From online experiments to smart devices

Dr Ch. Salzmann and Dr D.Gillet

École Polytechnique Fédérale de Lausanne, Switzerland

http://lawww.epfl.ch

Outline

Remote experimentation timeline

Physical device constraints

From online devices to ..

.. smart devices

Concluding remarks

Remote experimentation

Motivation
- flexibility, asynchronous access, access on demand, collaborative learning
- lack of resource
- sharing of expensive resource
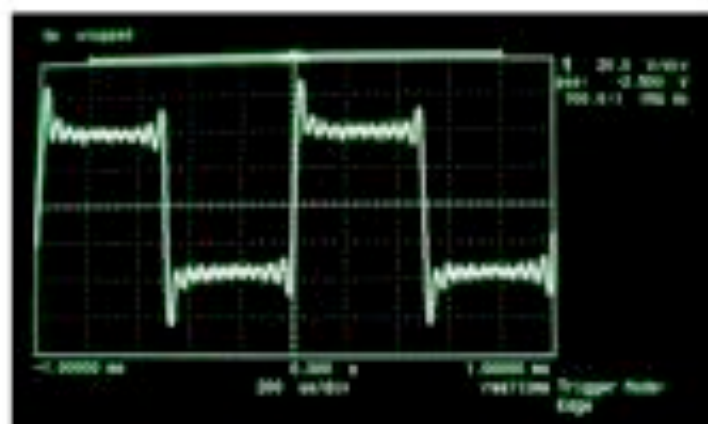- live demonstration during an ex-cathedra class

Learning material
- control theory, system identification, synthesis, validation
- concepts illustrated with the help of an electrical drive

Same theoretical concepts for the last 20 years

~ 1980 - Early days

Analog signal generator
Analog controller
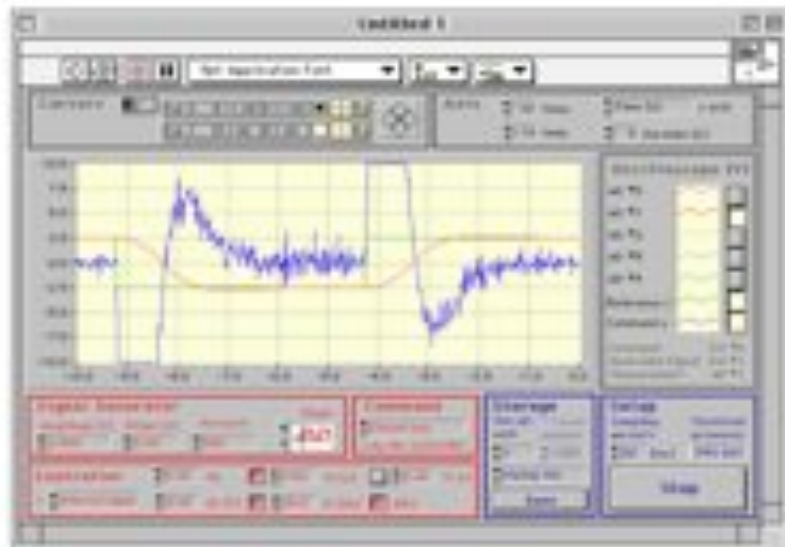Signal visualization via oscilloscope

Data saving by taking pictures
of the oscilloscope screen or
via a plotter

1992 - Computer-based control

Replaces
    the analog signal generator,
    the analog controller
    and the oscilloscope

with a

    computer and a DAQ board

LabVIEW and associated DAQ
drivers drastically speed up
the controller development

1996 - LAN access

Webcam

Video feed

Ex-cathedra demonstration

Add a webcam + streaming software

Add a communication layer + deported GUI

1997 - Internet access

Many clients
Online reservation and allocation
    system
Synchronized information streams
    (data + video)

2002 - Deployment

First batch of students to access the remote lab 24/7

Outside lab activities > 50 %

Integration to specific *closed* environments

Client moved LabVIEW -> Java

2005 - Other environments

Integration to *open* environments/clients
    Mashed-up environments

Integration with other tools
    shared space, analysis tools, video chat

Drastic student increase (40 -> 180)
    the whole class connected remotely every other week

Online device - how to
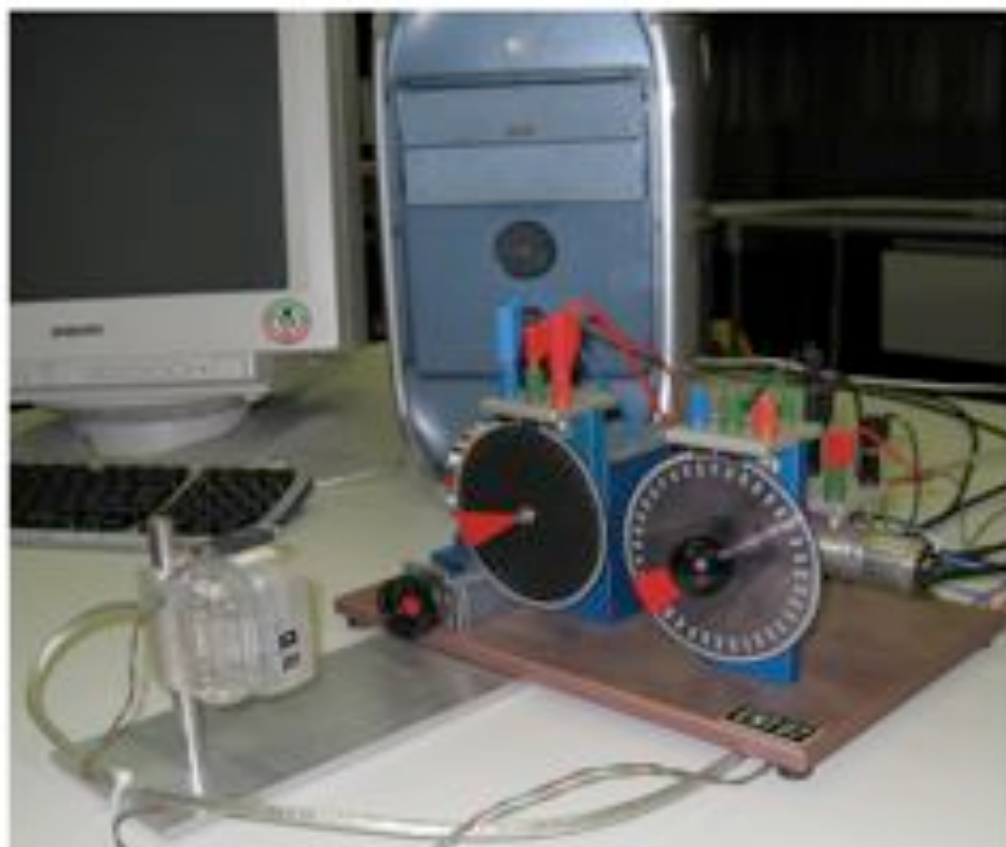
Specific device

Full control
Full diagnostic
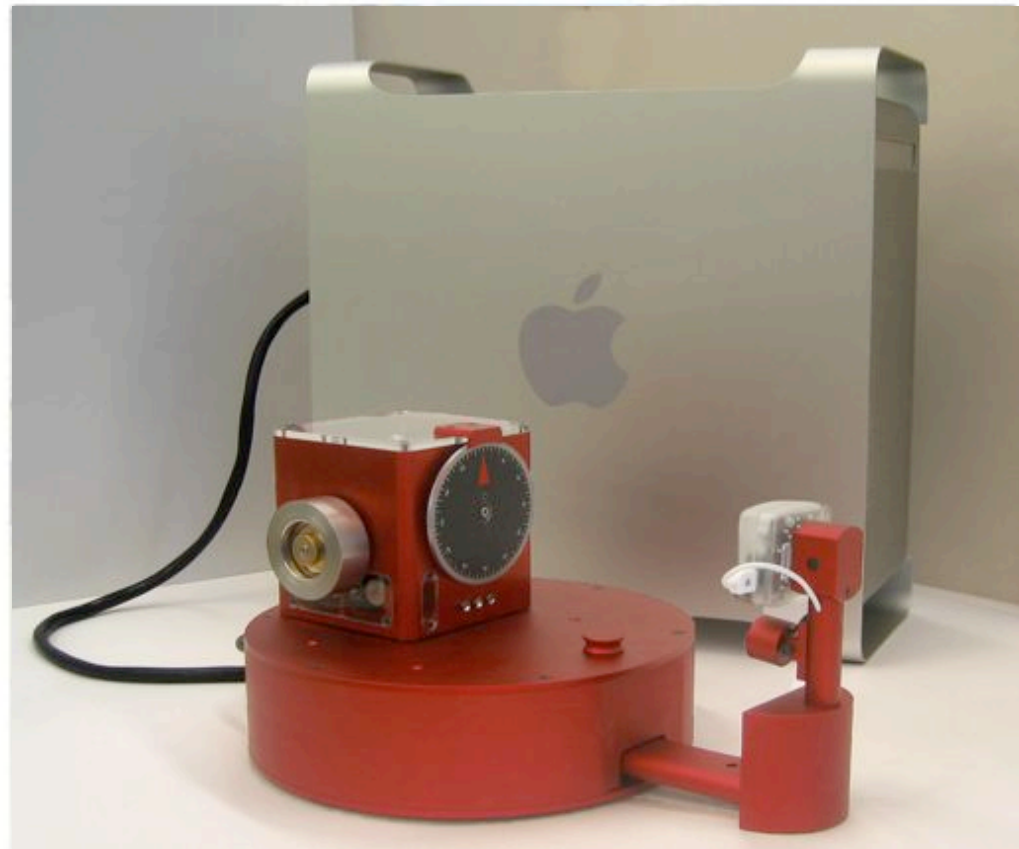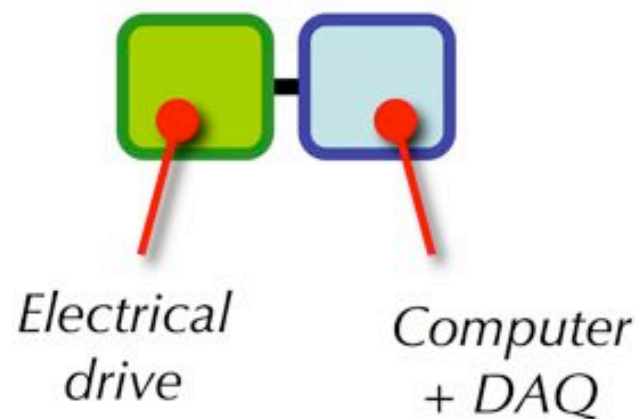3 + 3 sensors
2 + 3 actuators
Integrated video camera

Online device - how to

Specific device

Full control
Full diagnostic
3 + 3 sensors
2 + 3 actuators
Integrated video camera

Online device - how to

Specific device

Full control
Full diagnostic
3 + 3 sensors
2 + 3 actuators
Integrated video camera

Electrical drive

Computer + DAQ

Online device - how to

Turnkey solutions
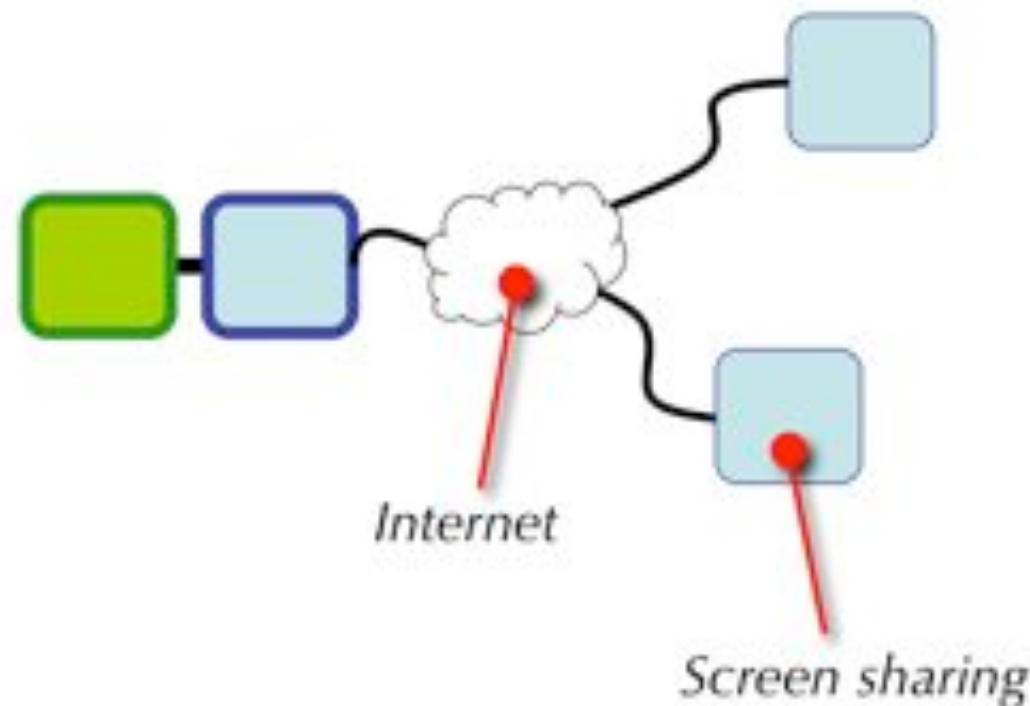
Screen sharing *
Controlab/WebLab (Simulink)
Remote panel (LabVIEW)
Dynamic web page (LabVIEW)

Pros: instantaneous

Cons: lots of bandwidth
           no video
           *too much rights granted

Internet

Screen sharing

Online device - how to
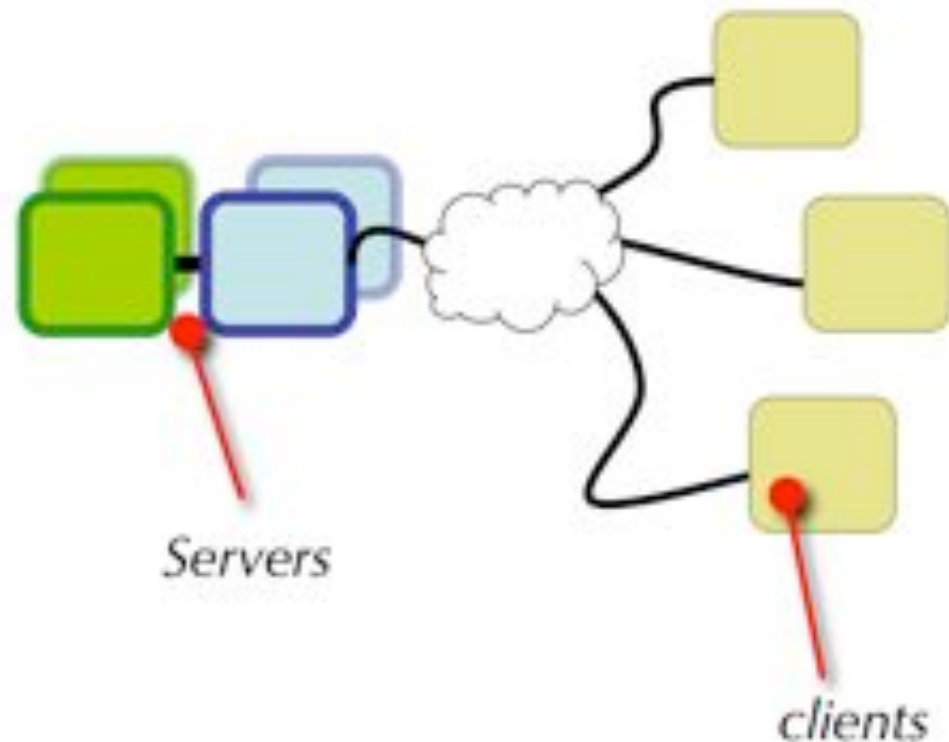
Custom solution (client-server)

Modify the local control
    add a communication layer
    add video capture
      -> **server**

Create the **client** applications
- Only GUI + Communication
- Java, Flash, ActiveX, LabVIEW, etc.

Global supervision
- Dynamic allocation
- Usage statistics

Servers

clients

Online device - how to

Integration to other environments

Client and server applications need to be adapted to get the most of collaborative environments

Client & server may require
  - additional data format
  - additional protocols
  - authentication

elogbook

Online device - how to

Integration to other environments

Client and server applications need to be adapted to get the most of collaborative environments

Client & server may require
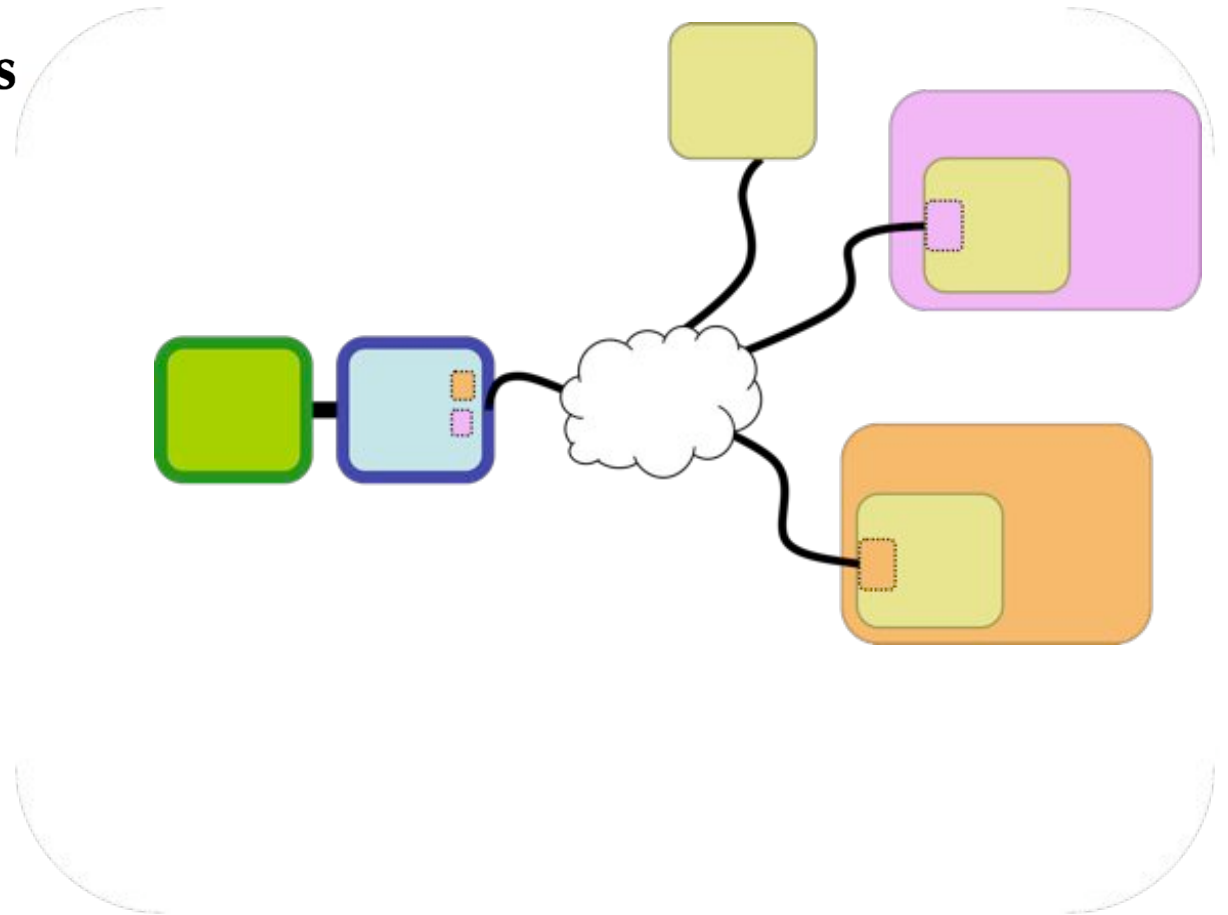– additional data format
– additional protocols
– authentication
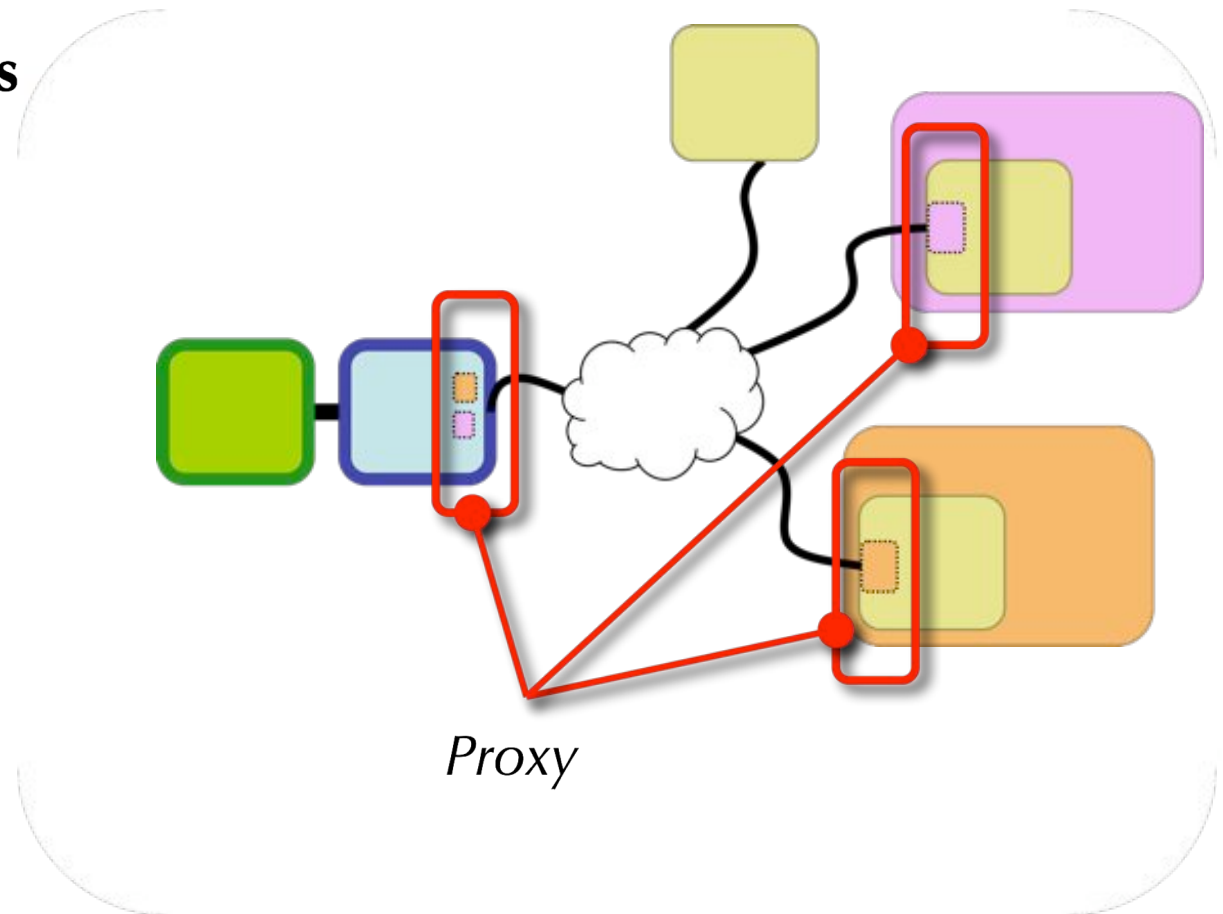
Online device - how to

Integration to other environments

Client and server applications
need to be adapted to get
the most of collaborative
environments

Client & server may require
- additional data format
- additional protocols
- authentication

Implemented as proxy

Proxy

From online to smart devices

Integration to new open environments
    Forest of proxies
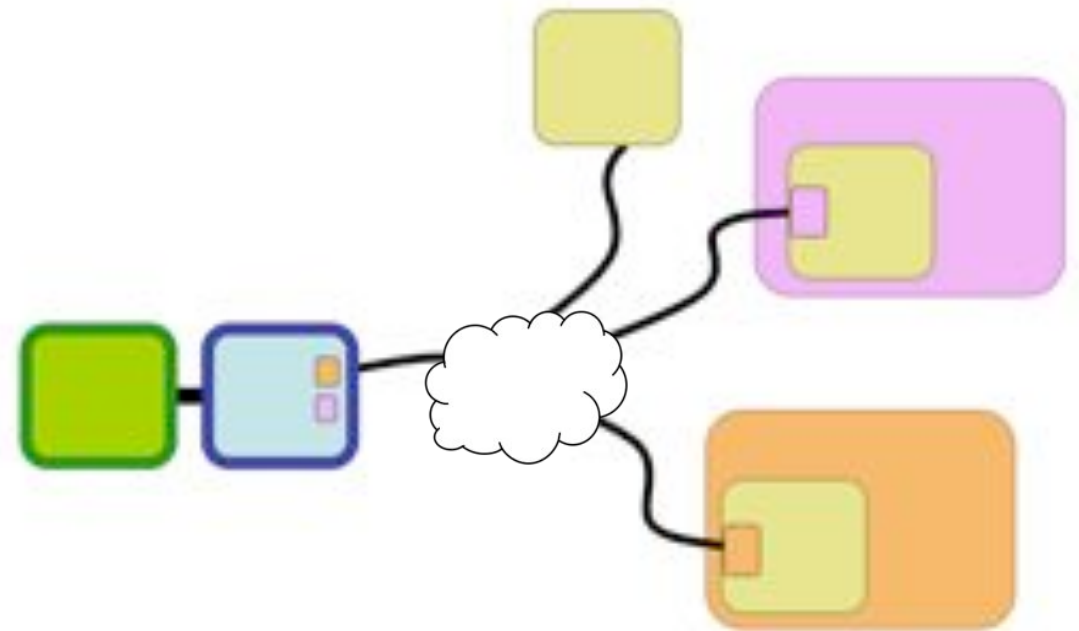   Pool information

Able to handle
    Multi protocols
    Multi data formats
    Etc.

Clients and server complexity increase

From online to smart devices

Integration to new open environments
- Forest of proxies
- Pool information

Able to handle
- Multi protocols
- Multi data formats
- Etc.

Clients and server complexity increase

From online to smart devices

Integration to new open environments
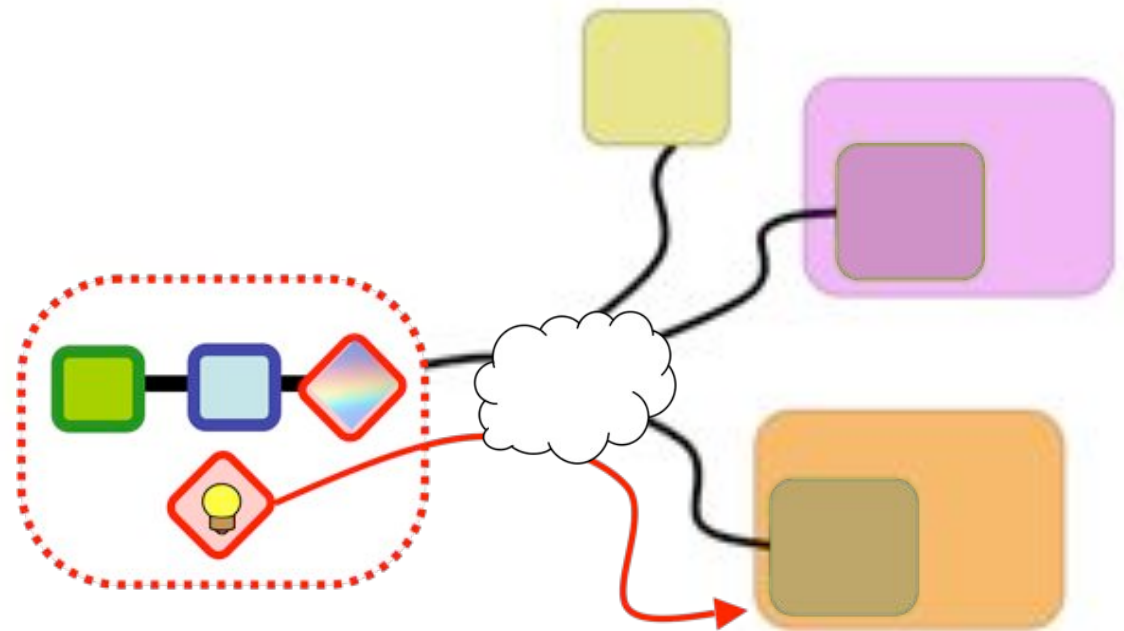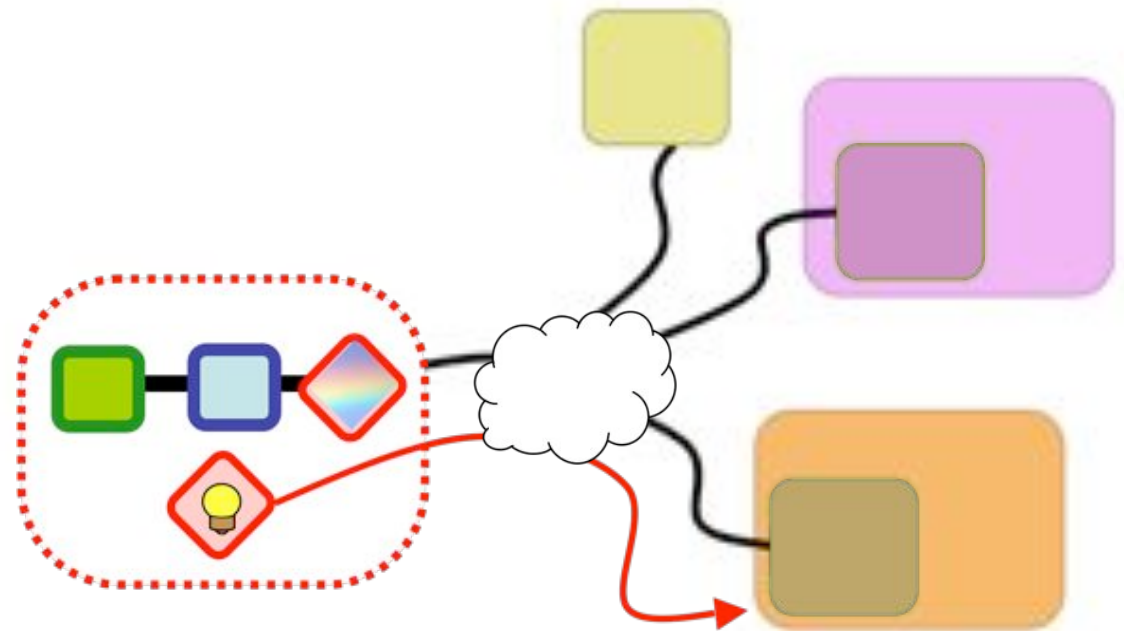   Forest of proxies
    Pool information

Able to handle
    Multi protocols
    Multi data formats
    Etc.

Clients and server complexity increase

Keep the same hardware, enhance the software

Smart device

- A way of implementing functionalities (paradigm shift)
- Transfer client functionalities to smart device (server)
- Can initiate information exchange (push)
- Is seen as an agent in collaborative environments
- Ideally supports all formats/protocols or is ready to

Thomson's[1] definition:

A smart device has communication capabilities

A smart device has sensors and actuators

A smart device is capable of "reasoning" and "learning"

A smart device has identity and kind

A smart device has memory and status tracking

[1]Thompson, C. W. **Smart devices and soft controllers**, IEEE Internet Computing, 2005 vol. 9-1

Smart device example
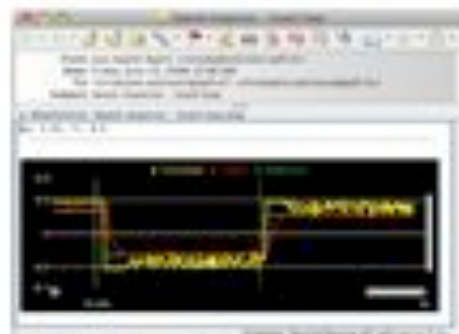

Same hardware
Enhanced software
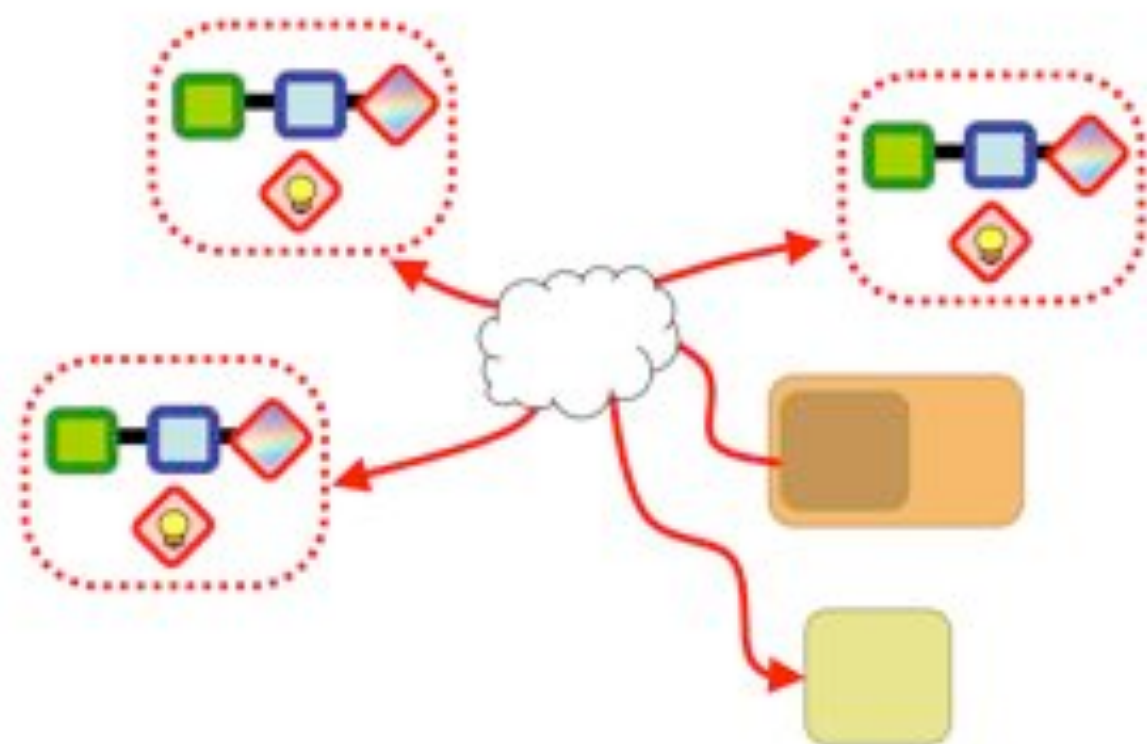
Agent in elogbook

SMS: initiate tasks

RSS feed: self diagnostic

eMail: multiple formats

Internet of things

The internet of things is the interconnection of smart devices and other intelligent objects

"Where are my Pals ?"

"I'm busy at the moment,
*   I'll redirect your request to the next free device"*

"3230 3435 3038 3030 3109 332E 3435 0932 2E38 3409 332E 30"

"<mailto:rev2008@rev-conference.org- status OK, 3 connections>"

Concluding remarks

Smart device is
- The natural evolution of online device
- A new paradigm for implementing functionalities

Smart device has
- Sensors and actuators
- Some "intelligence"
- Identity, kind, memory, status
- Communication capabilities
- Support for "any" protocols/formats

Smart device can
- Initiate information exchange
- Work as an agent on the user's behalf

http://lawww.epfl.ch
http://emersion.epfl.ch
http://elogbook.epfl.ch

christophe.salzmann@epfl.ch