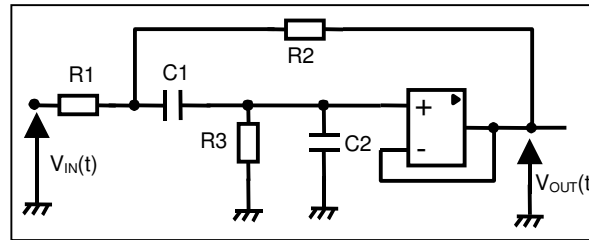
## Client side



# Student Application Example

## ■ Characterization of electronic circuits & systems:

- Use of real systems & measurement devices



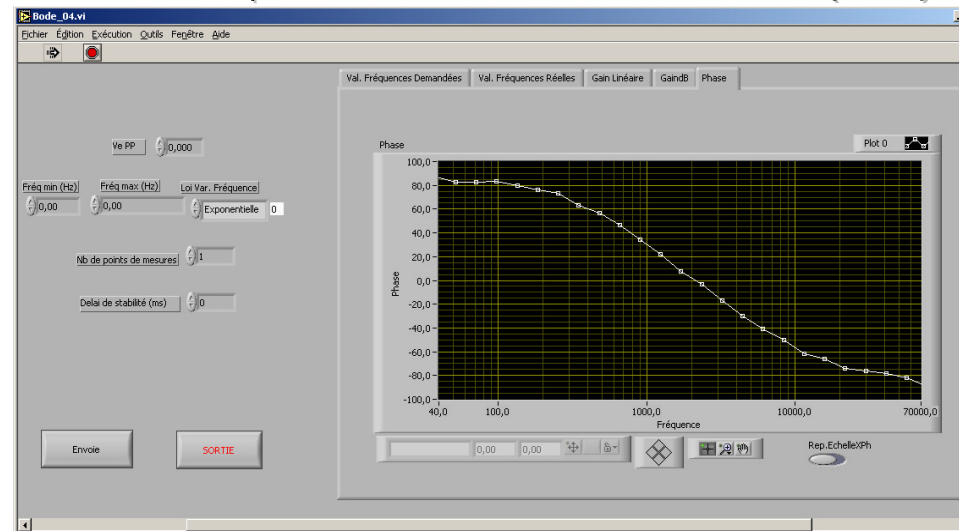
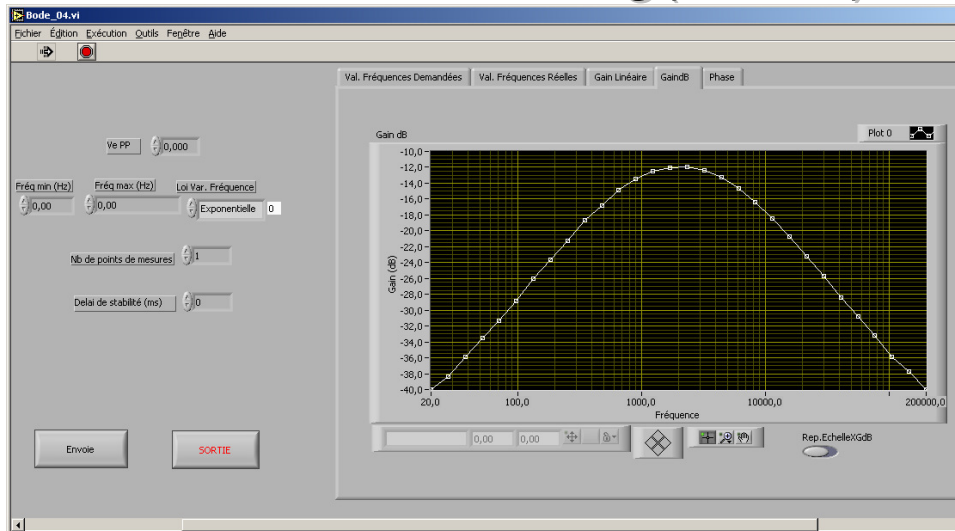
## ■ Typical experiment: Bode plots

- **Gain**  $G_{dB} = 20 \log(V_s/V_e)$  & **Phase**  $\Delta\phi = 2\pi f\Delta t$ : function of  $f$  (Hz)
  - frequently used for system characterization in electronic labs
  - precise measure of **time delay** with oscilloscope (BWL, averaging, gain limit, autoscale, noise...)
- ## ■ Student uploads experimental parameters, instrument settings and electrical connections

# Student Application

- **Download of results + graphical display**

- **Gain**  $G_{dB} = 20 \log(V_s/V_e)$  & **Phase**  $\Delta\phi = 2\pi f\Delta t$ : function of  $f$ (Hz)



- **Interpretation + send report (cf pedagogical data)**

- **Other experiments:**

- data acquisition + signal processing, image processing, automation, supervision of programmable devices and interfaces, electrical characteristics of circuits & systems, mechanical engineering...



# Advantages

- **Reduced cost** for education
  - expensive devices
- Pedagogical **resource sharing**
  - within / between universities
- **Availability : 7/7days 24/24 hours**
- **Fast prototyping, easy maintenance, extensible**
  - plug-in concept
- **Automated measurements**
  - speed-up, error free

# Outline

- **Keywords:** Distant Learning, Labwork, Technical Education, LabVIEW
- **Main Results:**
  - multi-user (30 simultaneous connections tested)
  - multi-experiment, multi-session,
  - entire learning process including **practical work**
- **Discussion:**
  - pedagogical limits of all virtual, all digital
  - pros & cons: Simu vs. Real ? (cf. university survey)
  - collaborative work (distant team-work)
  - evaluation process, learning objectives
  - online/off-line? (cf video, real-time)