

# OPEN ARCHITECTURE FOR SIGNAL PROCESSING LAB DISTANCE LEARNING

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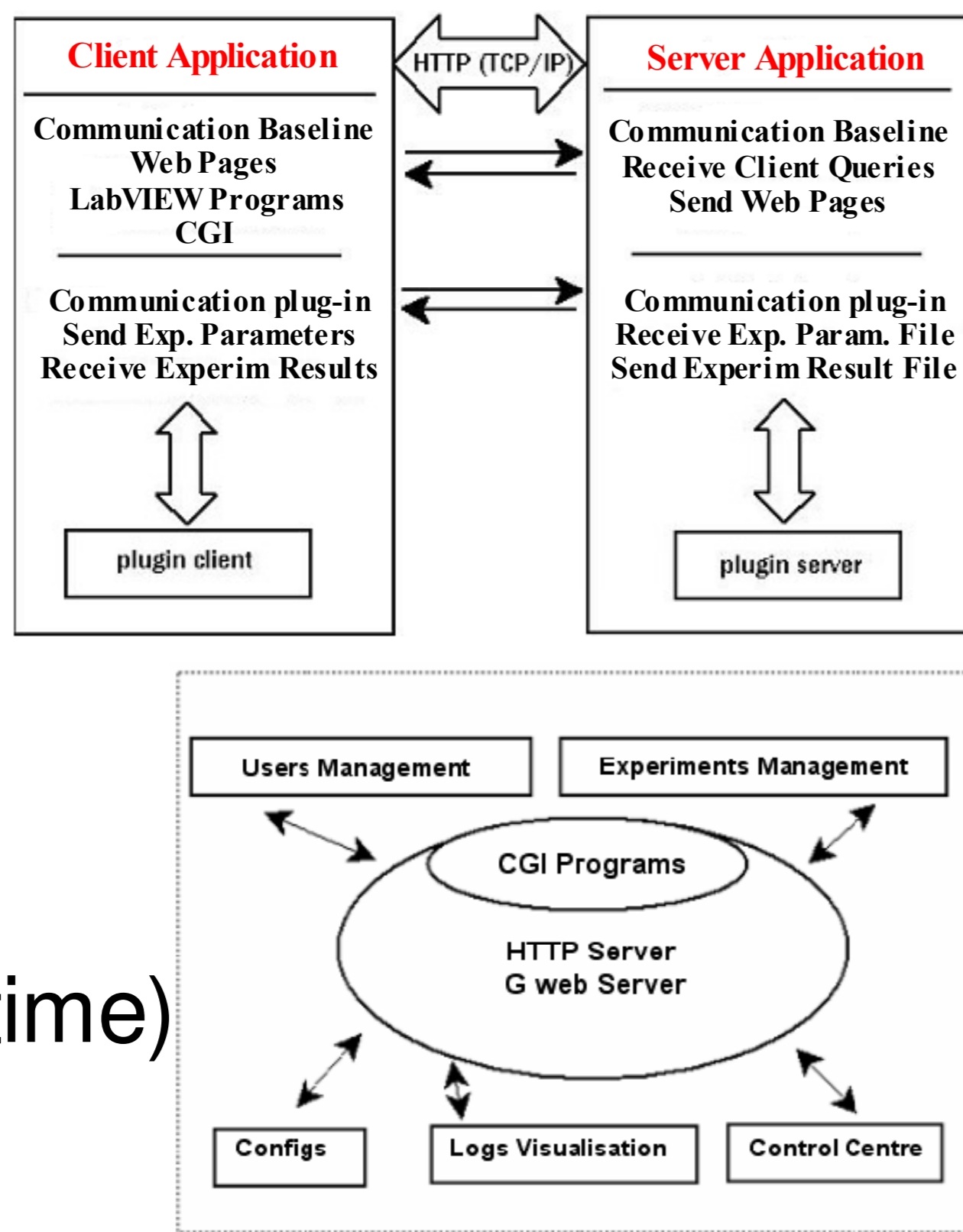
**KEYWORDS:** Distant Learning, Laboratory Work, Technical Education, Client-Server Architecture, Plug-in, Programmable Instrumentation, LabVIEW

## 1) Context: Remote Lab Work

- SP & electronics lab: engineering students
- 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
- Advantages:
  - **reduced cost** for education
  - pedagogical **resource sharing**
  - fast prototyping, easy maintenance, extensible
  - automated measurements, speed-up, error free

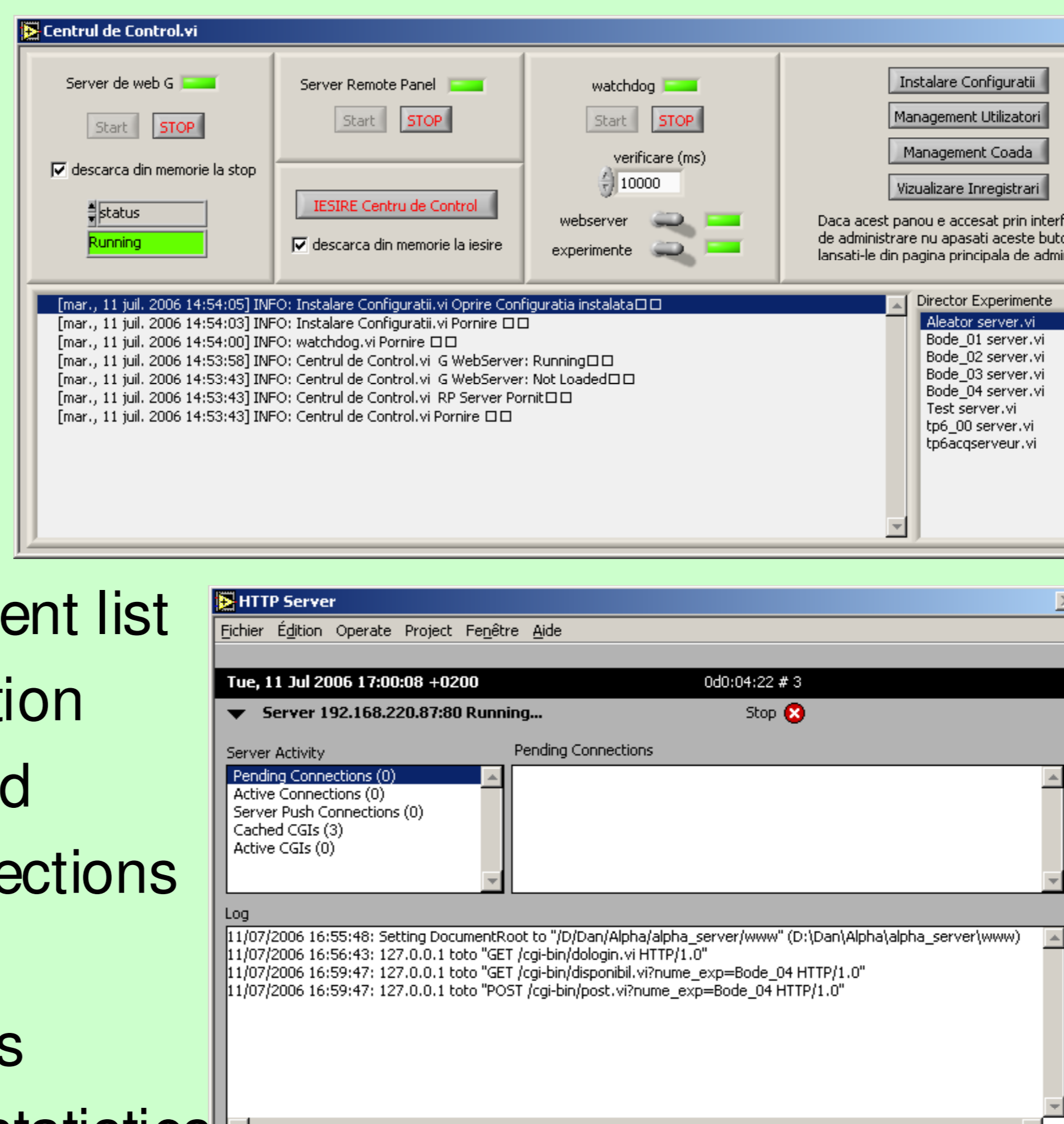
## 2) Client-Server Architecture

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



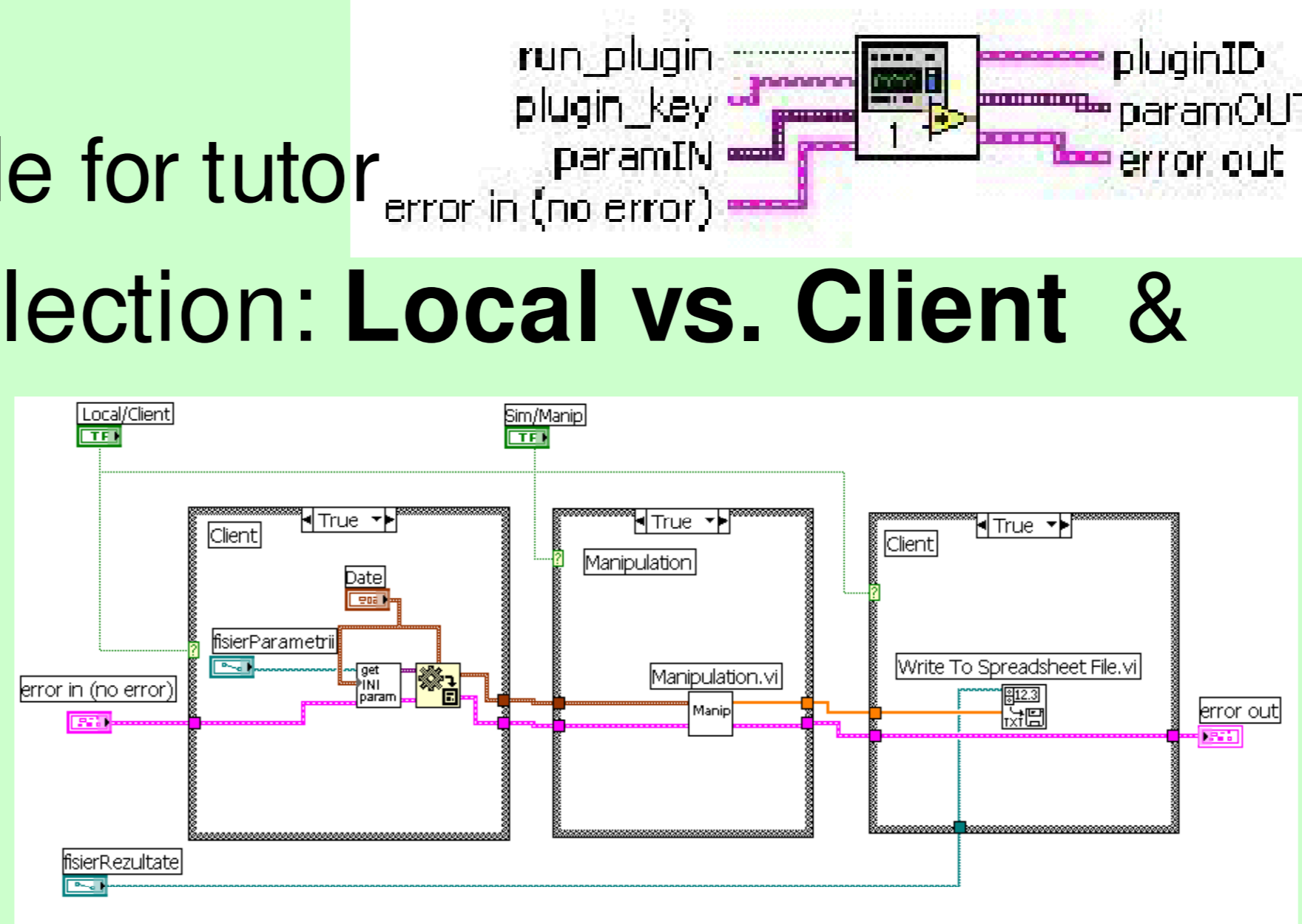
## 3) Control Center

- 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



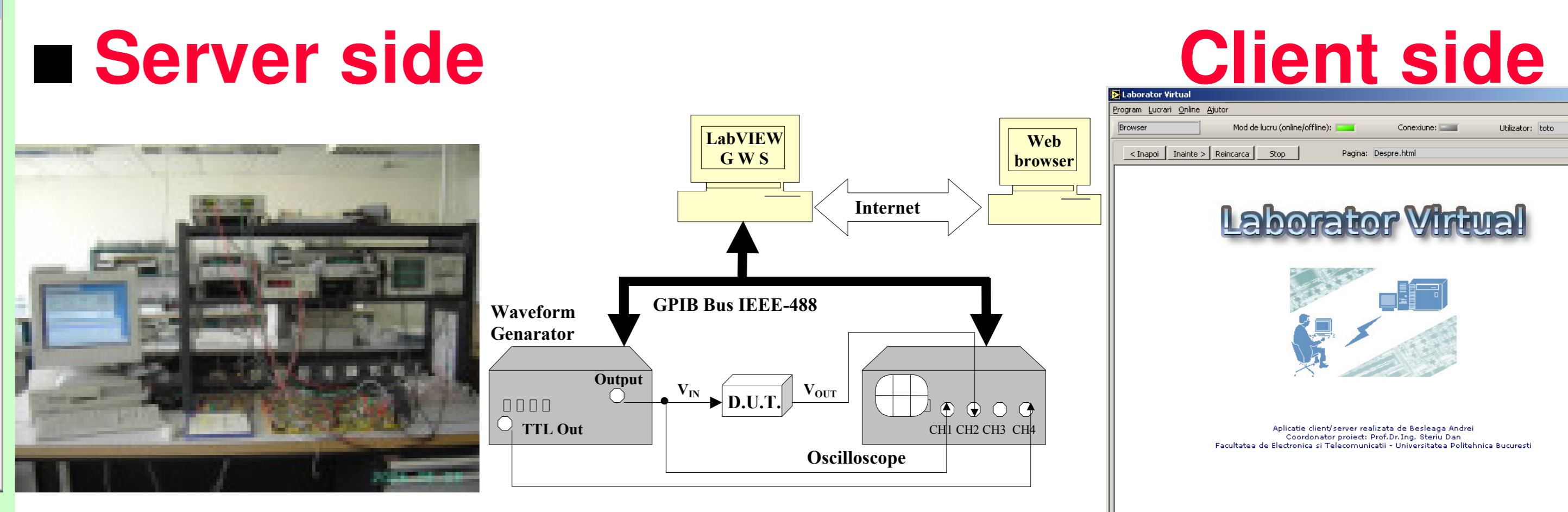
## 4) Plug-ins

- 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.**



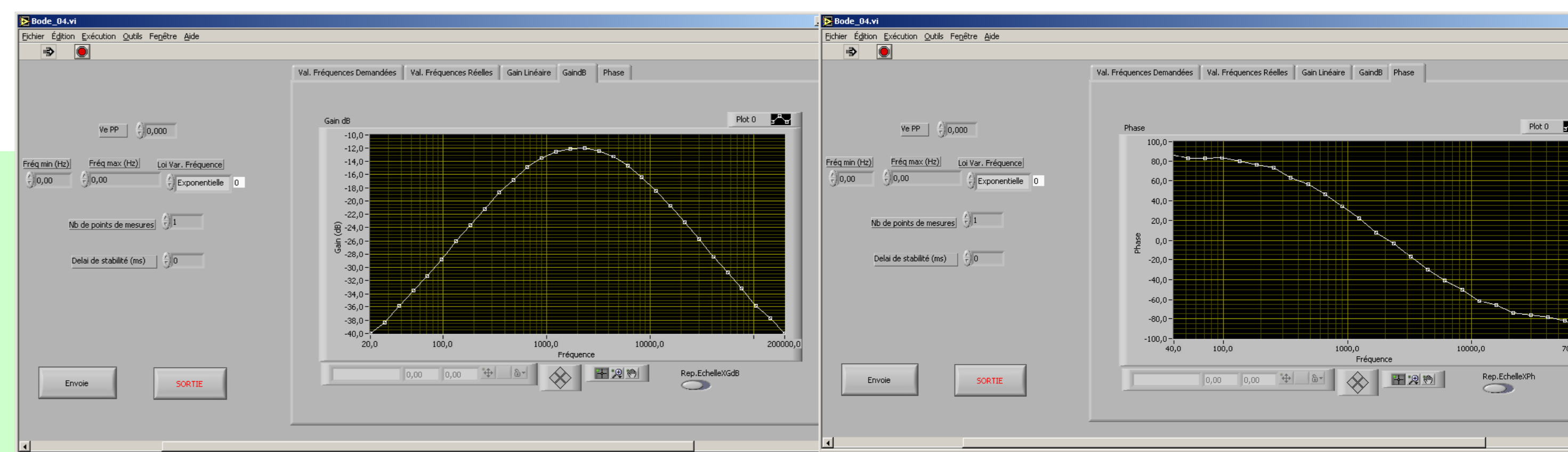
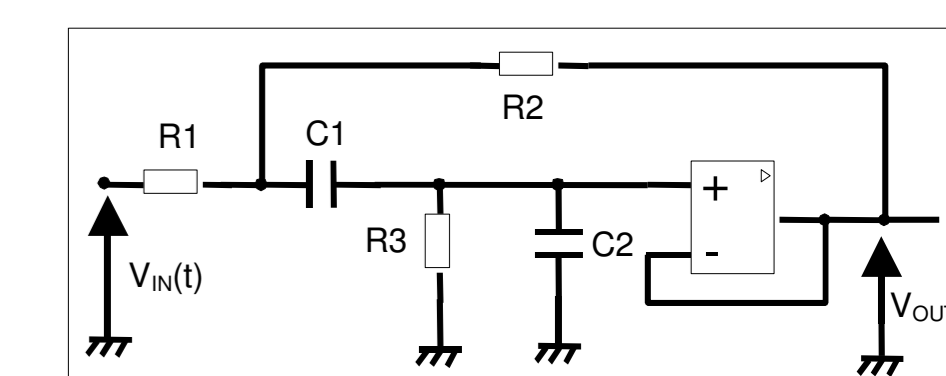
## 5) Prototype Implementation

- Server:
  - PC Windows, **GPIO 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



## 6) Student Application

- Typical experiment: **Bode plots**
  - frequently used for system characterization in electronic labs
  - precise measure of **time delay** with oscilloscope (BWL, averaging, gain limit, autoscale, noise...)
  - **Gain**  $G_dB=20\log(V_s/V_e)$  & **Phase**  $\Delta\phi=2\pi f\Delta t$ : function of  $f$ (Hz)



- More: data acquisition + SP, image processing, automation, supervision of programmable devices and interfaces, electrical characteristics of circuits & systems

**Main Results:** multi-user (30 simultaneous connections tested), multi-experiment, multi-session, 7/7 days 24/24 hours, entire learning process including practical work

**Discussion:** pedagogical limits of all virtual, all digital; collaborative work (distant team-work); evaluation process, learning objectives; online/offline; pros & cons of Simu vs. Real ?