



EVIDENCE[®]
EMBEDDING TECHNOLOGY

Scicos code generation for embedded microcontrollers: examples based on the FLEX boards

ScilabTec'09

The first Scilab Users' Conference

Paris, July 1, 2009

agenda

- the team
- Evidence profile
- objective
- building blocks
- Scicos support for microcontrollers
- community and wish list
- examples
- contacts
- live demos!

the team (alph. order)



Microchip design center, FLEX boards production
<http://www.es-online.it>



Firmware, RTOS, Linux embedded, device drivers
<http://www.evidence.eu.com>

EVIDENCE®
EMBEDDING TECHNOLOGY



FLEX concept, early prototypes, drivers, demos
<http://retis.sssup.it>



Scilab and Scicos
<http://www.scilab.org> – <http://www.scicos.org>



Code generator customizations for FLEX
<http://web.dti.supsi.ch/~bucher/>

Evidence profile

founded in 2002, headquarters in Pisa, Italy, 13 people

we make innovative firmware for embedded real-time systems

- from tiny microcontrollers to multicore devices
- from tiny RTOS to Embedded Linux

We participate in various EU FP6 and FP7 projects

ALTRAN
ITALIA

ERICSSON

SIEMENS

MAGNETI
MARELLI

MITS
GROUP

Indesit Company



Digi

ALTERA

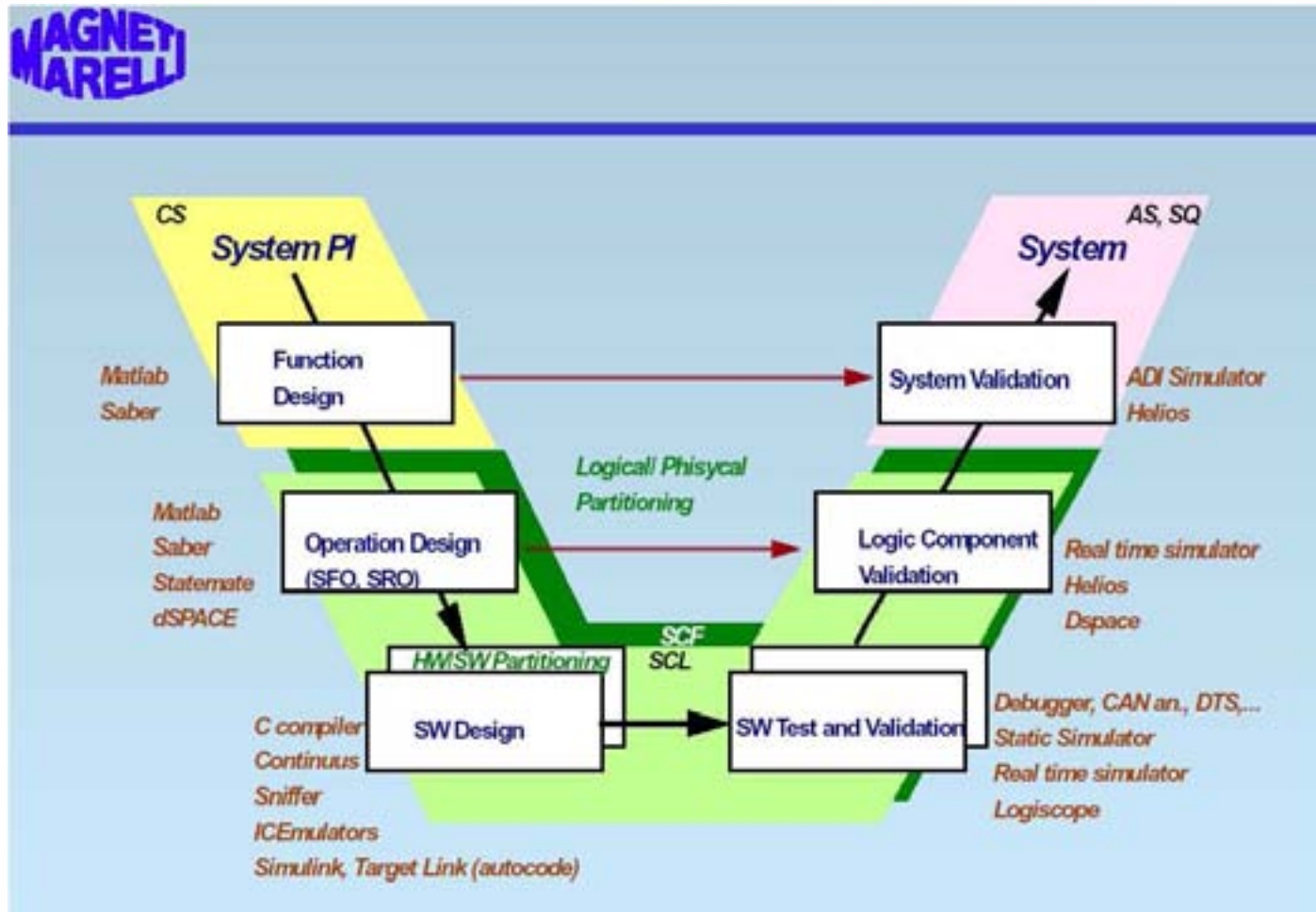
RENESAS
freescale™
semiconductor



all rights reserved

www.evidence.eu.com

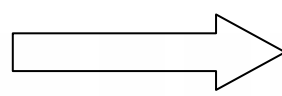
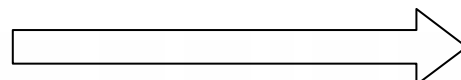
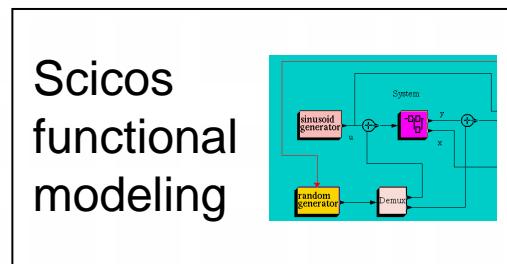
V-cycle



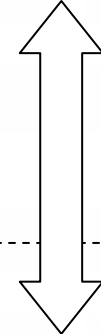
objective

The objective of our work is to provide
an open-source
code generation tool
for tiny embedded control devices

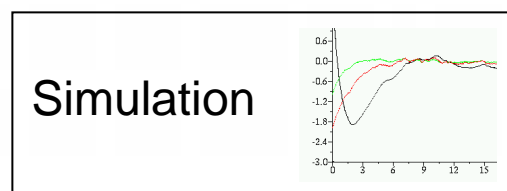
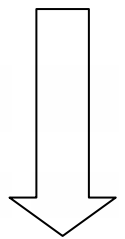
fast prototyping using Scilab/Scicos



INRIA/SUPSI
Code generator



USB
Connection



Same
Behavior!

HW + Erika
Enterprise
FLEX

Building Blocks

ERIKA ENTERPRISE

RT DRUID

- open source, RTOS, OSEK/VDX API
- 1-4 Kb ROM footprint



- simulation
- code generator for dsPIC
- hardware in the loop
- custom blocks

FLEX

- low-cost prototyping hardware
- Microchip dsPIC 40MHz



- “The Amazing Ball” ball & plate with touchscreen

some history

- ERIKA Enterprise started in 2002 for various platforms
- in March 2007 we presented the FLEX platform
- we started in April 2007 from the Scicos+RTAI toolchain
- we ported the toolchain to Scicos 4.1.2 on Windows
- we implemented more than 100 Scicos blocks
- in Aug 2008 we presented the Scicos Codegen to Microchip MASTERS in Phoenix, AZ
- in Jul 2009 we developed “The Amazing Ball”, a Scicos-enabled commercial educational platform

ERIKA Enterprise and RT-Druid

ERIKA ENTERPRISE

- open source, OSEK/VDX API
- 1-4 Kb ROM footprint
- support for Lauterbach Trace32
- available for dsPIC, AVR, Nios II, ARM7, Tricore, PPC, H8, ST10, and others



RT DRUID

- RTOS configuration using OSEK OIL
- schedulability analysis
- integrated in eclipse.org



the FLEX platform



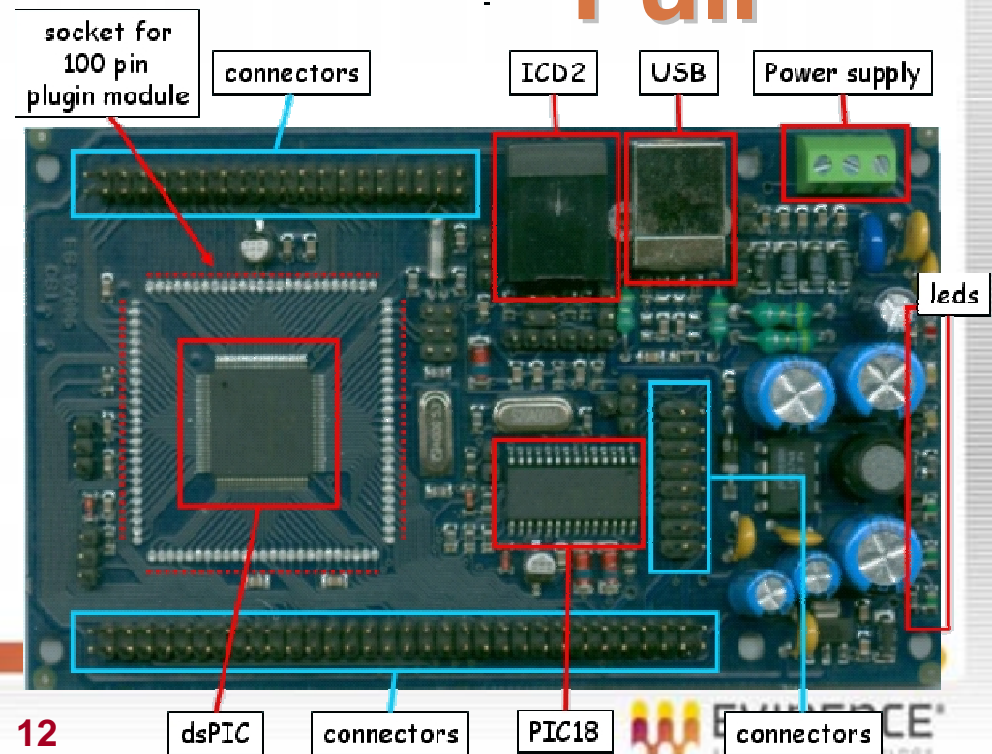
- LCD 2x16, 8 LED
- 4 buttons, 3-Axis Accelerometer
- 2 channels DAC, Temperature sensor
- Light sensor, Infrared I/O
- RS232/485/422 socket,
- 2.4 GHz radio transceiver ready

all rights reserved

Demo



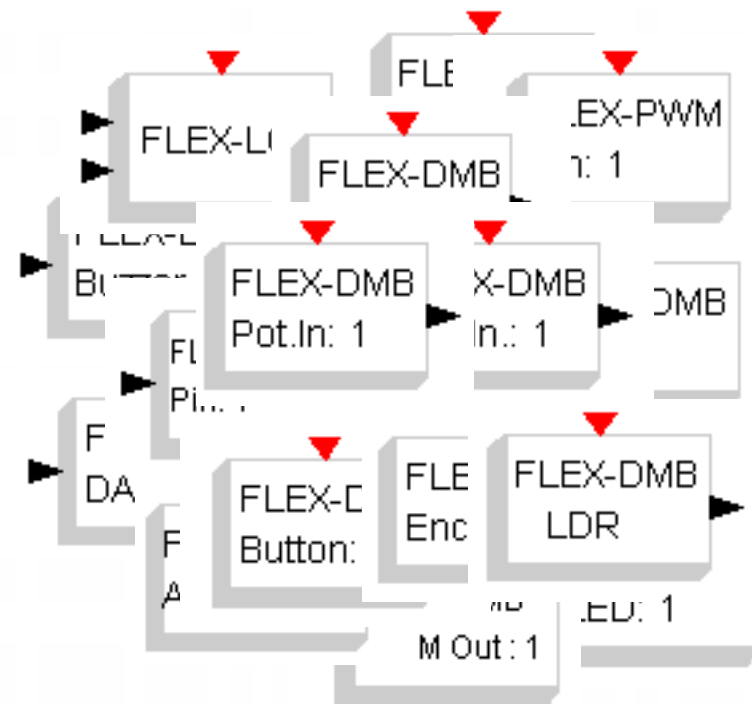
Full



12

support for Microchip dsPIC

- we considered the FLEX Demo Board, and we implemented more than 100 Scicos blocks
- basic math
- digital and analog I/O
- encoder, PWM
- Light, temperature sensors
- 3-axis accelerometer
- Communication:
 - Zigbee, USB, Serial



community

- the FLEX platform is currently used by more than 10 universities in Europe, USA, and Asia
- we made available
 - source code
 - application notes
 - Youtube videos
- we also have
 - wiki pages
 - forum

<http://www.evidence.eu.com/community>

wish list

A few features we believe important for the future of Scilab/Scicos:

- Eclipse integration
- state machines support
 - Papyrus?
- optimization of the code generated for microcontrollers
 - RAM/ROM optimization, inlining
- multithread support
 - semantic preservation for the code generated

some examples...

Scicos for Monitoring - MIRTES

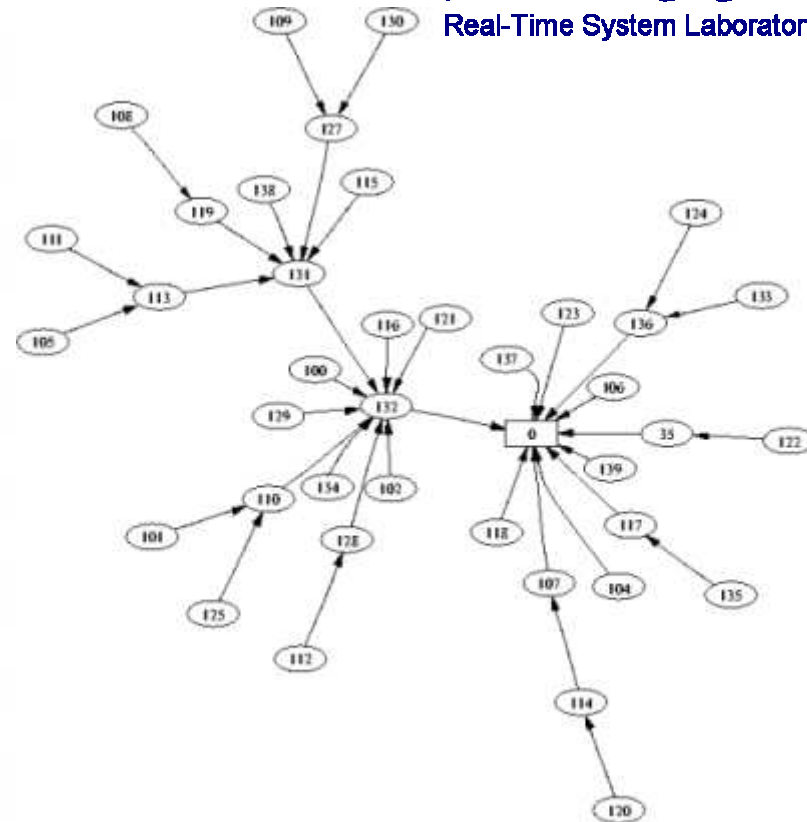
MIRTES

Middleware for Real-Time Transactions in Embedded Systems

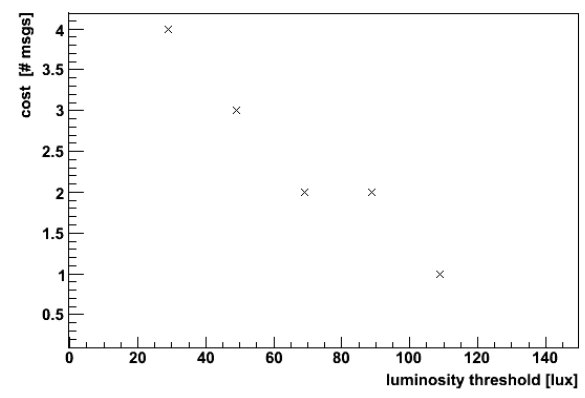
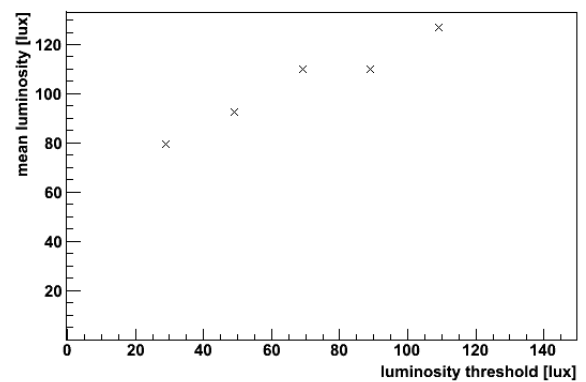
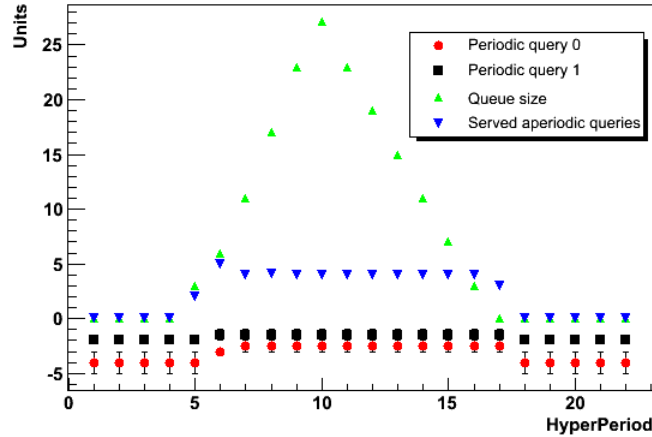
- Motivation:
 - need of a hybrid middleware (data/code/event centric) supporting real-time transactions;
- Status:
 - code-centric services are already implemented
 - SQL-like language in the client implemented in Java;
 - support for real-time periodic transactions;
 - quality of service for aperiodic queries.

Author: Daniele Alessandrelli

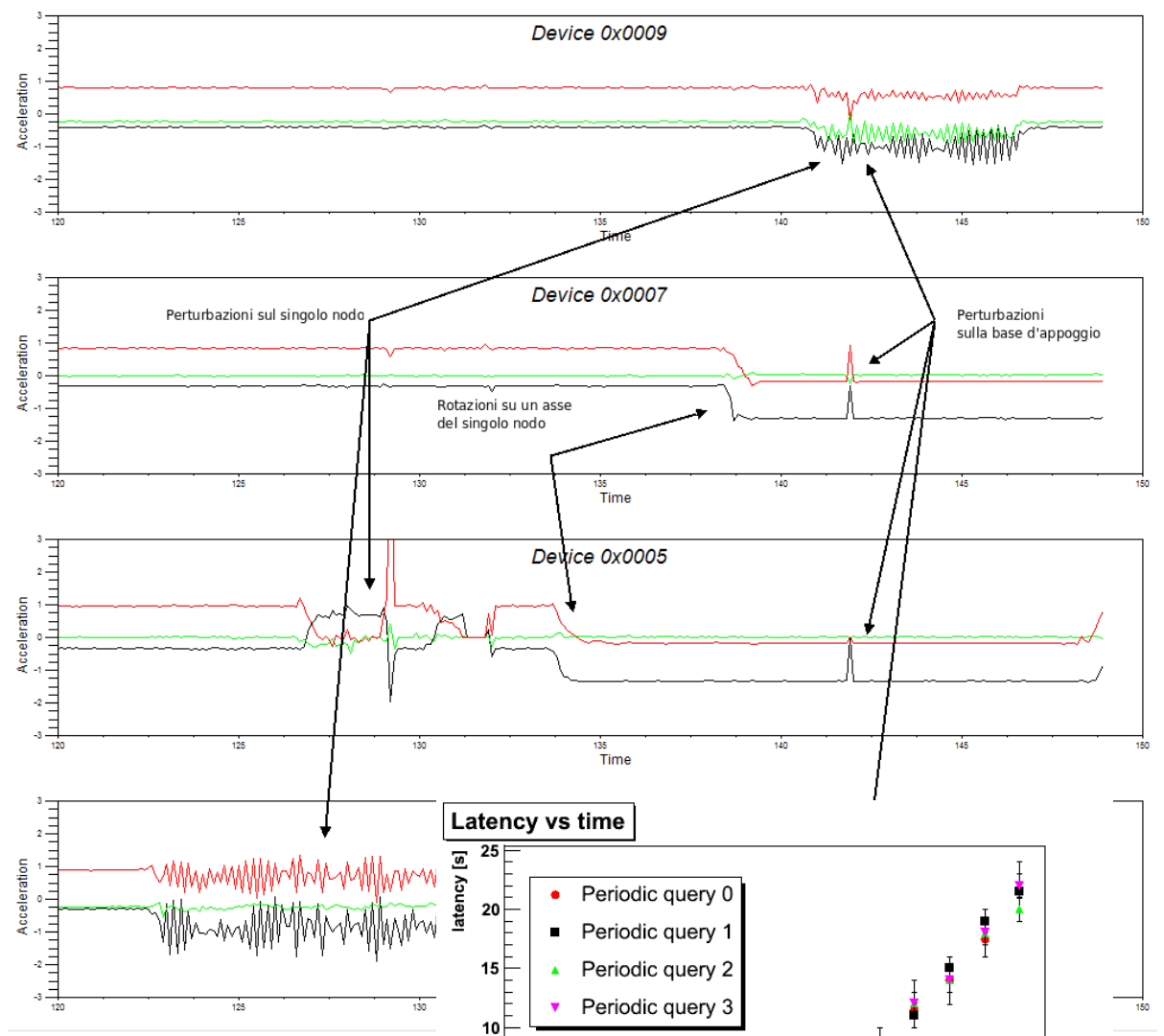
Reference: Paolo.Pagano@sssup.it



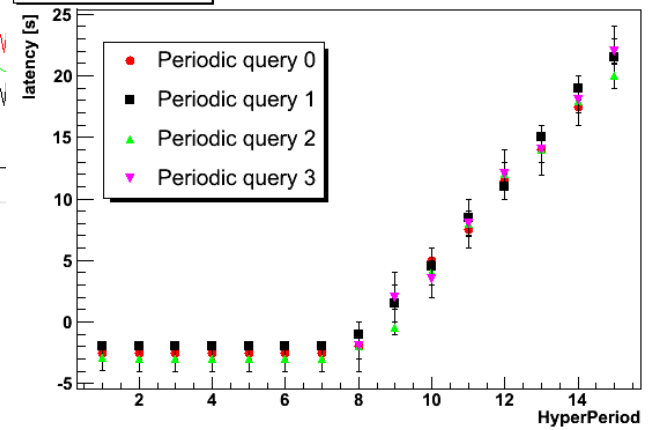
Real-Time response in presence of aperiodic queries



```
SELECT COUNT(LUX),MIN(LUX),MAX(LUX),MEAN(LUX) FROM LUMINOSITY
WHERE LUX > THR EVERY 100 ms
```

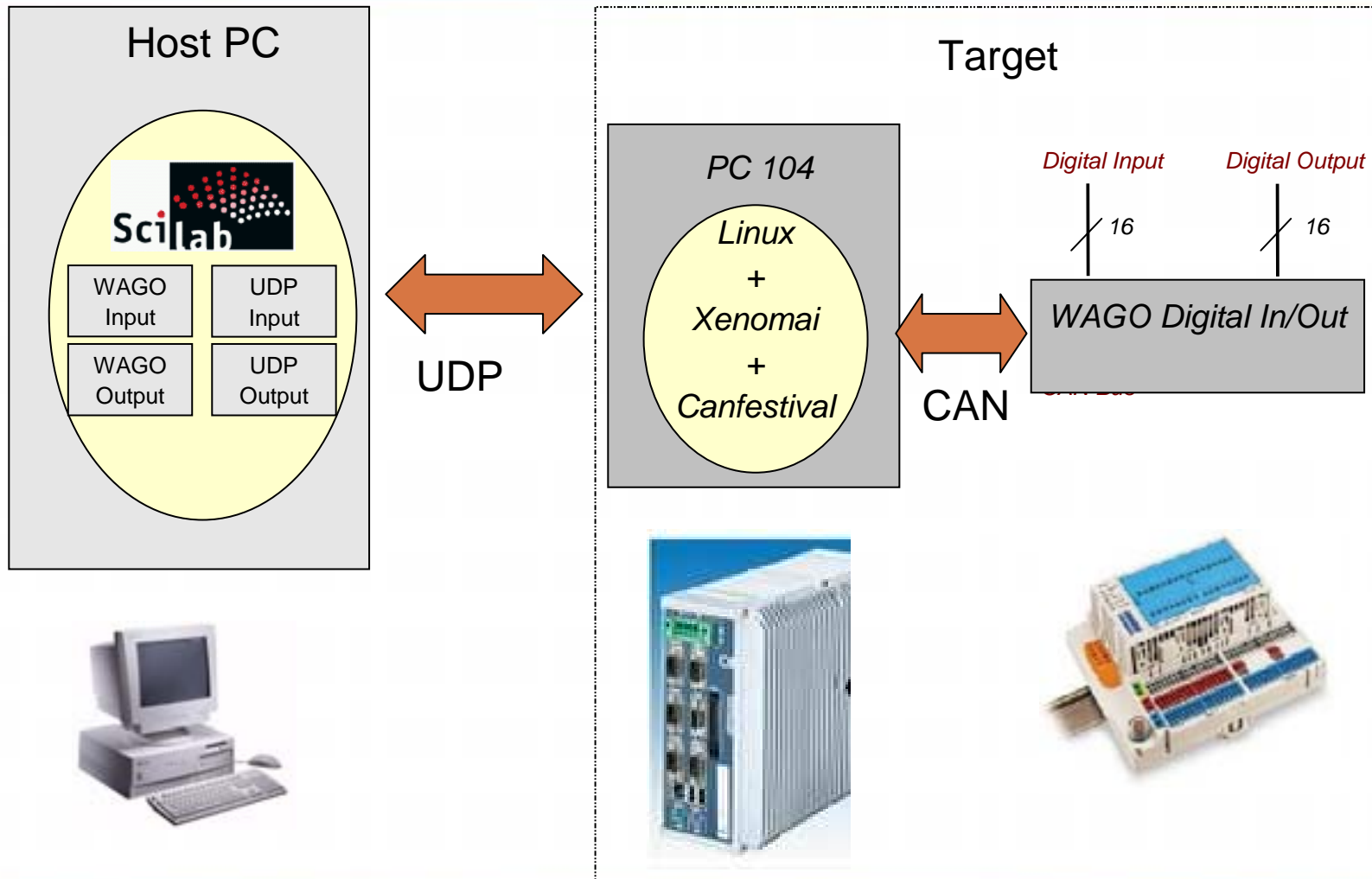


Latency vs time



```
SELECT NODE_ID,ACC_X,ACC_Y,ACC_Z FROM ACCELERATION EVERY 150 ms
```

Scicos, Data Acquisition and CANOpen



Scicos for control

- Inverted pendulum, CAN motors, Scicos application



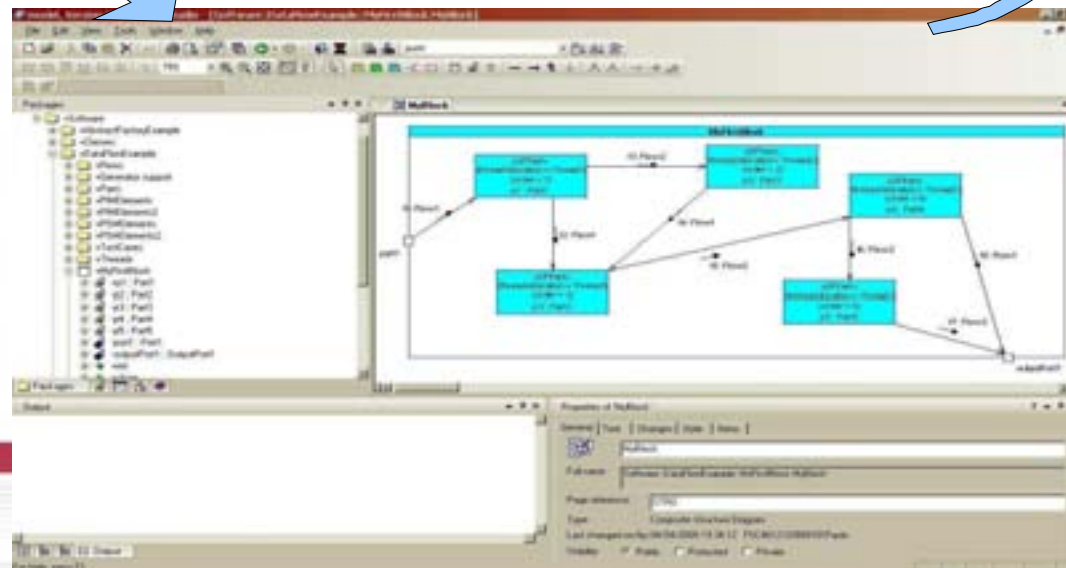
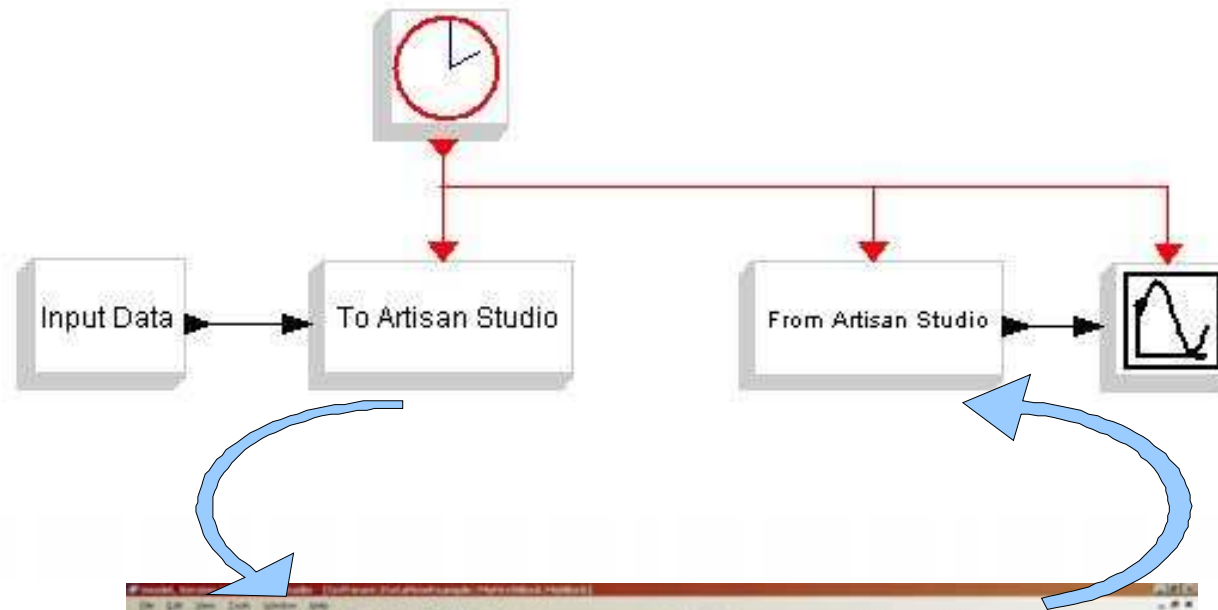
Scuola Universitaria Professionale
della Svizzera Italiana

SUPSI

Scicos for testing data-flow systems

- Rationale:
testing of a dataflow embedded application
designed in UML with Artisan Studio
- Integration with Data Flow Model designed with Artisan Studio (Defense Application)
- UDP sent locally received locally (non blocking)
- Scicos model gives stimulus and retrieves the results through the interfaces
- Boundaries are connected by custom blocks (Scicos side)

Scicos for testing data-flow systems (2)



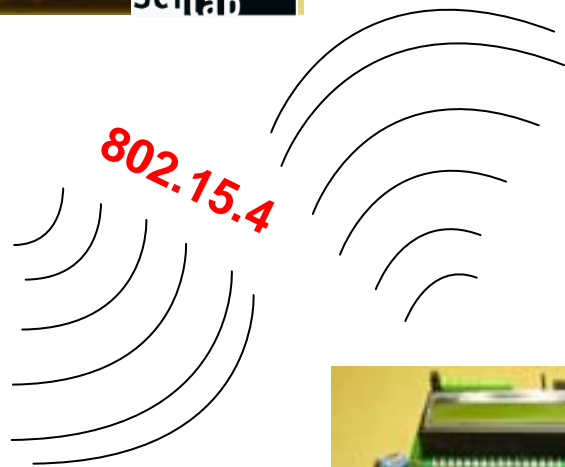
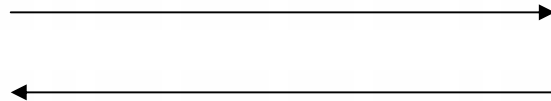
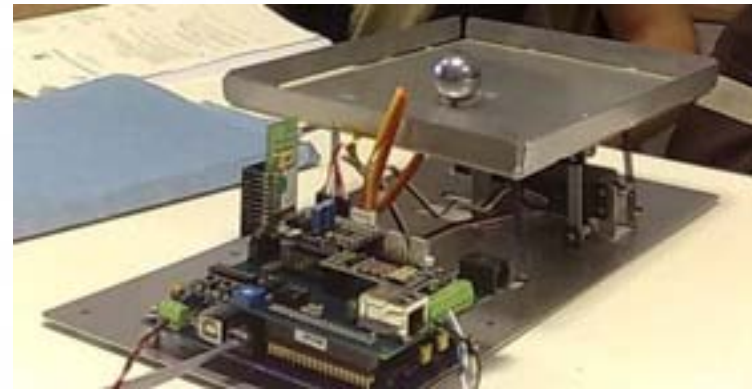
all rights reserved

www.evidence.eu.com

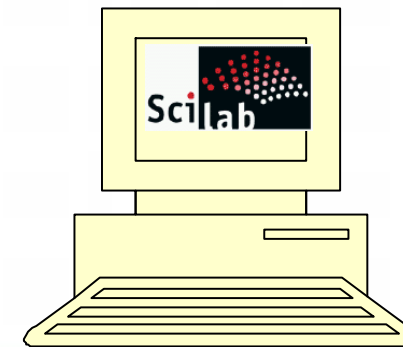
EVIDENCE
EMBEDDING TECHNOLOGY

Scicos for acquisition and control

Device



USB



PID controller

all rights reserved

www.evidence.eu.com

demos!

conclusions

We developed the FLEX platform and we provide a community-developed firmware which supports for it

We believe Scilab and Scicos can be a valid open-source tool useful

- for teaching control systems in educational institutes
- for fast prototyping on selected applications
- ...everything open-source!

acknowledgements

- Giorgio Buttazzo RETIS Lab Continuous support!
- Francesco Prosperi RETIS Lab Amazing Ball/code generator
- Christian Nastasi RETIS Lab Wireless stack
- Mauro Marinoni RETIS Lab Drivers and many other things
- Gianluca Franchino RETIS Lab Amazing Ball HW, MiWi integr.
- Paolo Pagano RETIS Lab Scilab and ROOT support
- Daniele Alessandrelli RETIS Lab MIRTES
- Simone Mannori INRIA Roquencourt Scilab/Scicos Support
- Roberto Bucher SUPSI Lugano Code generator
- Tan Chin Luh Solutions 4U Testing Testing Testing...
- Giuseppe Arturi Evidence UDP Scilab Blocks
- Paolo Tiberi Evidence USB support
- Francesco Focacci Evidence, now Rolls Royce USB support
- Daniele Sartorello Embedded Solutions Srl FLEX boards
- Antonio Bersani Microchip Italy Continuous HW support

contacts

- Paolo Gai
pj@evidence.eu.com
- Evidence community and downloads
<http://www.evidence.eu.com/community>
- the ball & plate will be available
as a product around end of July 2009!



the end

Questions ?

