Distributed Control Lab

Virtual Lab 2004 Setúbal, Portugal <u>Andreas Rasche</u>, Bernhard Rabe, Peter Tröger, and Andreas Polze





Outline

- Motivation / Overview
- The Distributed Control Lab (DCL) Architecture
- Protecting the Lab from Malicious Code
- Experiments in the DCL
 - Foucault' Pendulum
 - Higher Striker
- DCL Grid Computing Integration
- Conclusions

Motivation

- Online access to physical experiments over the Web
- Test-bed for interconnected middlewarecomponents and embedded systems
- Reach a predictable system behaviour in unstable environments
- Study techniques to prevent malicious code damaging physical equipment
- Foucault's Pendulum demonstrates usage of dynamic reconfiguration for online replacement of user control

Distributed Control Lab

- 2001 project start at Hasso-Plattner-Institute
- Practice of writing control algorithms for real-time control problems
- study of system predictability, availability and security in context of middleware-based dynamic control systems
- Extensible architecture for hosting physical control experiments
- Investigation of algorithms for user code observation and replacement of control components
- Experiment : physical installation and specific control software

The Distributed Control Lab



🦉 Distributed Control Lab - Mozilla

Forward

Back

Home

Experiments

Live Video

My Jobs

My Settings

Latest News

Logout

<u>File Edit View Go Bookmarks Tools Window</u>

3 Reload Stop

🤳 http://was.discourse.de/discourse/myjobs.aspx

Help

e Print

💌 🌛 Search

魏

My Jobs

The following jobs are registered for your account in the system :

Name	Location	State	Queued on		
Pendulum (Owner : Andreas Rasche)	HPI	Currently executed	Tue, 23 Sep 2003 10:51:27 GMT	View details	<u>Cancel</u>
Lego_Robots (Owner : Stefan Henze)	HPI	Finished (result code : StopSignal), 3 results available	Fri, 19 Sep 2003 16:59:36 GMT	View details	<u>Delete</u>
Lego_Robots (Owner : Lego Test Account)	HPI	Finished (result code : StopSignal), 3 results available	Fri, 19 Sep 2003 14:33:33 GMT	View details	<u>Delete</u>
Lego Simulator (Owner : Andreas Rasche)	HPI	Finished (result code : Successful), 4 results available	Fri, 19 Sep 2003 12:45:32 GMT	View details	<u>Delete</u>
Lego_Robots (Owner : Stefan Henze)	HPI	Finished (result code : StopSignal), 3 results available	Fri, 19 Sep 2003 11:18:49 GMT	View details	<u>Delete</u>
Lego_Robots (Owner : Andreas Rasche)	HPI	Finished (result code : StopSignal), 3 results available	Thu, 18 Sep 2003 16:28:56 GMT	View details	<u>Delete</u>
Lego_Robots (Owner : Andreas Rasche)	HPI	Finish_Experiment crashed	Thu, 18 Sep 2003 16:27:35 GMT	View details	Delete
Lego_Robots (Owner : Andreas Rasche)	HPI	Finished (result code : StopSignal), 3 results available	Thu, 18 Sep 2003 16:22:24 GMT	View details	<u>Delete</u>
Lego_Robots (Owner : Andreas Rasche)	HPI	Finished (result code : Failed), 2 results available	Thu, 18 Sep 2003 16:20:50 GMT	View details	Delete
Lego_Robots (Owner : Andreas Rasche)	HPI	Finished (result code : StopSignal), 3 results available	Thu, 18 Sep 2003 16:15:58 GMT	View details	Delete

Delete all entries

Page 1 of 46

[First Page] [Previous Page] [Next Page] [Last Page]

back to top

Research Focus: Problem : Malicous Code

- Investigation of Solution for malicious code detection
 - Source Code Analysis
 - Language limitations / special compiler
 - Simulation before execution on physical experiment
 - Analytic Redundancy
 - Online observation of user programs
 - Replacement of user programs before reach of uncontrollable state
 - Dynamic Reconfiguration of component-based control application
 - Monitoring of environmental settings and component states

Foucault's Pendulum

- Demonstrates earth rotation popular experiment
- Today many installation including one in UN-building in New York
- Problem : Pendulum must be kept swinging
- Solution : electro magnet under an iron ball
- Experiment: Find best control algorithm to keep the pendulum swinging
 - Using minimum energy
 - Reaching the highest amplitude







Pendulum Experiment Control Configurations



Measurements: Abnormal Termination of User Program



Our Approach : Dynamic Reconfiguration as safe-guard mechanism

 Mapping of profiles to application configurations based on environmental conditions and component states

• Xml-based description of

- observer : monitoring of environmental settings and component states
- profiles : mapping of environmental conditions to application configurations
- configurations of component-based applications
- Online monitoring of environment and components
- Change of application configuration using dynamic reconfiguration if required
- Configuration Manager instantiates, sets attributes, connects and starts components – performs reconfiguration
- Dynamic reconfiguration based on XML-based configuration description using an algorithm of M.Wermelinger
 - Based on blocking of connections between components

"Higher Striker" - Experiment

- Real Time Control experiment
 - Parallel I/O / 38 kHz sample rate / 256 Byte buffer
 - Use of Real Time OS
 - Smaller Buffers, Higher Sampling Frequency
 - Short control delay
 - COTS x86 PC
 - Intel Celeron 633 MHz, 128 MB RAM (max 64 MB usable)
 - 10 Mbit/s LAN (NE 2000 PCI)
 - Combination of non-RT .Net and RT application
 - CE-PC Windows Ce.Net 4.2



DCL - Grid Integration

- Heterogeneous
 - X86, Itanium, PowerPC
 - Windows 2000/XP, Linux, Mac OS X
- DRMAA Job Submission and Control for Clusters and Grids
- GLOBUS
- IDLE-Time
 - Condor
 - Sun Grid Engine, Condor



- Increased Throughput



or - Increased Response Time

Conclusions

- DCL : environment for remote experiment access based on COTS Operating System and Middleware
- Experiences in teaching real-time embedded systems
- Safety against malicious code demonstrated
- Analytic Redundancy / Runtime observation of user control at Foucault's Pendulum applicable
- Replacement of faulty control algorithms using dynamic reconfiguration
- Usage of Grid Computing Technologies to increase lab performance