



# Network of Excellence

## Thematic Priority 2

FP6 – IST- 511368

# HYCON

## Hybrid Control: Taming Heterogeneity and Complexity of Networked Embedded Systems

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### Dissemination Level

PU	Public	<b>X</b>
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

## EECI business plan

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## 1. Executive Summary

- **Company information**

EECI – European Embedded Control Institute, is an Association Law 1901;  
SIRET : 49192685300012

President: Françoise Lamnabhi-Lagarrigue  
Treasurer : Maryvonne Giron ; Secretary : Samuel Costantin

Seat: SUPELEC, 3 rue Joliot Curie 91190 Gif-sur-Yvette, France  
Fax: +33 1 69 85 17 27; Contact : lamnabhi at lss.supelec.fr

- **Brief description of project**

The European Embedded Control Institute (EECI) has been created in the framework of the HYCON Network of Excellence (FP6-IST-511368) [www.ist-hycon.org](http://www.ist-hycon.org), a funded EC project from September 2004 to September 2008. *EECI is a "lightweight" association (under the French Association Law 1901)*, based on volunteer work by its members. The EECI offers a legal structure for the Knowledge Community of Networked and Embedded Control.

## 2. Organizational Background

### 2.1 Mission Statement

Research on control of networked and embedded systems (NECS) have major strategic relevance for the European industry and society, since these systems form a key growth area in information and communication technologies with a broad range of applications that will affect the citizen in all aspects of their lives. Existing and emerging areas include transportation, energy management, environmental monitoring, factory automation, personal communication, process industry and biological systems. **There is a need of new methodological and engineering approaches that ensure efficient, predictable, safe and secure behaviour, that increase robustness and performance**, for manufacturing and process plants, for large scale infrastructures such as distributed energy production, energy distribution, airports or seaports, and in general for physical and biological systems, taking into account new technologies such as wireless sensing and actuation. Key challenges include the development of generic modelling and the design of control methods, under the multiple constraints inherent to embedded systems, based on a model approach (EDP, ODE, continuous, discrete, discrete events systems, hybrid systems), the dynamical reconfiguration of architectures, the implementation of languages and scalable algorithms for the control of evolvable, distributed and adaptable systems; the complexity mastering in terms of temporal and spatial uncertainties such as parameters, delays and disturbances, limited bandwidth in communications, actuation constraints and node availability. Addressing these ambitious objectives require the merging of different disciplines as diverse as computer, control, communications sciences and engineering together with biologic, physics and social science. The establishment of EECI is expected to become a long-term world-wide renowned focal point by stimulating new collaborative (multi-national and multi-disciplinary) research on networked and embedded control, to break down the barriers between the traditional disciplines, to disseminate associated methods and tools, to organize the education of students and researchers, and to transfer methodologies to industry. Its role, as a perennial institution, will be also a control platform by keeping tracking results and products of funded past projects.

## 2.2 Current Status

- **Number of employees**

- One secretary (half-time): Eugenie Gouveia
- One Maitre de Conference (Employed by Université Paris Sud): Antoine Chaillet

- **Key activities**

➤ **TECHNICAL ACTIVITIES** (coordination of the Chapters):

Contact Person: Sebastian Engell, University of Dortmund, Germany

➤ **TOOLS**

Contact Person: Bert van Beek (Technical University of Eindhoven),

➤ **WORKSHOPS & CONFERENCES**

Contact Person: Eduardo Camacho, University of Sevilla, Spain

➤ **OUTREACH AND INNOVATION**

Contact Persons: Manfred Morari, Swiss Federal Institute of Technology Zurich, Switzerland and Alberto Sangiovanni-Vincentelli, PARADES, Italy

➤ **SCHOOLS** - Summer Schools and Graduate Schools

Contact Persons: Alberto Bemporad (Summer Schools), University of Siena, Italy and Francoise Lamnabhi-Lagarrigue (Graduate Schools), CNRS, France

➤ **ICO** – International Curriculum Optino for Doctoral Studies in Hybrid Systems:

Contact Person: Antonio Bicchi, University of Pisa, Italy

➤ **MOBILITY** - Senior and junior researcher exchanges

Contact Person: Marika di Benedetto, University of l'Aquila, Italy

➤ **COMMUNICATION**

Contact Person: Antoine Chaillet, Université Paris Sud, SUPELEC and EECl, France

➤ **FINANCE AND RESOURCES**

Contact Person:: Francoise Lamnabhi-Lagarrigue, CNRS, France

- **Location of facilities**

EECI is currently located in SUPELEC, Gif-sur-Yvette, France, and has a Lab site NCS for networked embedded control in L'Aquila, Italy:

- NCS l'Aquila, see : [www.dews.ing.univaq.it/dews/projects/eeci/eeci-networked-ctrl-laboratory/presentations-eeci-networked-control-laboratory/](http://www.dews.ing.univaq.it/dews/projects/eeci/eeci-networked-ctrl-laboratory/presentations-eeci-networked-control-laboratory/)

- Part of new building (300m will be dedicated to EECl). In Annexe:

1) *Réponse des établissements du plateau de Saclay à la consultation « OPERATION CAMPUS »* page 26, ligne- **CSO 21 (ton ISRI, EECl, etc...)** **Supélec, Ecole Centrale Paris**

2) *Dossier de présentation et Programme général : « Un bâtiment pour les sciences et pour une coopération accrue entre deux acteurs majeurs de l'Enseignement Supérieur et de la Recherche ».*

- **Corporate structure**

EECI has been incorporated under the French Association Law 1901 in May 2006.

## 2.3 History

- **Founding date:** 16 mai 2006
- **Major successes:**

NCS Lab in l'Aquila & Space in CSO 21 in Gif-sur-Yvette  
2007-2008-2009 EECI Graduate School on Control;  
2007 Summer Schools in Siena;  
ICO Programme from 2006  
FP7 CSA NESTER  
Memorandum of Understanding with several Universities.

## 2.4 Management Team

- **EECI Executive Committee**

Françoise Lamnabhi-Lagarrigue (President)  
Sebastian Engell (Vice-President)  
Maryvonne Giron (Treasurer)  
Samuel Costantin (Secretary)

- **EECI Scientific Committee**

Sebastian Engell, University of Dortmund, Germany  
Bert van Beek, Technical University of Eindhoven  
Eduardo Camacho, University of Sevilla, Spain  
Alberto Sangiovanni-Vincentelli, PARADES, Italy  
Manfred Morari, ETH Zurich, Switzerland  
Alberto Bemporad, University of Sienna,  
Françoise Lamnabhi-Lagarrigue, CNRS, Gif-sur-Yvette  
Antonio Bicchi, University of Pisa, Italy  
Marika di Benedetto, University of l'Aquila, Italy

- **Board Members**


Albert Benveniste, IRISA  
Carlos Canudas-de-Wit, INRIA  
Antoine Chaillet, SUPELEC and EECI  
John Lygeros, Sebastian Mariethoz, ETHZ  
Jorge Raisch, TUB  
Olaf Stursberg, TUM  
Jan Lunze, RUB  
Cesar de Prada, UVA  
Benedetto Piccoli, CNR  
Fortunato Santucci, UAQ  
Alessandro Giua, UNICA  
Giancarlo Ferrari-Trecate, UNIPV  
Luca Benvenuti, UNIROMA1  
Bert van Beek, Maurice Heemels, Henk Nijmeijer, van de Wouw, Paul van den Bosh, TUE  
Bart de Schutter, TUD  
Arjan van der Schaft, Jacquélien Scherpen, RUG  
Karl-Henrik Johansson, KTH  
Anders Rantzer, Karl-Eric Arzen, Rolf Johansson, LTH  
Gilney Damm, IBISC, Evry, France  
Christophe Prieur, LAAS, Toulouse  
Jamal Daafouz, CRAN, Nancy  
Mohammed M'Saad, GREYC, Caen  
Antonio Loria, Silviu Niculescu, Romeo Ortega, Elena Panteley, L2S, CNRS

- **EECI Public Organization Members (March 2009) :**

SUPELEC Institute of Industrial and Control Engineering Delft University of Technology Tech. Univ. Berlin, Control Systems Lavsap University Dell'Aquila Helsinki University of Technology Université d'Evry IBISC Centro Interdipartimentale di Ricerca CNRS Departement STIC University of Dortmund Automatic Control Laboratory ETH Zurich MINES Paris tech RWTH AACHEN University of Groningen CNR Istituto per le Applicazioni del calcolo Universidad de Valladolid KTH ACCESS Linneaus Center Tech University of Delph Korea University	<a href="http://www.supelec.fr">http://www.supelec.fr</a> <a href="http://www.ioc.upc.es">http://www.ioc.upc.es</a> <a href="http://home.tudelft.nl/en">http://home.tudelft.nl/en</a> <a href="http://www.tu-berlin.de">http://www.tu-berlin.de</a> <a href="http://www.univaq.it">http://www.univaq.it</a> <a href="http://www.tkk.fi/en">http://www.tkk.fi/en</a> <a href="http://www.ibisc.univ-evry.fr">http://www.ibisc.univ-evry.fr</a> <a href="http://www.piaggio.cci.unipi.it">http://www.piaggio.cci.unipi.it</a> <a href="http://www.cnrs.fr/st2i/">http://www.cnrs.fr/st2i/</a> <a href="http://www.uni-dortmund.de/web/en">http://www.uni-dortmund.de/web/en</a> <a href="http://www.control.ee.ethz.ch">http://www.control.ee.ethz.ch</a> <a href="http://www.ensmp.fr">http://www.ensmp.fr</a> <a href="http://www.embedded.rwth-aachen.de">http://www.embedded.rwth-aachen.de</a> <a href="http://www.rug.nl">http://www.rug.nl</a> <a href="http://www.iac.rm.cnr.it/">http://www.iac.rm.cnr.it/</a> <a href="http://www.uva.es/">http://www.uva.es/</a> <a href="http://www.ee.kth.se">http://www.ee.kth.se</a> <a href="http://www.tudelft.nl/">http://www.tudelft.nl/</a> <a href="http://www.korea.edu">http://www.korea.edu</a>
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Updated  
23/03/2009

# EECI Organisational Structure

Under the French Association Law 1901 – Statutes 

Industrial  
Advisory  
Board - IAB

International  
Scientific  
Council - ISC

## Executive Committee

- Françoise Lamnabhi-Lagarrigue (President)
- Sebastian Engell (Vice-President)
- Maryvonne Giron (Treasurer)
- Samuel Costantin (Secretary)

## EECI Scientific Committee

### ➤ TECHNICAL ACTIVITIES

Contact Person: Sebastian Engell, University of Dortmund, Germany

### ➤ TOOLS

Contact Person: Bert van Beek, Technical University of Eindhoven

### ➤ WORKSHOPS & CONFERENCES

Contact Person: Eduardo Camacho, University of Sevilla, Spain

### ➤ OUTREACH AND INNOVATION

Contact Persons: Alberto Sangiovanni-Vincentelli, PARADES, Italy  
and Manfred Morari, ETH Zurich

### ➤ SCHOOLS

Contact Persons: Alberto Bemporad (Summer Schools), University of Sienna, and Françoise Lamnabhi-Lagarrigue (Graduate Schools)

### ➤ ICO – International Curriculum Optino for Doctoral Studies:

Contact Person: Antonio Bicchi, University of Pisa, Italy

### ➤ MOBILITY - Senior and junior researcher exchanges

Contact Person: Marika di Benedetto, University of l'Aquila, Italy

Nominates the  
Scientific Committee  
for 3 years

Elect the Management  
Committee for 3 years

## EECI Personals

**Project Management:** Elisabeth Kohler  
[elisabeth.kohler@cnrs-dir.fr](mailto:elisabeth.kohler@cnrs-dir.fr)  
(CNRS, voluntary)

**Technological transfert:** Jean-Michel Leroux  
[jean-michel.leroux@supelec.fr](mailto:jean-michel.leroux@supelec.fr)  
(SUPELEC-Digiteo, voluntary)

**Scientific liaison:** Antoine Chaillet  
[chaillet@ieee.org](mailto:chaillet@ieee.org)  
(UNIV PARIS SUD-SUPELEC-EECI)

**Webmaster:** Salah Laghrouche  
[salah.Laghrouche@utbm.fr](mailto:salah.Laghrouche@utbm.fr)  
(UTMB, voluntary)

**Communication:** Myriam Baverel  
[myriam.baverel@lss.supelec.fr](mailto:myriam.baverel@lss.supelec.fr)  
(CNRS, voluntary)

**Public accountant:** Christophe Rcaud  
[c.rcaud@cfecaudit.com](mailto:c.rcaud@cfecaudit.com)  
(External consultant)

**Secretary:** Eugenie Gouveia  
[eugenie.gouveia@lss.supelec.fr](mailto:eugenie.gouveia@lss.supelec.fr)  
(EECI)

## EECI Members

- PhD Students
- Individuals
- Public Organizations
- SMEs
- Companies
- Benefactors

## 3. “Marketing” Plan

### 3.1 State of the art

Networked and Embedded Control Systems (NECS) are a key enabling technology for future progress in automation in all areas of our modern society, from industrial production to transportation systems (cars, ships, trains, airplanes), communication infrastructure, consumer products and medical devices:

**Networked** indicates the tight interconnection and interaction between different elements of a system. This notion is understood in both its communication and physical aspects. Networks allow for collaboration, but the networking of (possibly simple) elements may result in complex emergent behaviours, which may be difficult to analyse.

**Embedded** refers to the computational resources, devoted to a specific task, that are closely interacting with the physical world and that usually have limited computation and communication abilities.

**Control** stands for the ability of making a dynamical system exhibit a prescribed behaviour with limited human intervention. It typically exploits the information coming from sensors and influences the system via actuators.

**System** is a notion used both from a dynamical point of view in control theory and from a functional or structural viewpoint in system engineering. In both cases, it suggests the idea of an independent element, which interacts with the environment through interfaces.

Over the past decades, the progress of technology has provided us with a set of embedded sensor systems capable of computation and communication between each other. These technological developments constitute an excellent weapon to handle the rapid growth of the complexity of processes and plants. In these emerging applications, the **tight collaboration between control, communication and software engineers has become fundamental**. In particular, research on NECS has major strategic relevance for European industry and society, since these systems form a key growth area in information and communication technologies with a broad range of applications that will affect the citizen in all aspects of their lives. **Existing and emerging areas include automotive industry, energy management, environmental monitoring, factory automation, personal communication, process industry, health and transportation, topics in which Europe is aiming to play a major role**. Contrarily to desktop computing where a few major players dominate the scene, NECS is still an open field with enormous potential in the future markets of ambient intelligence. The engineering of NECS is therefore a challenge common to a **wide scope of strategic application domains**. Although these domains are much diversified, the problems posed and the requirements for technological improvements have **a lot in common**.

### 3.2 Innovating contributions

#### 3.2.1 Scientific needs:

The EECI scope covers foundational multi-disciplinary research and proof of concept addressing the whole chain from modelling, sensing, monitoring and actuation, to adaptive and cooperative control and decision making. EECI will develop novel abstractions and methods or will adapt and extend existing techniques (i.e. Multi-agent or Hierarchical MPC, Relaxed dynamic programming, Control by interconnection). Four thematic areas (TA) have been distinguished:

- TA1 - Analysis of complex systems
- TA2 - Advanced embedded control
- TA3 - System-wide coordination and control
- TA4 - Networked control



These four TA cover challenges at different hierarchical levels of control, from the physical world to the networking and scheduling of multiple processes. Continued advances are needed to make systems easily constructible, make them self-configuring and adaptive, ensure their performance and safety, and make them user-friendly. "Interdisciplinary" is the keyword for the research outlined above because of the intricate ways in which embedded systems interact with the physical world. The scientific objectives addressed by EECl are driven by industrial needs. All theoretical developments will aim at better understanding, controlling or managing technical systems. EECl constitutes a unique initiative in this sense.

### 3.2.2 Collaborative research and training needs

EECl immediate objectives are to provide training in methodologies that can address the challenges resulting from the control of interconnected systems by taking into account communication and embedded computation limitations, in order to guarantee safety and performance of the overall networked systems.

Europe must position itself as a major player in automation, leading the development of intelligent and networked systems. Addressing this ambitious objective imposes the merging of different disciplines as well as the mobilisation of resources on a large scale.

### 3.3 Impact

At the European level, EECl will participate to address the following issues:

- Finding ways to make the European research area in embedded control more **competitive** in the international scenario, primarily with respect with the United States and Japan, by offering training in the most advanced research methods through mobilizing the intellectual resources that are available only at different sites throughout Europe;
- Achieving better **integration of European academia and industry**, allowing researchers to improve their abilities by getting stimuli and challenging their notions through elbow-to-elbow work with industrial R&D, thus training them to implement their ideas in market applications and production, while on the other hand providing industry with the scientific knowledge to be able to develop and produce higherquality products;
- Attracting the best intellects to pursue research **careers in Europe** in the field of embedded control systems, by offering them financial support delivered on excellence criteria, thus clogging the brain drain of European researchers to non-European countries. In a sector like that of networked embedded control systems, in which technological progress and new applications evolve quickly and permanently, it is crucial to be able to reactively give to motivated and brilliant students the possibility of carrying out highly motivating research.

Immediate fallout is for example expected in the following applicative domains: start-up and scheduling of chemical plants, real-time embedded electronic devices, micro combined heat power, control and coordination of autonomous vehicles, cognitive radios, low data rate communication systems, distributed monitoring of water networks, medical devices, fuel cell energy management, intelligent sensors for avionics and ventilation systems.

### 3.4 EECl « Brand Recognition »

EECl has strong 'brand recognition' within the European and international community. This is visible through:

- Dissemination activities: **major publications** (surveys, special international journal issues, handbook), organization of **major conferences and workshops**, strong

individual national and regional involvements, international collaborations (seminars, IFAC, IEEE CSS)

- International (now worldly renowned) training activities (EECI Graduate School on Control)
- EECI is an ARTEMISIA B Chamber Member

**EECI offers a legal and perennial (with a physical space, 300 m<sup>2</sup> in the heart of a new Campus Plateau de Saclay plus Lab in Univ. L'Aquila) structure making the European control community a reality.**

## **4. Operational Plan**

### **4.1 Research and Development Plan**

Driven by industrial concerns, EECI will focus on four major Training and Research Areas (TRA):

#### **TA 1 – Modelling and analysis of complex systems**

Distributed, networked, embedded control methods usually aim to address problems in large scale, complex systems. Modelling these systems and understanding their behaviour is an essential first step for the development of advanced control methods to improve their performance. In some cases, however, understanding the behaviour may even be an end in itself; this is the case for many applications in biology, where the end goal is to decipher the structure of a control systems put in place by nature. Novel analysis and modelling methods are needed to understand the behaviour of complex systems. Challenges include:

1. Compositional and hierarchical modelling and analysis
2. Emergent behaviour: understanding and analyzing how emergent behaviour arises out of distributed interactions
3. Networking effects: understanding how the network topology interacts with the primarily continuous dynamics of the underlying system.

#### **TA 2 – Advanced Embedded Control**

The new discipline merging control, computer, communication with physical or biological systems is facing new very interesting challenges. Capturing and representing the tight relationship of these two worlds expose a new set of problems that require the integration of continuous and discrete events dynamics along the path opened by hybrid systems research as well as communication and computation. Being the core of the lower level of all automation systems that are increasingly distributed and may be immersed in hostile environments, the analysis and design of embedded control algorithms is an essential technology for improving safety, performance, predictability and cost of the overall automated processes. Building on a rich heritage of decades of research, algorithms for systems with switching of the dynamics and of the inputs (hybrid systems) and tools for the analysis and synthesis of advanced control algorithms will be investigated on two fronts:

1. Methodologies for the design of such advanced control laws that are able to cope with all the constraints imposed by industrial reality and the tasks of the automation system
2. Implementation architecture that is essential to validate and optimize these designs.

Advanced embedded control is a research area where distant concepts are bridged together, e.g., the “fundamental” with the “physical”, the “continuous” with the “discrete”, the “centralized”

with the “distributed”. This is essential for pursuing effective and rationale exploitation of novel and pervasive technologies in modelling and controlling complex (large scale) systems where a number of subsystems (or components) should be considered in an integrated fashion

### **TA3: System-wide coordination and control**

Efficient resource utilization and rapid adaptation to market demands require flexible production systems where the available resources and the operating modes of the units are flexibly reconfigured to match the demands with lowest possible cost. Herein, the physical couplings and the competition for resources between the units of the overall process have to be taken into account to minimize cost and the consumption of resources, in particular energy. E.g., by optimal scheduling of the sub-processes in a chemical plant, the load as well as the load variations in utility systems for the provision of steam, hydrogen, electricity, treatment of waste gases etc. can be reduced, leading to a reduction of cost (due to lower and fewer peaks of the demand) and an energetically more efficient operation. Today, the operation of the sub-units of larger processes is often controlled quite accurately, but their interconnection is not yet taken into account. Due to the enormous complexity of the problems, plant- and enterprise-wide control and online optimization can only be implemented by decentralized, layered optimization and control schemes that delegate tasks to the lower-level systems but still achieve solutions close to the global optimum, e.g. by pricing mechanisms. The interaction of multiple elements that are efficient, safe and robust when taken individually thanks to a good design at the lower levels, has to be analysed to avoid performance deterioration and vulnerability with respect to disturbances (snow-balling or bull-whip effects) and model errors. Specific attention needs to be paid to security aspects, in particular if wireless communication is used.

### **TA4: Networked control**

While TA2 has as its fundamental goal “bridging the gap” between different paradigms to deal with the complexity of modern large scale systems, TA4 deals with systems that result from the composition of a relevant number of components (sensors, controllers, actuators) that interact in a networked context. In this domain, a multi-disciplinary approach is necessary, with the purpose of developing an explicit joint vision that encompasses control, computation and communication. Two different aspects deserve investigation:

1. Control over networks is typically concerned with the interactions between a set of components and their communication infrastructure, with limitations, but also opportunities;
2. Control of networks is about developing strategies for the automatic control of network functionalities.

## **4.2 Deployment Plan**

### **4.2.1 Training**

#### **- International Curriculum Option:**

A fundamental focus of the EECl will be to train a new generation of researchers involved in the study of embedded control systems, providing the breadth of coverage required by the interdisciplinary nature of the domain, but also the depth and strength of well funded methods to sustain principled investigation of fundamental issues. To the purposes of creating a common background and language across students in embedded control, and of exploiting synergies at the European level, EECl will undertake coordination of an International Curriculum Option for Doctoral Studies in Hybrid Control for Complex, Distributed and Heterogeneous Embedded Systems (ICO). ICO is currently regulated by a Convention for international interuniversity cooperation, originally signed by the Presidents of 14 universities (Eindhoven University of

Technology, Institut National Polytechnique de Lorraine, Kungliga Tekniska Hoegskolan, Ruhr Universitat Bochum, Universidad de Sevilla, Università degli Studi de L'Aquila, Università degli Studi di Siena, Université de Rennes 1, Université Paris-SUD 11, Universität Dortmund, University of Patras, University of Twente, University of California, Berkeley and Università di Pisa), and later extended to three further universities (Università degli Studi di Cagliari, Universidad de Valladolid, and Technische Universität Berlin). The goal of ICO is to develop, organize, enrich and promote the education and training in the theory and technology of hybrid control for embedded systems ([www.piaggio.cci.unipi.it/ICO](http://www.piaggio.cci.unipi.it/ICO)). Rather than creating new, narrowly specialized Ph.D. programs in this field, ICO has grafted a graduate Curriculum on existing PhD programs which, due to the non-uniformity of the rules and legislations, may have different durations and evaluation criteria. In order to fulfil the requirements of the Curriculum, which aims at the excellence of activities of the involved students, a program that is not less qualifying than any of the PhD programs followed by the participants is imposed. In other words, the candidate interested in applying to the Curriculum in one of the partner institution has to qualify according to all the criteria of his home institution but also to those of the Curriculum. Requirements of ICO PhD students, including e.g. training periods with foreign/industrial partners, focused summer schools and seminars, are deliberated by the Curriculum Board, who oversees to the excellence level and punctually follows the career of each involved student. The current set of rules for career advancement, thesis review and defence voted by the Board are publicly available at <http://www.piaggio.cci.unipi.it/ICO/>. The International Curriculum Option (ICO) was started in January 2006 and has already recruited over 20 doctoral students since its inception. The ICO Convention is an interuniversity initiative, not a funded project. EECI will undertake the coordination and provide necessary resources to continue ICO activities.

#### **- Schools:**

##### **1) EECI Graduate School on Control:**

Each year, independent modules on different topics of networked and embedded control are taught, one 21 hours module per week; these modules are eligible for 2nd Year Master Degree credits and Scientific Thesis modules. Topics of the EECI GSC 2008 modules include: LMI, Optimization and Polynomial Methods; Observability and Observer Design for Hybrid Systems; Optimality, Stabilization, and Feedback in Nonlinear Control; LMIs in Control; Robotics, Geometry and Control; Stability and Lyapunov Functions for Hybrid Systems; An Introduction to Networked Control Systems; Verification and Control of Non linear Systems; An Introduction to Local and Global Optimization; Hybrid Systems and Control. Previous HYCON-EECI Graduate School on Control, see [www.eeci-institute.eu](http://www.eeci-institute.eu)

##### **2) Summer Schools:**

Each two years, selected researchers will lecture at EECI Summer School on different topics of networked and embedded control, including modeling, mathematical properties, stability and stabilization, simulation, reachability analysis and verification of safety properties, observability and state estimation, model predictive control, identification, diagnosis, stochastic models, and the use of tools in industrial control applications. Previous HYCON-EECI Summer Schools: 2005: [www.dii.unisi.it/hybrid/school](http://www.dii.unisi.it/hybrid/school) and 2007: [www.dii.unisi.it/hybrid/school07](http://www.dii.unisi.it/hybrid/school07)

## **4.2.2 Research**

#### **- Technical activities:**

The scope of this activity is to organize scientific exchanges, by means of meetings, workshops, visits, joint projects, joint student supervision, and joint publications and to proactively influence the European and national research funding by roadmaps for the future such that areas with strong technological impact and of scientific interest are addressed. The immediate actions coincide with those of the HYCON network.

## **- Workshops and Conferences:**

A fundamental goal of the EECI is to promote activities aiming at enhancing scientific exchanges, disseminating information, coordinating research networks and technology transfer in the field of Networked and Embedded Control Systems within the Union. One of the first these activities will consist in launching a series of periodic conferences on Embedded Control System which will bring together most European researchers both from academy and industry as well as other international researchers in the field.

The conference will also serve to disseminate the results of the European funded projects and network of excellence in the field of Networked and Embedded Control Systems as well as new initiatives for the research programs coming both from the European Commission and the Research Community. The Conference will seek for an active participation from industry and will foster the presentation of joint works between researchers coming from industry and research centres. The quality of the papers presented at the conference will be guaranteed by a peer reviewed procedure carried out by an independent International Program Committee.

The EECI will collaborate and seek for the collaboration of the main scientific societies (EUCA, IFAC and IEEE) regarding the organization of the conference and other related activities (workshops, satellite workshops or invited sessions at international control conferences). In particular, this activity will help maintaining and stimulating the Control European Knowledge and Innovation Community.

## **- Mobility:**

One of the fundamental objectives of the EECI is to favour the interactions among members of its community. Only via sustained interactions among researchers can the goals of the EECI and of the European Community at large be reached. Visiting other Institutions interested in similar research activities can foster novel research directions and build stronger bases upon which develop an entire roadmap on hybrid distributed systems.

Researchers must be encouraged to travel to other institutions giving them the best environment to be productive and the best opportunities for synergy to be exploited for publications and for funding opportunities. The EECI activities for Mobility propose:

- To leverage the Networked Control Laboratory at L'Aquila and the Paris Laboratory founded during HYCON as the mainstays of the mobility program as these labs will offer physical locations and research facilities that facilitate joint activities.

- To support official agreements among the EECI partner institutions so that the time spent at each other's location could be counted towards degrees for students and towards advancement in the case of permanent or temporary research personnel.

- To leverage the EECI Outreach activities to include industry among the participants to the mobility program.

- To collaborate with the EECI ICO activities so that the students who participate to that program can be an integral part of the mobility program.

- To participate to the definition of the contents and the decisions about location of the EECI schools.

- To advertise widely among the community its activities so that mobility can be used to reach out to a wider user domain.

### **4.2.3 Innovation**

The activities of the Outreach Program of EECI are aimed at creating a bridge with communities that are not at present directly involved in the EECI intellectual agenda. In particular, the outreach program will focus on industry and research institutions outside the European Community. In particular, meetings will be set up with industrial organizations that have a strong interest and impact on the embedded system research directions such as Artemisia. This link has already been partially established recently and should be strengthened to bring the attention to control as a fundamental discipline for networked embedded system design. In addition, meetings and workshops will be organized with companies belonging to specific industrial segments to understand their needs and to illustrate the state-of-the-art of embedded distributed control. The organization of these interactions will leverage and benefit from the Technical Activities that are indeed partitioned according to sectors of specific industrial interest. This activity could be coordinated with the activities in the same directions of the Design Artist community. The other prong of the outreach program is the establishment of close relationships with institutions including but not limited to the ones in the US, Japan, China, India, and Korea. Good links with the US are already established by the individual researchers in the EECI. The scope of the outreach activities is to formalize and extend these relationships so that they can be of use to the entire EECI community. The outreach program will form a committee where each person will be in charge of interacting with a specific geography so that the program can be carried out in a focussed and efficient way.

#### **1) Demonstrator site & Tool repository**

From the perspective of HYCON WP3, the demonstrator site and the tool repository have already been (formally) transferred to the EECI. The new project MULTIFORM will continue the activities of WP3, and the participants will be eager to share their developments, especially the CIF, with the scientific community.

#### **2) Benchmark competitions:**

- Fuel Cell test bench at SUPELEC, Gif-sur-Yvette
- Solar Plant, Sevilla and Valladolid
- EECI NCS Lab, L'Aquila.

### **4.3 Information and Communications Technology Plan**

An EECI activity is dedicated to communication plans and its implementation. It will be used all possible ways of communication for promoting the various EECI activities at the international level. As soon as a sufficient budget will be available, a person dedicated to communication activities, including the hosting of visitors (before, during and after the stay) and maintaining the EECI Web site will be hired. Other tasks will include:

- EECI Website
- Updating annually the document: (10) reasons to join EECI
- Posters and leaflets editions
- IEEE e-letter announcements
- emails advertisements
- slides for announcements during presentations at conferences

### **4.4 Staffing Plan**

EECI being an Association under the French Law 1901, the Executive Committee works on a **voluntary basis**:

- the President: currently Françoise Lamnabhi-Lagarrigue
- the Secretary of the Association: currently Samuel Costantin
- the Tresorer: currently Maryvonne Giron

The Secretary of the Association is in charge of organizing the General Assemblies, delivering their minutes and all business related to the legal structure. This voluntary involvement should be differentiated from the EECI Secretary who is in charge of the financial management. Currently the EECI Secretary is Eugenie Gouveia (half-time CDI, permanent employment contract). EECI had to hire a half-time CDD, fixed employment contract during 4 months for helping the management during the 2009 EECI Graduate School on Control.

#### **4.4.1 Staffing Needs**

Besides the secretary that EECI has already hired (half-time), EECI will quickly need

- a full time Assistant of Direction dedicated to Communication as described in 4.3.

#### **4.4.2 Training Requirements**

Several complementary trainings for the Assistant of Direction mentioned above will be needed depending of his/her background.

#### **4.4.3 Hiring Time Table**

It is currently under discussion to have the full time Assistant of Direction hired by CNRS. A decision should come out before the end of September 2009.

#### **4.4.4 Staffing Budget**

The minimum budget needed corresponds to the salary of the EECI Secretary, 1200 EUR per month, including charges.

#### **4.5 Business Process Outsourcing Plan**

All the other needs for running EECI will be necessarily related to funded projects (from National, European or International resources). Therefore some specific funds will be allocated to these tasks. All the corresponding additional works will be sub-contracted with competent professionals'.

#### **4.6 Intellectual Property Plan**

##### **4.6.1 Legal links between EECI and its memberships**

EECI being a "light" association, it will not sign any IPR agreement with its associated Members. The only legal document signed will be with Public Organization Members and will be a **Memorandum of Understanding (MoU)**. These MoU agreements are currently in the signing process. We plan to have all the signatures of the current Public Organization members before 30 June 2009. A sample is in the Annexe of this document.

##### **4.6.2 Legal links between EECI and its Partners of funded projects**

However, IPR rules will be defined and applied in **all the consortium agreements signed between partners within the framework of the funded projects**, EECl being a partner or a coordinator of the project. These rules will follow the usual statements:

### **i) Intellectual property and Exploitation of the Results**

The conditions of the devolution of the rights of intellectual property and of exploitation of the results will be specified in the consortium agreement which will be established right after the labelling of the project, on the basis of following principles:

- Every contractor preserves the property (information, technical data patented or not...) of the knowledge generated before the project or independently of works from the project (Pre- Existing Know-How or knowledge). It is already specified that Pre-Existing Know-How or knowledge useful for the project will be listed in appendix of the consortium agreement.
- The results produced and realized by only one contractor within the framework of the Project will be the property of this contractor (own results). The results produced and realized jointly by several contractors within the framework of the Project (joint Results) will be the subject of an agreement specifying the distribution mechanism of the ownership and the exploitation rights of these joint results, any exploitation by one of the joint owners having to give place to remuneration of the other joint owners.

### **ii) Confidentiality**

Engagements of confidentiality of the contributors will be also specified in the consortium agreement. Being understood that from the moment this agreement signed on, each contributor begins to store strictly confidential the information, data, plans, in particular scientific models of any nature or techniques belonging to the other contributors of which it could have been informed at the time of the assembly or of the execution of the Project.

### **iii) Publications**

Any result from the Project submitted to a conference or journal must include a note that thanks the founders (National, European or international) to support the funding of the research work done in this project.

## **5. Financial Plan**

### **5.1 Current Financing**

- Membership Registration fees:

<b>PhD Student</b>	<b>Individual</b>	<b>Public body or SME</b>	<b>Company</b>	<b>Benefactor</b>
20 EUR	50 EUR	500 EUR	1500 EUR	≥ 500 EUR

- Management costs from funded projects: NESTER CSA (FP7)
- RTRA DIGITEO and French Ministry of Research supports for the 2009 EECl Graduate School on Control (mobility grants)
- RTRA DIGITEO support for the Fuel Cell Benchmark at Gif-sur-Yvette

### **5.2 Funding Needs**

Not essential but strongly needed: a permanent Assistant of Direction (Communication) position.



### 5.3 Funding Plan

The general resources of the Association include:

- Subscriptions
- Subsidies from government and public authorities
- All legacies allowed by legislative texts
- IPR results (when EECI is project Partner or Coordinator)
- Royalties (i.e., HYCON Handbook)
- Benefit from events (i.e., EECI Graduate School on Control)

The immediate plans are the following:

- Submission of proposals: EC (ICT, PEOPLE, ARTEMISIA) , NSF, National and Regional
- Negotiating supports from national Ministries of Research or Education (i.e., French, Italian)
- Convincing institutions and industrial to become EECI Members: a first step is that all the members of the board should convince their own institution to be an EECI member.

### 5.4 Financial History

- Membership Registration fees
- Registration fees at Conferences, Workshops and Schools
- HYCON NoE support for visiting researchers and student mobility
- Management costs from funded projects: HYCON NoE (FP6);
- RTRA DIGITEO support for the Fuel Cell Benchmark at Gif-sur-Yvette
- Université Paris Sud (months for visiting Professors)

### 5.5 Financial Forecasts

- Balance sheet (see Annexe)
- No Income statement : « L'Association EECI n'est pas soumise aux impôts commerciaux (TVA, impôt sur les sociétés et taxe professionnelle) ».
- Year projections cannot be provided because the most important of the EECI budget is depending on the continuous results of proposal submissions (and temporary negotiations with French and Italian Ministry of Research).

#### **Credit:**

- EECI Membership subscriptions
- Benefit from registration fees at Conferences, Workshops and Schools
- Management costs from funded projects

The current credit budget is estimated at: 40000 EUR

#### **Debit:**

- Salary of the EECI Secretary
- Insurance
- Public accountant
- Fonctionning

The minimum required for the running of EECI is evaluated at: 18000 EUR

### 5.6 Valuation

The annual budget is validated by a public accountant.

## 6. Risk analysis

### 6.1 Risk Evaluation

- There are no operational risks.
- There are no staffing risks: *The following page explains that, in case of termination of activity, all the consequent indemnities due to the staff are supported by AGS: [http://www.ags-garantie-salaires.org/index.php?ordre=ART\\_EDIT&idarticle=39&idPage=939486a9658ec6200c8cd9545dda90f6](http://www.ags-garantie-salaires.org/index.php?ordre=ART_EDIT&idarticle=39&idPage=939486a9658ec6200c8cd9545dda90f6)*
- There is no financing risks (see 6.2 about the reserve fund)
- There is a managerial risk: the Executive Board may not be enough strong for instilling enough dynamic.

### 6.2 Risk Management Plan

- Methods and procedures to limit liabilities:

From the EECI statutes, Article 20: **Liability**

*“The Association shall be liable for its contractual undertakings solely on the basis of its assets. None of the Association’s Members shall be personally liable with its own assets.”*

- **Reserve funds:** A reserve fund of a two years EECI budget (36000 EUR) will be voted at the next general assembly (July 2009).
- **Continuity of operations plan:**
  - i) The reserve fund will provide a two year ahead financial security for a minimum running. If this minimum is used during two years without bringing any other resources, the EECI Association will be cancelled by the Executive Committee sufficiently in advance before the time of termination so that any penalties are applied.
  - ii) The Executive Committee being elected each three years by the EECI Members, it is quite obvious that the result of this election will lead to a judicious choice of its members allowing to insure a strong momentum and thus providing a sufficient positive dynamic for a smooth continuous running.

## **ANNEXES**

- EECl Statutes
- Memorandum of Understanding
- EECl building

# **EECI**

## **European Embedded Control Institute**

*Statutes : Association according to French Law of July 1st, 1901*

### **Article 1 : Constitution and name of the association**

An association named EECI , Institut européen pour le contrôle de systèmes embarqués (in English : European Embedded Control Institute) and governed by the French Law of July 1<sup>st</sup>,1901 and the Decree of August 16th, 1901 is founded between the members adherent to the present statutes.

### **Article 2 : Purpose**

The purpose of this Association is to contribute to the development of scientific research in the area of embedded control systems, and this at European level. Three topics are emphasized: research integration, training and technology transfer.

### **Article 3 : Headquarters**

The headquarters are located at Supélec – 3 rue Joliot Curie – F-91192 Gif-Sur- Yvette Cedex , France. They can be transferred by simple decision of the Management Committee.

### **Article 4 : Duration**

The duration of the association is indefinite.

### **Article 5 : Composition**

5.1- The association is composed of :

- Active Members
- Honorary Members
- Benefactors

5.2- Active Members are individuals or corporate bodies that pay an annual subscription, the amount of which is fixed by the General Meeting.

5.3- Honorary members are those who have contributed significantly to the Association. They can be exempted from subscription and are appointed by the Management Committee. Honorary members are entitled to attend the General Meeting with speaking rights.

5.4- Benefactor members are those who pay an annual subscription which is at least ten times the amount of the subscription for active members, without actively participating in the Association.

5.5- Membership requests for active members and benefactor members are sent to the Executive Committee of the Association which solely has the power to accept them. The Committee is not obliged to justify the refusal.

5.6- Joining the Association implies acceptance of these statutes and any further decision taken by the General Meeting or by the Management Committee and an obligation to comply with them.

5.7- Members must pay an annual subscription, the amount of which and the means of payment will be fixed by the General Meeting.

### **Article 6 : Loss of membership**

The following situations lead to loss of membership without dissolving the Association:

- Resignation by letter addressed to the Management Committee
- Failure to pay subscription
- Exclusion by the Management Committee

No exclusion decision shall be taken without the person concerned being allowed to put their case. Resigning or excluded members can not reclaim the sums already paid for subscription. These sums remain the property of the Association. In the case of death of a member, his/her heirs or legal representatives do not automatically acquire the possibility of becoming a member of the Association.

#### **Article 7 : Ressources**

The resources of the Association include :

- Subscriptions
- Subsidies from government and public authorities
- All legacies allowed by legislative texts

#### **Article 8 : General Meetings**

The General Meetings include all paid up members of the Association. All decisions are binding for all members, whether absent, in agreement or not. Only members can attend the General Meetings, apart from consultance specially invited by the Management Committee. Each individual member has one vote, each corporate member, either public or private, has ten votes. Each member can only vote for one other member by proxy. Voting by mail is not allowed. The decisions are taken by a simple majority vote of the members present or represented at the Ordinary General Meeting, by a 2/3 majority vote of the members present or represented at the Extraordinary General Meeting.

#### **Article 9 : Notice of General Meetings**

The General Meetings can be ordinary or extraordinary. They are chaired by the President. The Ordinary General Meetings are convened once a year, during the semester following the end of the fiscal year. The Extraordinary General Assemblies are convened by the President in concordance with the Management Committee in case of exceptional circumstances.

All members of the Association will be convened by mail or equivalent means (fax, electronic mail, etc...) at least fifteen days before the date fixed for the meeting.

#### **Article 10 : Agenda of the General Meetings**

The agenda will be decided by the Management Committee. Only questions on the agenda will be treated at the General Meetings.

#### **Article 11 : Deliberation of the General Meetings**

To meet the quorum two members of the Management Committee must be present. If the quorum is not met, a second meeting must be convened, with the same agenda and at least six days after the first. No quorum is required for the second convocation. The decisions are made by majority vote. In the event of a tie, the President casts the deciding vote. The President and the Treasurer shall sign the minutes of the meetings.

#### **Article 12 : Ordinary General Meeting**

The Ordinary General Meeting approves the annual activity and financial reports. It approves the accounts of the previous fiscal year and votes on the budget for the following fiscal year. It deliberates on all the questions concerning the working of the Association. It confers to the Management Committee all the authorizations for accomplishing the tasks which are part of the purpose of the Association and for which the statutory powers would not be sufficient. It decides on the replacement or on the renewal of the members of the Management Committee whose mandates have arrived at the end. The Ordinary General Meeting determines the annual subscription of the members.

#### **Article 13 : Extraordinary General Meeting**

It concerns statutes changes or internal administrative changes. It can decide the dissolution of the Association or its merger with any other association pursuing a similar purpose.

#### **Article 14 : Management Committee**

The Management Committee is made up of eight members elected by the Ordinary General Meeting from the active members for three years. The members of the Management Committee are re-eligible.

It is composed of :

- the President of the Scientific Committee
- the activity leader for "Training"
- the activity leader for "Research integration"
- the activity leader for "Technology transfer"
- the Executive Committee made up of :
  - o One President
  - o One Vice-President
  - o One Secretary
  - o One Treasurer

In case of vacancy, the Management Committee has the power to provisionally replace its members. The replacements shall be confirmed by the Annual General Meeting. Members thereby elected lose office at the normal expiry date of the replaced members date.

To form a quorum 2/3 of the members of the Management Committee have to be present or represented. The decisions are taken upon a majority vote.

#### **Article 15 : Role and power of the Management Committee**

The Management Committee has extensive powers to act in the name of the Association, to authorize and oversee all matters pertaining to the Association objectives, to its functioning and in particular those matters which are not in the domain of the General Meetings. It oversees the management of the Executive Committee. It can prohibit the Executive Committee or one of its members from executing an action which is normally part of its mandate but which is deemed to be inopportune. It can delegate any power to the President. It can also delegate power to a third party or a member of the Association on specific questions. It authorizes the President to execute all purchases, sales or rentals necessary to the functioning of the Association. The Management Committee defines general policy.

#### **Article 16 : Role and power of the Executive Committee**

The Executive Committee executes the decisions of the Management Committee. Between two meetings of the Management Committee, the Executive Committee is empowered to take all necessary decisions concerning the operation of Association which do not require the approval of the Management Committee. It prepares the agenda for all Management Committee meetings. It works out all projects, propositions and suggestions which may promote the Association. It takes all necessary decisions in any relevant domains. It drafts reports on the Association activities and all financial matters. It accepts memberships or appoints a membership officer. Decisions taken by Executive Committee and the Treasurer are immediately and fully applicable.

#### **Article 17 : Power delegation**

The Management Committee can delegate its powers to an administrator or a managing director. In this case, these persons act on behalf of the Association. The extent of this delegation shall be specified in the contracts of the managing and/ or administrator.

#### **Article 18 : Scientific Committee**

A scientific made up of a maximum of ten members is elected by the Ordinary General Meeting for three years, on proposal of the Management Committee. The members of the Scientific Committee are re-eligible. It will determine the scientific strategy and implement the scientific policy of the Association.

#### **Article 19 : Formalities for notice of modifications**

According to Article 3 of the Decree of August 16th, 1901 regulating the Law of July 1st, 1901, the President must notify to the Prefecture any change related to :

- Statutes
- Name of the Association
- Transfer of the headquarters
- Members of the Executive Committee
- Members of the Management Committee
- Purpose of the Association

- Merger of the Association
- Dissolution of the Association

The register of the Association must be signed on each page by the legal representative of the Association.

#### Article 20 : **Liability**

The Association shall be liable for its contractual undertakings solely on the basis of its assets. None of the Association's Members shall be personally liable with its own assets.

#### Article 21 : **Dissolution**

In the event of dissolution pronounced by two thirds at least of the votes during the General Meeting, one or more liquidators, members or not of the Association, are appointed by the same. The General Meeting shall determine the powers to realize the assets and pay off the liabilities. The vesting shall be in accordance with Article 9 of the Law of July 1<sup>st</sup>, 1901 and with the Decree of August 16<sup>th</sup>, 1901.

The assets of the association can be transferred to another association, to a company or to any organisation of common public interest or not which has been designated by the general Meeting;

#### Article 22 : **Litigation**

In the event of a litigate involving the Association, the competent court shall be the one for the registered address of the headquarters.

Gif-Sur-Yvette, 27 May 2007

Dr. Françoise Lamnabhi-Lagarrigue  
President of EECI

# MEMORANDUM OF UNDERSTANDING

BETWEEN  
UNIVERSITY OF VALLADOLID (UVA)  
AND  
EUROPEAN EMBEDDED CONTROL INSTITUTE (EECI)

1. University of Valladolid (UVA) and European Embedded Control Institute (EECI), in desiring to develop academic exchange and cooperation in teaching and research for the advancement and dissemination of learning, agree as follows:
  - a) to allow and use their best endeavours to affect visits from one university to the other by members of the academic staff for the purpose of participating in joint teaching, joint research, joint conferences and joint cultural programs.
  - b) to offer admission from one university to the other to qualified students to undergraduate and graduate courses.
  - c) to encourage the exchange of scientific materials, publications and information.
  - d) to prepare, as necessary, additional working programs detailing specific forms and contents of cooperation.
2. The organizations UVA and EECI agree to provide exchange faculty members with proper academic status at the host institution, research facilities, access to university libraries, and other assistance and advice when necessary.
3. The organizations UVA and EECI acknowledge that all visits of staff and admissions of certified students will be subject to compliance with requirements for staff appointments and student admissions of their own organization.
4. The organizations UVA and EECI understand that any additional financial arrangements will have to be negotiated and will depend on the availability of funds.
5. The Agreement shall remain in effect for an initial period of five years. Thereafter, except for any notice to terminate it, it shall be automatically renewed from year to year. However, it is understood that either party may end this agreement anytime by mutual consent or by six months notice.

## *Agreement for Cooperation*

### European Embedded Control Institute & University of Valladolid

For this purpose, the responsible parties will be the Rector of the University of Valladolid and the Head of the European Embedded Control Institute.

*Signed on behalf of:*  
University of Valladolid

**Prof. Evaristo J. Abril Domingo**  
**Rector**  
**University of Valladolid**

Date:

*Signed on behalf of:*  
European Embedded Control Institute

**Dr Lagarrigue-Lamnabhi Françoise**  
**President**  
**European Embedded Control Institute**

Date: