Project IST – 511368
HYCON
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Hybrid Control: Taming Heterogeneity and Complexity of Networked Embedded Systems

Periodic Progress Report – PPR2

Reference period: from 15/03/2005 to 14/09/2005

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1. OVERVIEW OF PROGRESS DURING PERIOD, STATUS, ACHIEVEMENTS, DELAYS, MILESTONES, PROBLEMS (IF ANY) AND CORRECTIVE ACTIONS

1.1 Overview

The project is in line with its objectives and the milestones as mentioned in the contract have been reached. All recommendations of Review 1 have been implemented or have been faced with detailed arguments, see part 7.1 of this report. Integration activities as well as research and spreading activities are now efficiently pursuing all together in parallel with a deep concern of crossing initiatives ensuring a working flow among the WPs. This is clearly shown below in the detailed description of each WP activities and with the list of the HYCON deliverables included in Part 3 of this report. The role of the IAB and ISC has been specified and several initiatives have been conceived for the maximum benefit of HYCON as they will be operating at two levels: technical and strategic. The creation of EIHS is in a very good way after having detected its most appropriate shape, location and manager profile.

The HYCON Executive Committee is very efficient and there is a good working ambiance. Actions are unanimously decided and quickly implemented. The HYCON image is more often pushed toward rather than personal interests.

We agreed to include 3 new Institutions in the HYCON consortium, RWTH Aachen, University of Valladolid and CNR Rome, We also agreed to include a Light Association partnership with University of Pennsylvania (UPENN)

1.2 Dissemination

The deliverable D8.1.1 summarizes all the knowledge dissemination activities including a list of publications. They are also listed in the HYCON website

http://www.ist-hycon.org/wp8/index.php?p=4-Activities&wp=8

We classified them as follows:

1) Publications and Special Issues of international journals
2) Organization of Schools, Conferences, Workshops and Sessions at conferences
3) Plenary talks and Prices

Besides those already mentioned in PPR1 we would like to point out:

- 1st HYCON PhD School on Hybrid Systems, University of Siena, 19-22 July 2005.
- 1st HYCON Workshop on Automotive Applications, Parades, 25-27 May 2005

both have had a tremendous success and have been reported in additional deliverables D1.7.1 and D4c.4.1 respectively.

We have already mentioned in PPR1 the organisation of a Tutorial Session at CDC-ECC'05 - *Hybrid Control of Networked Embedded Systems*- This leads also to a contribution in a Special Issue of the European Journal of Control, *Hybrid control of networked embedded systems*, (action: John Lygeros) co-authored by A. Balluchi, L. Benvenuti, S. Engell, T. Geyer, K.H. Johansson, F. Lamnabhi-Lagarrigue, J. Lygeros, M. Morari, G. Papafotiou, A.L. Sangiovanni-Vincentelli, F. Santucci and O. Stursberg. This paper contains a survey of the main theoretical control problems that have been treated in the hybrid systems setting and classify them into stabilization, optimal control and language specification problems. We then provide an overview of recent developments in the HYCON application areas. Besides numerous accepted papers by HYCON members at CDC-ECC'05, let us also mention the *Workshop on Model Predictive Control of Hybrid Systems* organized by Alberto Bemporad.

It is also worth mentioning

- the IFAC Congress Applications Paper Prize presented to Andrea Balluchi, Luca Benvenuti, Claudio Lemma, Alberto Sangiovanni-Vincentelli, Gabriele Serra for the outsanding paper *Actual Engaged Gear Identification: A Hybrid Observer Approach.*
- the semi-plenary *Controlling Hybrid Systems From Theory to Application* by Manfred Morari and co-authored by M. Baotic, F. Christophersen, T. Geyer, P. Grieder, M. Kvasnica, D. Niederberger, G. Papafotiou

Concerning collaboration with other projects, the deliverable D8.5.1 lists the synergy actions taken place in this reporting period. A Committee has been established for executing synergy actions. Its role is to coordinate and integrate research activities across NoE boundaries. We have made initial agreements with other projects to guarantee an efficient communication between projects with the purpose of enabling continuous integration of the developed methodologies, so that the complementary results of projects can be integrated.

Joint actions with the CTS Marie Curie Multi-partner Training Site have been proceeded. 72 Person-Months have been allocated to European PhD students hosted in HYCON institutions (UNISI, UNIPI (CNR), CNRS, US). A joint CTS-HYCON Workshop started to be organized and will be held 10-12 July 2006.

Added to these projects, HYCON partners are involved in a large number of projects funded by national research agencies and industry. Several of these projects are linked to HYCON and sometimes they even provide co-funding for HYCON activities. HYCON has also provided a natural platform for project proposals.

2. MAIN ACTIVITIES AND ACHIEVEMENTS – SCIENTIFIC AND TECHNICAL PERFORMANCE

In the following we adopt the notations:

Di.j.k = deliverable **k** of **task i.j** in the workpackage **WPi**

Mi.j.k = milestone **k** of **task i.j** in the workpackage **WPi**

D = drafted ; S = submitted ; A = accepted ; Add. = Additional deliverable

2.1 WP1 – WP leader: Antonio Bicchi and Alberto Bemporad

	WP1 – Establishment of the European Institute of Hybrid Systems	**PPR1**						**PPR2**											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
1.1	Definition of the mission and of the size of the institute. Choice of financial structure																		
1.2	Choice of organizational structure																		
1.3	Choice of location of future EIHS. Sharing and common management of equipment, installations, infrastructure																		
1.4	Instituting the EIHS																		
1.5	Infrastructure set-up. Manager and staff hiring.																		
1.6	Operations Start																		
1.7	PhD Schools																		
N°	**Deliverables (D) / Milestones (M)**																		
D1.1.1	Report of the mission and the size of the institute drafted			A															
D1.1.2	Inventory of possible funding sources						S												
D1.2.1	Report on criteria for the choice of EIHS structure						S												
D1.3.1	Report on criteria for the choice of EIHS location						S												
M1.2.1	Adoption by the Executive Board of criteria for the choice of EIHS structure							X											
M1.3.1	Adoption by the EC of criteria for the choice of EIHS location and call for proposals							X											
D1.3.2	Inventory of equipment, installations and infrastructure at the disposal of the network									S									
D1.4.1	Proposed Draft Statute and Bylaws									S									
M1.1.1	Decision by the Governing Board on financial structure of EIHS									X									
M1.2.2	Decision by the Governing Board on organizational structure of EIHS									X									
M1.3.2	Decision by the Governing Board on EIHS location									X									

M1.4.1	Adoption of Statute and Bylaws by the Governing Board –Applications filed for institution of EIHS as a legal entity												X						
D1.5.1	Ideal Profile of the Manager and Call for Applications issued by the Gov. Board												M13						
D1.7.1	Report on the 1st PhD School												S						

(i) Major progress and achievements

During the second half of the first year of HYCON, the Consortium has carried out several activities to detect the most appropriate shape and location of the European Institute for Hybrid Systems (EIHS) and organized the first HYCON PhD School on Hybrid Systems.

Criteria for the choice of the most suitable structure and location of EIHS were adopted by the Executive Committee. A call for proposals for hosting EIHS was launched and five applications came from **CNRS** (Paris), **UAQ** (L'Aquila), **UNIPI** (Pisa), **UNISI** (Siena) and **UOP** (Patras). The applications were presented by each node at the ExCom meeting in Siena on July 19, 2005. In view of the importance of the decision, and of the number of applicants, the ExCom decided that the case needed further study. An agile committee of three people was elected to interact directly with the proposers to gain more insight in the implications of different choices. The final choice of the hosting institution(s) has been discussed at the ExCom meeting in Paris on September 16, 2005.

An inventory of the equipment, installations and infrastructure at the disposal of the network was prepared and reported in D1.3.2.

Regarding the structure and statute of EIHS, several examples were surveyed in D1.4.1 and presented at the ExCom meeting in Siena. The Consortium is oriented towards a non-profit association model.

In terms of dissemination activities, the 1st HYCON PhD School on Hybrid Systems was held in Siena on July 19-22, 2005. The school was attended by 112 students, of which 5 from industry and the rest attending PhD program in several countries. Remarkably, 61 out of 112 students came from universities/industries that are not affiliated with HYCON, and 85 out of 112 from outside Italy. 14 selected speakers provided lectures on different topics of hybrid systems, where 12 speakers are affiliated with HYCON and another speaker is from Upenn (now affiliated with HYCON). The school was extremely successful, in terms of didactics, of logistics, and of social events, as also witnessed by the outcome of a questionnaire distributed at the end of the school. This analysis has been reported in an additional deliverable D1.7.1.

As an outgrowth of HYCON, in the reference period a rather intense activity has been developed to prepare an International Curriculum Option for Doctoral Studies in Hybrid Systems. This involved a formal Convention to be prepared and signed by Presidents or their delegates of all involved institutions, including overseas associated partners. This activity was not included in the technical annex. However, it appears to be clearly in the interests of HYCON, and should be considered an important additional result, to be continued in the future development of the network.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

At the moment no major problems were encountered. Contrarily to the original plan, the school was anticipated to month 10. As mentioned, the final decision on the location of the Institute has been postponed, while a committee has been created in order to further study the interconnections between legal issues and local legislation and conditions. Some other activities are slightly delayed with respect to original plans, such as the decision about the details of the legal structure and statute of EIHS, due to the involved legal complexities. Activities in the following period M13-M18 have been slightly re-planned according to the cascade effect of such postponements.

2.2 WP2 – WP leader: Eduardo Camacho

	WP2 – Benchmarking	**PPR1**						**PPR2**											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
2.1	Development and implementation of a Benchmark Model-Guide																		
	Definition of the Model-Guide requirements																		
	Design and implementation of an interactive environment to assist the designers of a benchmarks																		
2.2	Preparation of benchmarking cases																		
	Preparing the installation and models for the benchmark exercises M1 and I1																		
	Preparing the benchmark documentation for benchmark M1 and I1																		
2.3	Implementation of Benchmark exercises																		
	Announcing the call for Benchmark exercises M1 and I1 and collecting proposals																		
	Selection of the accepted proposals and scheduling experiment time slots																		
N°	**Deliverables (D) / Milestones (M)**																		
M2.1.1	Set qualitative and quantitative criteria for benchmarking activities.				X														
D2.1.2	Web based Interactive Environment								S										

(i) Major progress and achievements

Task 2.1.1 – Definition of the model guide requirements

This task with a duration of 4 months, is finished. It included

1. Benchmark examples recompilation of benchmark proposed by partners.
2. Development of a questionnaire to guide benchmark developers.
3. Guidelines for control architecture to be used in the benchmark implementation step.
4. Qualitative and quantitative assessment criteria for benchmarking activities have been proposed.
5. Document M2.1.1 on Qualitative and quantitative criteria for benchmark activities prepared and uploaded on the website

Task 2.1.2 – Design and implementation of an interactive environment to assist the designer of a benchmark.

This task is finished.

1. Design and implementation of a web based environment to help benchmark developers
2. Deliverable D2.1.2 on Web based interactive environment has been submitted

Task 2.2.1 – Preparing the installation and models for the benchmark exercises M1 and I1.

US is in charge of benchmark I1 (Solar Cooling System) and the activities performed had been the preparation of the solar platform and the web based server for performing tests, the development of models and the data collection for identification.

WP2 General activities

1. WP2 website design, implementation and maintenance.
2. WP2 Meeting organization: Two specific WP2 meeting were hold, one in Zurich (March.2005) and the other one in Siena (July 2005).

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

No major problems detected. The late arrival of funds was compensated by more intensive use of unfunded Person Months by all partners and work progressed as planned.

2.3 WP3 – WP leader: Sebastian Engell

	WP3 – Tool integration	**PPR1**						**PPR2**											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
3.1	Tool repository																		
3.2	HYCON tool demonstrator site																		
3.3	Standard data format and toolbox for switched linear systems																		
3.4	Model sharing among tools																		
3.5	Co-simulation platform																		
N°	**Deliverables (D) / Milestones (M)**																		
M3.1.1	Web-site and specification of the required standard documentation available						**X**												
D3.2.1	Report on available tools for hybrid systems and interchange formats						**S**												
D3.2.2	Specification of demonstrator site functionality									**S**									
M3.3.1	Standard model interchange format defined									**X**									
D3.4.1	Specification of Modelica interface (report)											**S**							
M3.1.2	2 tools deposited											**X**							
D3.3.1	Report on toolbox design											**S**							
D3.5.1	Report on the feasibility of a co-simulation platform											**S**							

(i) Major progress and achievements

Meetings: 2005-01-17 in Dortmund on Tasks 3.4 and 3.5
2005-03-08 in Zurich on Task 3.3
2005-04-20 in Dortmund on Tasks 3.4 and 3.5
2005-06-18 in Siena, general
2005-08-10 in Eindhoven with members of SICONOS

Task 3.1: A first version of the tool repository web site was released in February (M3.1.1) and two tools were deposited in March (M3.1.2). A second version has just been released represents a significant upgrade: the search capabilities have been improved; the template and style files have been adapted to the new HYCON layout; the database scheme, terms and definitions have been changed according to the taxonomy of WP5. In the current version, tools are described and deposited using an HTML form in a uniform way. For this task, a tool developer has to logon using a back-end user-account
http://wp3.hycon.bci.uni-dortmund.de/typo3, login: repositoryeditor, password: wp3###3pw

Members of the NoE can view the tool repository using the general front-end account
http://wp3.hycon.bci.uni-dortmund.de/, login: hyconmember, password: wp3###3pw

There is a concise comparative view where the tools are arranged in a table that lists their main features, and a detailed view for each tool. The tabular view shows up to 4 tools at the same time and allows browsing through all tools. The list of tools to be displayed can be confined by specifying selectively the desired features of the tools.

Task 3.2: The specification of the HYCON Demonstrator Site functionality (D3.2.2) analyses the needs of potential users and proposes a strategy to campaign for the hybrid systems approach. The main structure of the web-portal and the desired abilities of on-line experiments were defined. Furthermore, the document clarifies responsibilities of the parties involved and proposes a work flow process that ensures a high quality results.

The implementation of the HYCON Demonstrator Site already started including the central web server and the main web pages, the database for tools and examples, the authoring tools (to ensure consistency and ease of data entry), the connection of Matlab to the web allowing parallel instances (including load-balancing, distributed computing, etc.).

Comment on task 3.1 and task 3.2: A lot of effort has been put on the selection of a powerful platform for the online presence, in order to enable a seamless integration of standard web pages, tool repository, and demonstrator site, to reduce the administration effort later on, and to being able to cope with unknown requirements in the future. The web content management system Typo3 (http://typo3.org/) seems to fit best to our needs. It is a very powerful open source software based on PHP and MySQL, and it has also been recommended by an extensive survey of the Austrian Department of Education (conclusions of the survey in German language: http://edu.typo3.com/fileadmin/edu/Studien/bmbwk-Evaluation-CMS.pdf).

Due to its versatile possibilities, it consumed a lot of time to become acquainted with Typo3 and we still are learning by doing. It is a valuable investment that will pay of when realising M3.2.2. Many of the modules realised yet can be reused for the demonstrator site.

Task 3.3: An architecture that allows for data exchange between different tools for analysis and controller synthesis of switched linear systems has been developed (M3.3.1) and documented (D3.3.1). In order to

exchange data, the Piecewise Affine (PWA) system model was selected as common model. The tool-dependent models must be converted into a piecewise affine form following the specified format for model exchanged. The architecture has three levels, so that the tool developers can exploit the platform dependent languages for converting their system model into PWA form. Then, the platform independent representation, based on XML, is obtained by a shared function.

Task 3.4: The S-function approach of Matlab Simulink is used to connect different modelling and simulation tools developed by partners of the HYCON network. The interface is documented in the deliverable D3.4.1. To realise this concept without licensing problems a Modelica library is being developed which allows embedding S-function blocks generated by other HYCON tools. Thus, the full power of object-oriented equation-based modelling provided by Modelica as well as the many already existing component libraries for different domains can be combined with the specific strengths of other HYCON simulation tools.

So far, C functions representing a switched ODE system were embedded into a Modelica model without the need to extend the language. The simulations carried out with Dymola produced good results and the state event detection worked fine.

The tool Chi has been extended to generate S-functions. These were tested with Matlab. The semantics of Chi is retained, if a model is represented by one monolithic S-function (otherwise the semantics may change).

Task 3.5: The deliverable D3.5.1 gives a survey on frameworks for hybrid co-simulation. It discusses three standards for co-simulation and comes to the conclusion that there is no approach which is satisfactory for hybrid simulation. Since the S-function approach applied in task 3.4 is already a kind of co-simulation, no additional co-simulation platform will be developed (M3.5.1).

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

The work on the HYCON Tool Repository of task 3.1 is almost done and task 3.2 is already being tackled. It is expected to finish the HYCON Demonstrator Site earlier than proposed. The Architecture for Data Interchange of Switched Linear Systems of task 3.3 is defined and the work on the implementations already started, so that the goals will be achieved in time. The same holds for the simulation interface of task 3.4. Thus, all tasks are being executed successfully.

As already explained in the first periodic progress report, the basic concept of task 3.4 changed. Because the new approach covers discrete-event interaction, the deliverable D3.4.2 *report on the definition and the semantics of an interchange format for timed DES blocks* has become obsolete.

2.4 WP4a – WP leader: Manfred Morari

	WP4a – Energy management	PPR1						PPR2											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
4a.1	Define task force goals and responsibilities																		
4a.2	Report on simulation, benchmark and control method																		
4a.3	Conclude on plans for future activities																		
N°	**Deliverables (D) / Milestones (M)**																		
M4a.1.1	Report on group activities			X															
M4a.1.2	Group meeting with industrial advisors / assignment of responsibilities					X													
D4a.1.1	Report on task force goals and responsibilities						S												
M4a.2.1	Group meeting with industrial advisors / assessment of proposals												X						
D4a.2.1	Draft Survey Report													S					
M4a.3.1	Evaluation of task force progress																X		
D4a.3.1	Final Report																		X

(i) Major progress and achievements

The WP4a on Energy Management focuses on the development of Hybrid Control Techniques for applications related to the production, distribution and conversion of electric energy. The work done during this period (M7 – M12) has followed the plan of the workpackage, as it was defined by the partners during the first six months of the project.

According to the schedule, the partners have focused on task 4a.2, "Report on simulation, benchmark and control methods". In preparation for this task, the research effort of the partners was organized along three main focus areas:

- Modelling and Simulation Tools,
- Power Generation and Transmission Control, and
- Power Electronics Control.

A person responsible for the coordination of the partners, and an internal (within the WP4a) document to be delivered at the end of the round of activities was assigned for each focus area. The progress of each focus area was reviewed in the milestone meeting (M4a.2.1) of the partners that took place in Zurich, on July 11 and 12, 2005.

The three documents that were delivered by the coordinators are the building elements of the Deliverable D4a.2.1, "Draft Survey Report on Modelling Tools, Benchmarks and Control Methods", which was submitted on September 14th, 2005 (at M12 instead at M13). More specifically:

Modelling and Simulation Tools
The partners involved in this area investigated the available modelling and simulation tools that are applicable for power systems and power electronics control.

- Coordinator: J. Buisson
- Deliverable: Draft Report on Modelling Tools

Power Generation and Transmission Control
In this thematic area, the partners defined benchmark examples related to the control of power generation and transmission systems, and reported on the control methods that will be used.

- Coordinator: B. De Schutter
- Deliverable: Definition of Benchmark Examples for Power Generation and Transmission Control

Power Electronics Control
The activities of the Power Electronics Control focus area comprised problems related to dc-dc conversion. The involved partners also defined benchmark examples describing different control problems on dc-dc converters, and reported on the control methods that will be used.

- Coordinator: G. Papafotiou
- Deliverable: Definition of Benchmark Examples for the Control of dc-dc Converters

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

During the period covering M7 to M12, the work done in the framework of the WP4a followed the schedule that the partners adopted during their first round of activities. No deviations were observed or correcting actions deemed necessary. The deliverable D4a.2.1, "Draft Survey Report on Modelling Tools, Benchmarks and Control Methods" provides a detailed overview of the activities of the WP4a partners and a comprehensive planning of the future steps.

2.5 WP4b – WP leader: Sebastian Engell

	WP4b – Industrial controls	PPR1						PPR2											
N°	**Tasks**……..Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
4b.1	Procedures for development and verification of safety related discrete controls																		
4b.2	Control of large transitions in processing plants																		
4b.3	Plans for the future																		
N°	**Deliverables (D) / Milestones (M)**																		
M4b.1.1	Choice of 3 case studies for safety.related discrete controls						X												
M4b.2.1	Definition of a benchmark for large transitions in the processing industries						X												
M4b.3.1	In depth look at the dissemination activities, recommendations for the future									X									
M4b.1.2	Documentation of the case studies in abstracted form where necessary											X							
D4b.2.2	Report on the benchmark example for the consortium												S						

(i) Major progress and achievements

Status of the Case Studies and the Application of Design Techniques

For the case studies considered within the two strategic areas, the following activities were carried out in the reporting period:

- Area 'Safety-related discrete controls':
  - Landing system: a document reporting on an extended Petri net model and on verification results based on ehaviour abstraction has been provided by CNRS.
  - Fuel cell system: US prepared a more detailed description including verifications tasks for the fuel cell system.
  - Evaporator module: a verification problem for a safety-related discrete controller supervising an industrial evaporation system was newly developed by UNIDO.
- Area 'Large transitions in processing plants':
  - End section of a sugar plant: UVA currently reviews the system to identify a part of this industrially relevant system, for which a task of the category 'large transitions' can be defined.
  - Laboratory tank system: UVA provided a full description (including the hybrid model) and a simulation model is available in the language EcosimPro.
  - Industrial furnace (proposed by UP): A control task of common interest is not yet defined for this system, and it will likely not be considered in the further work of the work package.
  - Multi-product batch plant: While a complete model and description was already available at the beginning of the reporting period, UMD has produced and published application results in the last months.
  - PVC production plant: UCL has obtained first application results for this system, as documented in a conference paper (see below).
  - Multi-stage evaporator: UNIDO has completed the description and implemented a simulation model in Matlab (available through the webpage of WP4b). The simulation results show possible start-up sequences for the evaporator.
  - Open plate reactor: LTH has recently suggested and documented this new case study. The interesting aspect is that it involves a hybrid system with distributed parameters. A complete problem description containing a task description of general interest is expected to be provided soon.

Meetings

The second meeting of the work package took place on July 18 in Siena, and the topics discussed during the meeting can be summarized as follows:

- The participating nodes briefly presented their activities since the first meeting (January 28, Dortmund). The presentation slides are posted on the webpage of WP4b as far as they have been made available.
- It was discussed to which extent the strategic area 'safety-related discrete controls' can be strengthened, since at that point only one case study was fully developed (landing system; not in the core area of process control), and for a second (fuel cell system) only a preliminary description was available. It was planned to investigate, for which of the case studies proposed for the area 'large transitions', a safety-related analysis task can be defined. The new verification task for the evaporation system is an outcome of this investigation.
- Plans for improving dissemination of the work of WP4b in the future were discussed, leading to the milestone report M4b.4.1.
- It was clarified which groups can make tools available for the design of controllers for hybrid industrial systems. It was planned to insert links to these tools into the webpage of WP4b (and to insert the tools into the tool repository of WP3 if possible).
- The preparation of the reports which are due in the period M10 to M12 was discussed.
- Possible topics for the work in the period M13 to M30 were identified. These discussions were continued per email and led to a report on future planning in M12.

- The simulation model for the case study 'multi-stage evaporator' was presented by the node UNIDO.

Minutes of the meeting with a detailed description of planned actions can be downloaded from the webpage 'astwww.bci.uni-dortmund.de\hycon4b' [username: hyconer, password: 04hycon08].
It was decided to schedule the third meeting of WP4b for mid of December 2005 such that it takes place before or after the CDC-ECC conference in Seville (Spain).

Dissemination

For disseminating the outcome of the work of the WP4b, the following publications on the cases studies were submitted and accepted:

- T. Moor, J. Raisch: Hierarchical Hybrid Control of a Multi-Product Batch Plant. *16th IFAC World Congress* (Prague), 2005, Paper-ID: WeM12-TO/3.
- J. Raisch, T. Moor: Hierarchical Hybrid Control Synthesis and its Application to a Multi-Product Batch Plant. In: *Control and Observer Design for Nonlinear Finite and Infinite Dimensional Systems*, Springer Series LNCIS, Vol. 322, 2005.
- I. Simeonova, F. Warichet, G. Bastin, D. Dochain, Y. Pochet: Online Scheduling of Hybrid Chemical Plants with Parallel Production Lines and Shared Resources: a Feedback Control Implementation. *17th IMACS World Congress on Scientific Computation, Applied Mathematics, and Simulation*, 2005, Paper-ID: T5-I-76-0718.
- S. Haugwitz, P. Hagander: Process Control of an Open Plate Reactor. *16th IFAC World Congress* (Prague), 2005, Paper-ID: ThA06-TO/2.
- C. de Prada, S. Cristea, D. Sarabia, W. Colmenares: Hybrid Control of a Mixed Continuous Batch Process. *European Symposium on Computer-Aided Process Engineering (ESCAPE 14)*, 2004, 473-484.
- C. de Prada, D. Sarabia, S. Cristea: NMPC of a Hybrid Continuous Batch Process. *European Conference on Mathematics for Industry (ECMI)*, 2004, Ref. 15.
- D. Sarabia, C. de Prada, S. Cristea, R. Mazaeda, W. Colmenares: MPC Control of a Sugar House. *International Workshop on Assessment and Future Directions of Nonlinear Model Predictive Control*, 2005.

Furthermore, the following lecture within the 1st HYCON-PhD School on Hybrid Systems provided an overview of different methods for hybrid control applied to industrial systems:

- O. Stursberg: Hybrid Systems in Industrial Process Control. *Lecture within the 1st HYCON-PhD School on Hybrid Systems*, Siena, July 2005.

At the upcoming CDC-ECC conference, the following tutorial paper will give a survey of hybrid control techniques for industrial systems:

- S. Engell, O. Stursberg: Hybrid Control Techniques for the Design of Industrial Controllers. Accepted for: *44th IEEE Conf. on Decision and Control and European Control Conf.*, 2005.

The webpage of the work package has been adapted to the new general style of HYCON. Future efforts to disseminate the results obtained in WP4b are described in M4b.4.1.

Reports prepared and submitted during the reporting period

- M4b.4.1: In depth-look on the dissemination activities and future recommendation.
- M4b.1.2: Documentation of the case studies for the area safety-related discrete controls.
- D4b.2.2: Report on the case studies for the area large transitions of processing plants.
- Report on future plans for the work of WP4b during the period M13 to M30.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

One of the discrepancies (between status and plan) which was reported in PPR1 (less than three case studies in the area ‘safety-related discrete control’) is now resolved by providing the verification task for the evaporator system as additional case study.

The relatively high number of case studies in the area ‘large transitions of processing plants’ is intentionally kept, since the six proposed systems (those listed above without the furnace system) address different aspects that are relevant for the work of WP4b. However, from the current point of view, the three systems *multi-product batch plant*, *PVC production line*, and *multi-stage evaporator* establish the set of case studies on which future work will focus in this area, since a complete hybrid model and problem statement is available and industrial relevance is clearly given. The case study *sugar plant* will be shifted into this category when a suitable task is defined.

Another deviation from the original plan is that the task ‘Planning of future work’ has been moved from M17-18 to M12.

2.6 WP4c – WP leader: Alberto Sangiovanni-Vincentelli and Andrea Balluchi

	WP4c – Automotive control	PPR1						PPR2											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
4c.1	Hybrid models for automotive control																		
4c.2	Engine and vehicle control during fast transients																		
4c.3	Design methodologies for embedded automotive control systems																		
4c.4	Plans for the future																		
N°	**Deliverables (D) / Milestones (M)**																		
M4c.1.1	Analysis of hybrid interactions in engines, powertrains and vehicle dynamics				X														
M4c.1.2	Analysis of injection, ignition and combustion processes in GDI and HCCI engines				X														
M4c.2.1	Analysis of event-based and time-triggered actions in multivariable engine control						X												
M4c.2.2	Identification of the hybrid behaviors in traction and braking control						X												
M4c.3.1	Analysis of the major effects of the implementation on closed-loop performances								X										
M4c.4.1	In depth look at the dissemination activities, recommendations for the future									X									
M4c.3.3	Analysis of requirements for hybrid models in automotive software product lines									X									
D4c.1.1	Hybrid models of automotive powertrains and braking systems												S						
D4c.1.2	Hybrid models of GDI SI engines suitable for control design												S						
D4c.1.3	Hybrid models of HCCI engine suitable for control design												S						
D4c.2.1	Formulation of hybrid control problems for vehicle dynamics and engine control												S						
D4c.3.1	Hybrid models representing implementation details of control algorithms												S						
D4c.3.2	Comparison of techniques for representing & binding variability in hybrid models												M18						
D4c.4.1	Proceedings of the First HYCON Workshop on Automotive Applications of Hybrid Systems												S						

(i) Major progress and achievements

In this reporting period, the Partners proceeded working on the projects that had been reported in the six-month report with the inclusion of some new additional topics. The contributions of the Partners to each task, milestone and deliverable are summarized in the table below that reports the open projects in the workpackage.

Partner	Tasks	Research Project	Milestone/ Deliverable
CNRS	Task 4c.1	Hybrid modelling of anti-lock brake systems	D4c.1.1
ETHZ	Task 4c.1	Control and state estimation of mechanical systems with backlash: a hybrid approach	D4c.1.1
	Task 4c.1	Application of model predictive control for lateral vehicle stabilization	D4c.1.1
INRIA	Task 4c.1	Observability analysis and state observers for discrete-time piecewise affine models of automotive powertrains with backlash	D4c.1.1
UPAT	Task 4c.2	A hybrid system approach to off-tracking suspension in multi-articulated vehicles	D4c.2.1
UAQ	Task 4c.1	Digital idle speed control of automotive engines	D4c.2.1
UNIPI	Task 4c.1	Hybrid model of electronically-controlled limited slip differential	D4c.1.1
UNISI	Task 4c.1	Explicit hybrid optimal control of direct injection stratified charge engines	D4c.1.2
	Task 4c.2	Hybrid model predictive control application towards optimal semi-active suspension	D4c.2.1
PARADES	Task 4c.2	Actual engaged gear identification: a hybrid systems approach	D4c.2.1
	Task 4c.4	WP4c dissemination activities	M4c.4.1
	Task 4c.4	Proceeding of the "*First HYCON Workshop on Automotive Application of Hybrid Systems*"	D4c.4.1
PARADES / UNIPI	Task 4c.3	An integrated control-implementation design methodology	D4c.3.1
	Task 4c.1	Hybrid modelling of the common rail	D4c.1.3
	Task 4c.2	Control of the high-pressure pump in common rail injection systems	D4c.2.1
TUD	Task 4c.2	A comparative assessment of PWA-MPC methods for adaptive cruise control	D4c.2.1
	Task 4c.2	Validation of fault-tolerant controllers for automotive applications	D4c.2.1
KTH	Task 4c.1	Fuel economy for heavy vehicles	D4c.2.1
LTH	Task 4c.1	Hybrid models of HCCI engine suitable for control design	D4c.1.3
UCAM	Task 4c.1	Exhaust after-treatment supervisory control	D4c.2.1

As shown by the long list of projects, the research activities carried out by the Partners cover a wide spectrum of topics in automotive hybrid control, including engine and vehicle dynamics control, exhaust after-treatment and energy management.

After one year only, most of the projects are at a preliminary stage. However, the opportunities for the application of hybrid systems techniques have already been clearly identified in all projects. The first results achieved in some of the projects provide evidence of the advantages of approaching automotive control using hybrid systems techniques.

In general, the contributions are of high quality and demonstrate a mature insight of the team in automotive control. The deep expertise of the team is the result of long-term collaborations with the automotive industry. A relevant part of the projects had been proposed by industrial partners and are developed in tight interactions with them.

The fruitful collaborations with OEMs and Tier-1 automotive companies and their interest in the research activities carried out within this workpackage are also demonstrated by the affiliations to HYCON received in the first year from important automotive industries and tools providers: Ford Motor Corporation, Drivetrain Innovations, Swedish Defence Research Agency (Premium Member Companies); Ferrari Gestione Sportiva, Pirelli Labs, The MathWorks (Associate Member Companies). HYCON affiliation by Centro Ricerche Fiat, CNH, Magneti Marelli Powertrain, Renault is being processed. This successful result has been achieved in collaboration with workpackage WP6 within the industrial partner engagement activities.

An important opportunity for interactions between the partners and dissemination was the "First HYCON Workshop on Automotive Applications of Hybrid Systems" held in Rome on May 26-27, 2005, where most of the partners presented the projects under development and discussed the approaches and preliminary results with the participants from automotive industry.

The major contributions to each task of theWP4c workpackage are briefly summarized below.

Task 4c.1 – Hybrid models for automotive control

Initially devoted to hybrid modelling of automotive engines, in particular of Gasoline Direct Injection (GDI) engines and Homogeneous Charge Compression Ignition (HCCI), this task has been extended to include modelling and analysis of automotive drivelines and vehicle dynamics.

Hybrid modelling of automotive engines was applied to describe the behaviours of GDI and HCCI engines, as well as the common rail injection system for compression ignition engines.

- GDI engines (also referred to as DISC engines) have two operating modes: the stratified charge (with non-homogeneous fuel-air mixture) and the homogeneous charge (with homogeneous fuel-air mixture). The stratified mode is characterized by low pumping and thermal losses, which result in improved fuel economy. However, it can be sustained in a restricted part of the engine operating range only (at low loads and low engine speed). A hybrid model of the GDI engine representing the two operation modes is proposed. Based on the proposed model, optimal controllers that minimize fuel consumption by optimizing the switching between the homogeneous and stratified modes are investigated (see deliverable D4c.1.2).

- HCCI engines are innovative engines that are characterized by high efficiency and very low emissions. The control of the combustion timing is identified as the most challenging problem for HCCI engines. In order to guarantee combustion stability in the high-load region, feedback control has to be used. The estimation of the combustion state is then necessary to avoid the use of expensive sensors. Hybrid modelling of the HCCI engine is investigated and an approach to the on-line estimation of the crank angle of 50% burnt is proposed. (see section "*Hybrid Models of HCCI Engine Suitable for Control Design*" of deliverable D4c.1.3).

A hybrid model of a new common rail fuel injection system conceived by Magneti Marelli Powertrain for Diesel engines has been developed. In the proposed injection system, high efficiency is obtained by the introduction of a flow rate valve before the high-pressure pump, which allows for effective fuel flow control. Hybrid interactions in the common rail system are due by the continuous fuel flow through the regulation valve and the impulsive behaviour of the high–pressure volumetric pump and the fuel injectors. Being the pump powered by the camshaft, fuel delivery occurs at the frequency of 3/2 the engine speed, while sequences of fuel injection occur at twice the engine speed. (see section "*Hybrid modelling of the Common Rail*" of deliverable D4c.1.3).

Hybrid modelling proved to be useful for representing and analysing the behaviour of automotive drivelines.

Hybrid models of mechanical transmission systems with backlashes, used in automotive applications, have been developed. Benchmark problems for hybrid control and identification strategies can be defined based on the proposed driveline hybrid models. Advanced hybrid systems design methodologies have been analyzed and the feasibility of the obtained control strategies has been assessed using the proposed driveline

hybrid models (see section "*Control and state estimation of mechanical systems with backlash*" of deliverable D4c.1.1).
Furthermore, a dead-zone hybrid model of backlash has been integrated in a discrete-time piece-wise affine (PWA) model of an automotive driveline. Then, the hybrid model is analyzed with the final goal of designing a state estimator. Knowledge of the driveline state is fundamental to achieve effective driveability control. The observability properties of the system have been investigated by using a recently developed algorithm for evaluating the maximal observable sets for hybrid systems. (see section "*Observability analysis and state observers for discrete-time piecewise affine models of automotive powertrains with backlash*" of deliverable D4c.1.1)

The impact of hybrid systems modelling in vehicle dynamics control has also been investigated.

A detailed hybrid model of a limited slip active differential for F1 cars has been developed. The use of a limited slip differential has major effects on the cornering behaviour of the car, because it plays an important role in determining the under-steer or over-steer characteristics. The model has been developed in collaboration with Ferrari Gestione Sportiva that provided us with experimental data for identification and validation. The proposed model has been analyzed to identify possible improvements in braking, traction and cornering behaviours. (see section "*Hybrid model of electronically-controlled limited slip differential*" of deliverable D4c.1.1)
Furthermore, by using hybrid modelling techniques, a simplified model of a car in tire-slipping mode has been proposed. Usually, vehicle dynamics control strategies include predictors that provide future state estimations (under opportune validity conditions and for a wide range of road conditions). Such predictors are based on vehicle dynamics models. Hence, the availability of simplified and yet meaningful models is essential to both drastically simplify controller design and obtain control algorithms with feasible implementation requirements. Existence of limit cycles in the proposed models is investigated using Poincare's maps. This research was partially supported by PSA Peugeot Citroen. (see section "*Hybrid modelling of anti-lock brake systems*" of deliverable D4c.1.1)

Finally, hybrid techniques are applied to lateral vehicle stabilization control. The problem considered here is the rejection of the side wind disturbance acting on a vehicle. A hybrid model of the lateral dynamics has been developed. Nonlinear static relations in the model are approximated by means of parameter-varying and piecewise-affine functions. Then, active steering control is investigated to cope with insufficient engine and brake interventions on slippery roads and in emergency situations. The control law is based on Model Predictive Control algorithms for hybrid systems (see section "*Application of Model Predictive Control for lateral vehicle stabilization*" of deliverable D4c.1.1)

Task 4c.2 – Engine and vehicle control during fast transients

Hybrid systems design techniques have been applied to several automotive control problems regarding engine, powertrain and vehicle dynamics control, as well as energy and emissions management.

A multi-rate hybrid control strategy for common rail pressure regulation in fuel injection systems has been proposed. The approach to the design of the hybrid control algorithm derives from an accurate analysis of the hybrid model of the common-rail system developed in Task4c.1. By applying hybrid systems design methodologies, controller design is achieved taking into account both the slow time–varying frequency of the high–pressure pump and the fast fixed frequency of sensing and actuation, which are affected by a relative drift being the former synchronized with the engine speed. (see section "*Control of the high-pressure pump in common rail injection systems*" of deliverable D4c.2.1) .

A hybrid control strategy for idle speed control of spark ignition engines has been designed on the basis of a hybrid model that accurately describes the behaviour of the engine at idle regime. The objective is to maintain the engine speed within a given range, robustly with respect to engine load changes. The constraint on the engine speed has been formalized as a safety specification for the hybrid engine model. Hybrid verification techniques are used to compute the safe set and to obtain the controller taking into account that sampling times and engine model switching are not synchronized. (see section "*Digital idle speed control of automotive engines*" of deliverable D4c.2.1).

Engine control strategies achieving high performance and efficient emissions control depend critically on the knowledge of the actual engaged gear. A hybrid algorithm for on–line identification of the actual engaged gear has been developed. The behaviour of the driveline is described by a hybrid model, where the engaged gear and clutch connection state are represented as discrete states. The actual engaged gear estimation problem corresponds to the identification of the discrete state of the driveline hybrid model. The proposed

algorithm is obtained by applying hybrid observer design techniques. The algorithm has been validated by extensive simulations, using a very accurate hybrid model of the driveline, and by experimental data. (see section "*Actual engaged gear identification: a hybrid systems approach* of deliverable D4c.2.1).

The design of adaptive cruise controllers (ACC) has also been considered. The main objective is to ensure a minimal separation between the car equipped with the ACC and a preceding car. A fairly good approximation of the real system is achieved by piecewise affine (PWA) approximation of nonlinearities in the model. The problem, which is formalized as a constrained optimization problem, represents an interesting benchmark for the design of model predictive controllers for PWA systems (see section "*A comparative assessment of PWA-MPC methods for adaptive cruise control*" of deliverable D4c.2.1).

Furthermore, hybrid model predictive controller has been investigated for the semi-active suspension systems. To reduce the complexity of the control laws, new solutions are derived by recurring to sub-optimal "clipped-optimal" and "steepest gradient" methodologies. The performances achieved with different optimization horizons have been compared along with the complexity of the corresponding explicit MPC controllers (see section "*Hybrid Model Predictive Control Application Towards Optimal Semi-Active Suspension*" of deliverable D4c.2.1).

Moreover, hybrid controllers for road trains, i.e. multi-articulated vehicles consisting of a tractor pulling a large number of semi-trailers, have been studied. The major problem in road trains control is the off-tracking problem, i.e., the deviation of a pulled vehicle from the paths of its preceding vehicles. Accurate hybrid controls of the trailers junction positions have been designed in order to realize optimal sliding junction control and to drastically suppress off-tracking (see section "*A hybrid system approach to off-tracking suspension in multi-articulated vehicles*" of deliverable D4c.2.1).

Fuel economy is one of the most important properties of heavy vehicles. A hybrid model has been used to predict the energy consumption of heavy vehicles and to design optimal strategies for the energy consumption minimization. The hybrid model, which has been obtained by assembling several sub-models, is a multi-domain model and accurately represents power consumption in the longitudinal motion of the vehicle on hill paths. Energy optimal control of the cooling system has been investigated, assuming on-line information about the road and driving conditions ahead of the truck (see section "*Fuel economy for heavy vehicles*" of deliverable D4c.2.1).

Finally, a hybrid control strategy for purging exhaust pollutants, such as diesel particulate filters, from the after-treatment system has been investigated. The objective is to minimise the extra fuel consumption necessary for purging and regeneration, avoiding reaching undesirable states. The DPF is regenerated by running at an increased temperature for a short period to burn off the collected soot every few hundred miles (see section "*Exhaust after-treatment supervisory control*" of deliverable D4c.2.1).

Task 4c.3 – Design methodologies for embedded automotive control systems

The introduction of hybrid systems techniques in design methodologies for automotive embedded systems has been investigated.

A successful design of automotive control systems, without costly and time consuming re-design cycles, can be achieved only by using efficient design methodologies that allows for component re-use and evaluation of platform requirements at the early stages of the design flow. An integrated control-implementation design methodology has been investigated to address the design in the top layers in the automotive design flow. Hybrid modelling and verification techniques are extensively used to obtain quantitative results that guide design space exploration (see section "*An integrated control-implementation design methodology*" of deliverable D4c.3.1).

A methodological approach for probabilistic performance validation of automotive fault-tolerant controllers has been investigated. The proposed approach has been applied to the validation of an advanced driver assistance system (ADAS). The unavoidable risk of failure (though small) has been compared with the one obtained using other conventional validation process (e.g. test drives) based on probabilistic analysis. (see section "*Validation of fault-tolerant controllers for automotive applications*" of deliverable D4c.3.1).

Task 4c.4 – Dissemination activities

The results achieved within this workpackage have been presented at several international congresses and had been published on journals. Some topics have also been presented at "*First HYCON PhD School on Hybrid Systems"*.

A detailed description of the dissemination activities is given in the report on the milestone M4c.4.1. "*In depth look at the dissemination activities, recommendations for the future"*.

The paper "*Actual engaged gear identification: a hybrid observer approach*", by A. Balluchi, L. Benvenuti, C. Lemma, A. L. Sangiovanni-Vincentelli, and G. Serra, reporting a research activity supported by this workpackage received the IFAC Congress Best Applications Paper Prize at the 16th IFAC World Congress held in Prague (CZ) in July, 2005.

Moreover, seven papers have been submitted by HYCON partners to the Special Issue on "*Advanced design methodologies in automotive control*" of the International Journal of Control, which will be published beginning of 2006.

Furthermore, a major dissemination event was the "*First HYCON Workshop on Automotive Applications of Hybrid Systems*" held in PARADES, Rome (I), on May 26-27, 2005. The aim of the workshop was identifying challenges and opportunities for hybrid systems in automotive design. In particular, the following topics were discussed: industrial trends and concerns; methodologies, flows and tools; theoretical open problems. The workshop was attended by HYCON partners and representatives from automotive companies: DTI, Elasis, Ferrari, Ford, Renault, and Scania. Alberto Sangiovanni Vincentelli (PARADES, Univ. of California at Berkeley), Antonio Bicchi (Univ. of Pisa) and Gabriele Pieraccini (Ferrari Gestione Sportiva) gave invited presentations. The proceedings of the workshop have been collected in the deliverable D4c.4.1 "*Proceeding of the First HYCON Workshop on Automotive Applications of Hybrid Systems*".

Finally, seminars on the application of hybrid systems techniques to automotive control problems had been given by PARADES at Magneti Marelli Powertrain, CNH, and Ferrari Gestione Sportiva.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

The status of milestones and deliverables due in period M7-M12 is as follows.

- Planned milestones and deliverables that have been finalized:
    - Milestone M4c.3.1: achieved in M7, in advance with the schedule;
    - Milestone M4c.4.1: scheduled for M9 and achieved in M12.
    - Deliverables D4c.1.1, D4c.1.2, D4c.1.3, D4c.2.1, D4c.3.1: delivered in M12 as planned;
- Additional milestones and deliverables that have been finalized:
    - Milestone M4c.3.3 "Analysis of requirements for hybrid models in automotive software product lines": additional milestone of Task4c.3 introduced in M7.
    - Deliverable D4c.4.1 "Proceeding of the "First HYCON Workshop on Automotive Application of Hybrid Systems": additional deliverable of Task4c.4 delivered in M12.
- Planned milestones and deliverables that have not been finalized:
    - Deliverable D4c.3.2: due at M12, postponed to M18 due to missing HYCON support by one partner for administrative difficulties.

Due to the high number of partners involved in the WP4c workpackage and the high number of open projects, the coordination effort is highly demanding. More collaboration among the partners will be asked in the future to reduce the coordination effort for the WP leaders.

2.7 WP4d – WP leader: Fortunato Santucci and Karl Henrik Johansson

	WP4d – Multimedia communication networks	PPR1						PPR2											
N°	**Tasks**……..……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
4d.1	Survey of control problems in wireless communications																		
4d.2	Hybrid modelling and control in selected wireless environments																		
4d.3	Survey of control problems in end-to-end communications through heterogeneous networks																		
4d.4	Plans for the future																		
N°	**Deliverables (D) / Milestones (M)**																		
M4d.4.1	In depth look at the dissemination activities, recommendations for the future									**X**									
D4d.1.1	Report on control problems in wireless communications									**S**									
D4d.1.2	Report on distributed control over wireless networks										**S**								
M4d.2.1	Selection of two case studies												**X**						
M4d.1.2	Decision on promising topics to be addressed in future investigations												**X**						

(i) Major progress and achievements

WP4d is about the development and application of hybrid methodologies for networked control systems. Networked systems are pervasive in control applications today, as they are on factory floors, in automobiles, in airplanes, in hospitals and homes. Their role is to monitor the behaviour of systems, to control the system so that a desired behaviour is obtained, and to distribute information. The strategy of WP4d is to impact on specific problems in control over wireless networks, demonstrate through case studies and disseminate through tight collaboration with industries and other initiatives.

The activities of WP4d have during this period being focused on finalizing two deliverables and on the identification of two case studies in the area of networked control. Part of the work was presented in the first two deliverables (D4d.1.1 and D4d.1.2). The deliverables summarize the state-of-the-art in hybrid technology as it pertains to networked control, they present opportunities for further applications, and they discuss focusing areas and potential case studies within WP4d. The documents have been delivered according to the initial schedule and all partners have provided their planned contributions.

The second workpackage meeting was held on July 18, 2005 in Siena and was attended by nineteen participants. Partners provided detailed presentations of their research activities and joint research efforts, and future plans were discussed. Selenia Communications spa from the IAB participated and gave useful advice. A particular emphasis was put on the work of defining joint test beds and experimental activities. This work is proceeding well and will be reported in next deliverable. It includes a quite extensive mobility of faculty, postdocs, PhD and MSc students between WP4d partners. A cross-WP activity with WP4c on wireless automotive manufacturing is being developed.

Dissemination activities has advanced through several actions. A contact has been established with the NoE NEWCOM and a the opportunity to plan a joint workshop has been considered. Close link has been established with the newly founded IFAC Technical Committee on Networked Systems. Possibilities of joint future initiatives will be investigated. WP4d has succeeded in attracting substantial industrial interest. Relations in the area of networked control have been established with ABB, Comau, Ericsson (IAB), Swedish Defence Agency (IAB), Scania (IAB), Schneider, Selenia Communications (IAB), Siemens CNX (IAB), and Thales (IAB). Recently, Micron Technologies has expressed formal interest, and Atmel Gr is about to join the initiative. The industrial partners are taking an active role in the selection of case studies discussed above and also provide frequent feedbacks in the frame of close contacts established with HYCON partners.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

Progress of activities has proceeded according to the workplan. As a result of the initial work and comments by the Project Reviewers and Programme Officers, we have taken actions to more clearly define the focus of the work area as described in D4d.1.1 and D4d.1.2. In this process, it was also decided to change the name of the workpackage to “Networked Control”, which better reflects the objectives and the focus. No other change to the Description of Work was needed, but rather an explicit effort to finalize the activity during the next phase of the project to the topic of control over networks.

D4d.1.1: Report on control problems in wireless communications
The deliverable was submitted according to the schedule to the Commission, and was also submitted for review by ISC members, who provided encouraging feedbacks. The report provides a basic motivation for the considered hybrid control problems, a short survey of available literature and a discussion on integration with other workpackages and potential industrial impact. Opportunities for hybrid control in wireless communication systems are discussed together with joint research activities conducted within WP4d. It is evidenced how these opportunities arise when network control functionalities are properly modelled as complex dynamical systems with a hierarchy of cascaded control loops.

D4d.1.2: Report on distributed control over wireless networks
The deliverable was submitted according to the schedule to the Commission. It provides a basic motivation for the research line and a short survey of available literature. The deliverable also discusses motivations and challenges for using hybrid systems methodologies for networked control. The joint research activities

conducted within WP4d are discussed. The research activities encompass distributed coordination of agents, fundamental limitations of networked and quantized systems, cross-layer mechanisms based on joint control and communication design, and monitoring and control over ad-hoc wireless sensor networks. Ongoing experimental activities at various partners sites are also briefly documented.

M4d.1.2: Decision on promising topics to be addressed in future investigations
This milestone has been intended as the basic module for defining the research program for the second year. The activity is briefly documented in the minutes of the Siena meeting and substantially included in the submitted planning for the period M13-M30. Main emphasis is put on several converging technologies for enabling effective modelling and control in the frame of "control over networks", including the "control of network" component that should be here tailored to allow proper transport of measurement/commands in order to meet requirements of applications with e.g. safety constraints and bounded delay.

M4d.2.1: Selection of two case studies
WP4d work over the first year has resulted in the choice of two case studies: one on control of multi-robot systems over distributed wireless communication for industrial automation and one on distributed and hybrid control of resources in actuator and sensor networks. Industrial partners have taken an active role and provided recommendations. The case studies, briefly described both in the minutes of Siena meeting and planning for the period M13-M30, have been considered to be complex enough to motivate further actions after M18.

4d.3 Survey of control problems in end-to-end communications through heterogeneous networks
Estimation and control of QoS parameters (loss, delay etc.) for packet-switched networks through hybrid modelling has been proposed and evaluated. However, in the proposed planning for M13-M30, the purpose of this task has been further focused on transport of measurements/commands through across heterogeneous networks, and related problems that may arise in managing resources both within an ad-hoc sensor/actuator patch and within a cellular system, that is required to transfer information to a remote control/operator site.

M4d.4.1: In depth look at the dissemination activities, recommendations for the future
Dissemination activities during this period was further described above.

2.8 WP5 – WP leader: Jan Lunze

	WP5 – Knowledge management	PPR1						PPR2											
N°	**Tasks**……Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
5.1	On-line handbook on hybrid systems																		
5.2	Virtual library																		
5.3	European Curriculum on hybrid systems																		
5.5	**CDC-ECC'05 organization**																		
N°	**Deliverables (D) / Milestones (M)**																		
M5.1.1	Creation of a working group for the taxonomy and glossary definition						X												
M5.3.1	Creation of a working group for the summer school organisation						X												
M5.1.2	Workshop for the discussion and extension of the first draft of the taxonomy and glossary												X						
M5.3.2	Definition of the aim and scope of a HYCON summer school												X						
M5.2.1	Creation of a working group for the creation of the annotated bibliography												X						

(i) Major progress and achievements

The **work package has performed exceptionally well** in this reporting period. **All planned objectives** in the work plan **of WP5 were met** without any problems. The relevant progress of WP5 has been achieved in the following areas:

1) Adaptation of the tasks structure of WP5
2) Elaboration of a Taxonomy of hybrid systems
3) Setup of the technical infrastructure for the annotated bibliography
4) First HYCON PhD School on Hybrid Systems
5) 2nd WP5 workshop, July 18th, 2005 at University of Siena, Italy
6) Implementation of reviewer recommendations
7) Definition of the future WP5 work plan

1) The activities of WP5 in the last reporting period (the starting period of HYCON) revealed that a slight **adaptation of the overall task structure** seems sensible and adequate in order to reflect the lines of activities and the concept of WP5 more precisely. This adaptation of the task structure is a mere matter of presentation, as the objectives of our work package, i.e. the outcome, remain the same as outlined in Annex I to the HYCON contract. It **does not represent a deviation from the original work plan** of our work package. This action has been executed at the beginning of the last period. The new structure is depicted in the figure below.

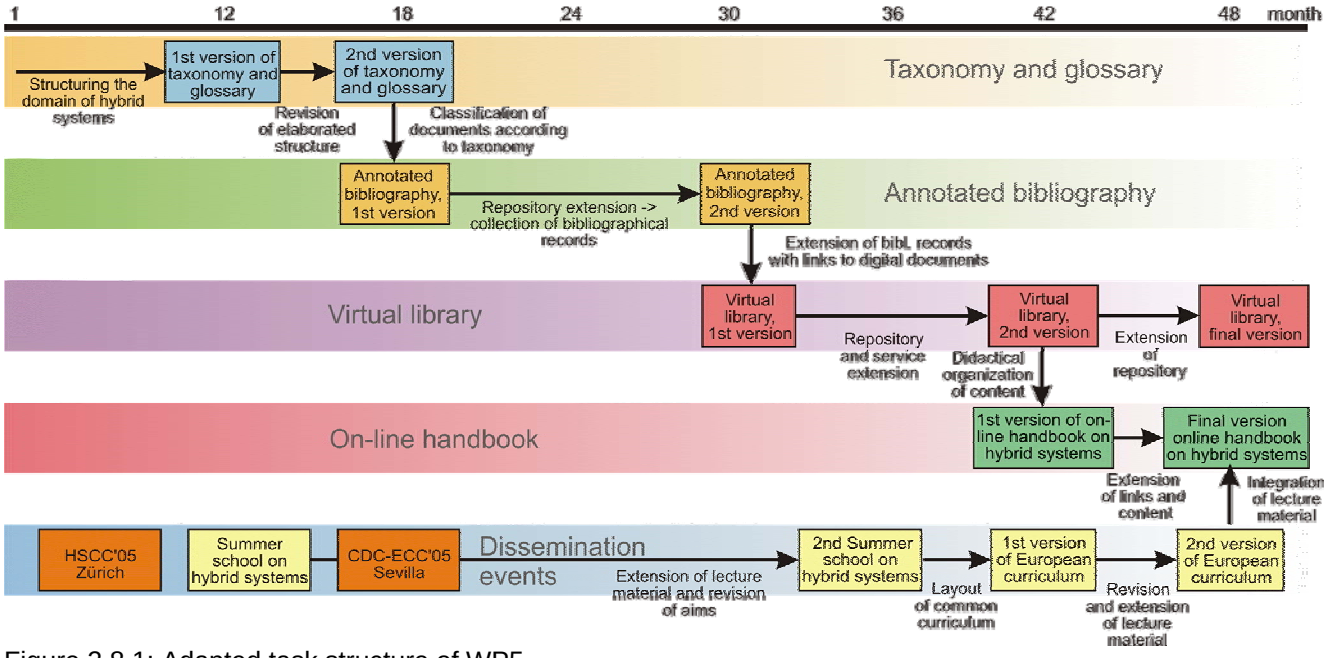

Figure 2.8.1: Adapted task structure of WP5

The new task structure of WP5 emphasizes the chronological arrangement of deliverables. The main difference to the initial task structure lies in the fact, that the content of the tasks 5.1 and 5.2 have been split into two seperate tasks each. The “handbook on hybrid systems” has be taken out of task 5.1 and put into a separate task 5.4 since, chronologically, the handbook of hybrid systems is the last deliverable and also the final objective of WP5, incorporating all previous steps and deliverables. The same applies to task 5.2 where the setup of the virtual library (now task 5.3) has been separated from the annotated bibliography, which is an intermediate step on the way. This adapted structure is based on the concept of WP5 to use a uniform software framework for all tasks 5.1 through 5.4 and continuously develop and extend this software to meet the described steps on the path to the handbook on hybrid systems.

The tasks formerly numbered 5.3 and 5.4 have been merged into the new task 5.5 with the name “Dissemination activities”. This line of activity runs in parallel with all the other tasks related to the setup of

technical infrastructure and incorporates all activites related to the organization of events for spreading knowledge on hybrid systems. In accordance with this work plan WP5 concentrated its activities of the current reporting period on the following tasks

5.1 Taxonomy and glossary of hybrid systems,
5.2 Annotated bibliography and
5.5 Disemmination activities

2) At first a major part of activities was focused on task 5.1 (main activity in the last reporting period), which was continued according to the work plan of WP5. A **first version of the taxonomy of hybrid systems** was drafted according to the elaboratred concept. In this task all partners of WP5 were involved, were each partner extended the taxonomy with respect to his/her field of expertise on hybrid systems. All intermediate results were merged into a first draft of the taxonomy by partner RUB. This draft of the taxonomy was discussed at the 2nd WP5 workshop held in Siena on July 18th, 2005.In addition to the good work of all partners several necessary minor improvement of this version of the taxonomy were identified as anticipated (see milestone report M5.1.2). The adaptation of the taxonomy with respect to the results of the discussion and the **extension of the taxonomy** will be **carried out from month 12 to month 18** by all partners **as planned**. The **objective D5.1.3** to make this taxonomy available to all nodes of the NoE over the Internet by month 18 **will be met**.

3) Another main focus was the **setup of the technical infrastructure for the annotated bibliography** (Task 5.2) in order to meet the deliverable D5.2.4 by month 18. The essential parts of these activities related to the technical infrastructure include

- the configuration of a web server for hosting the on-line user interface to the database,
- the evaluation of existing digital library software packages and the appropriate choice of one of these,
- the configuration and adaptation of the digital library software to satisfy the requirements of the concept of the annotated bibliography,
- the implementation of a user interface for accessing the annotated bibliography over the Internet (see Figure 2.8.2),
- the start of the implementation of an on-line tool (HYDRA) for the creation of metadata of documents (see Figure 2.8.3), which are submitted into the repository of the annotated bibliography by authors and
- the testing and debugging of the written software modules.

As a result of the current distribution of MM-resources for WP5 these tasks were carried out at the HYCON partner RUB. All other partners of WP5 did not possess the necessary MM-resources for a thorough participation in implementation and software work. However all partners participate in the testing of the current technical infrastructure, in particular by submitting their first documents into the repository of the annotated bibliography. This testing and debugging period stretches out from June 2005 until March 2006. The so far implemented technical infrastructure was discussed at the second WP5 held at Siena, in July 18th, 2005. An important result of this discussion was that all WP5 partners were highly satisfied with the current functionality and the progress towards D5.2.4. Based on the current status suggestions for further improvements were discussed. The **implementation of the technical infrastructure of the annotated bibliography will continue as planed until month 18**, when the first version of annotated bibliography will be made accessible to the public (D5.2.4). In particular the functionality of the annotated bibliography will be further adapted to the needs of users.

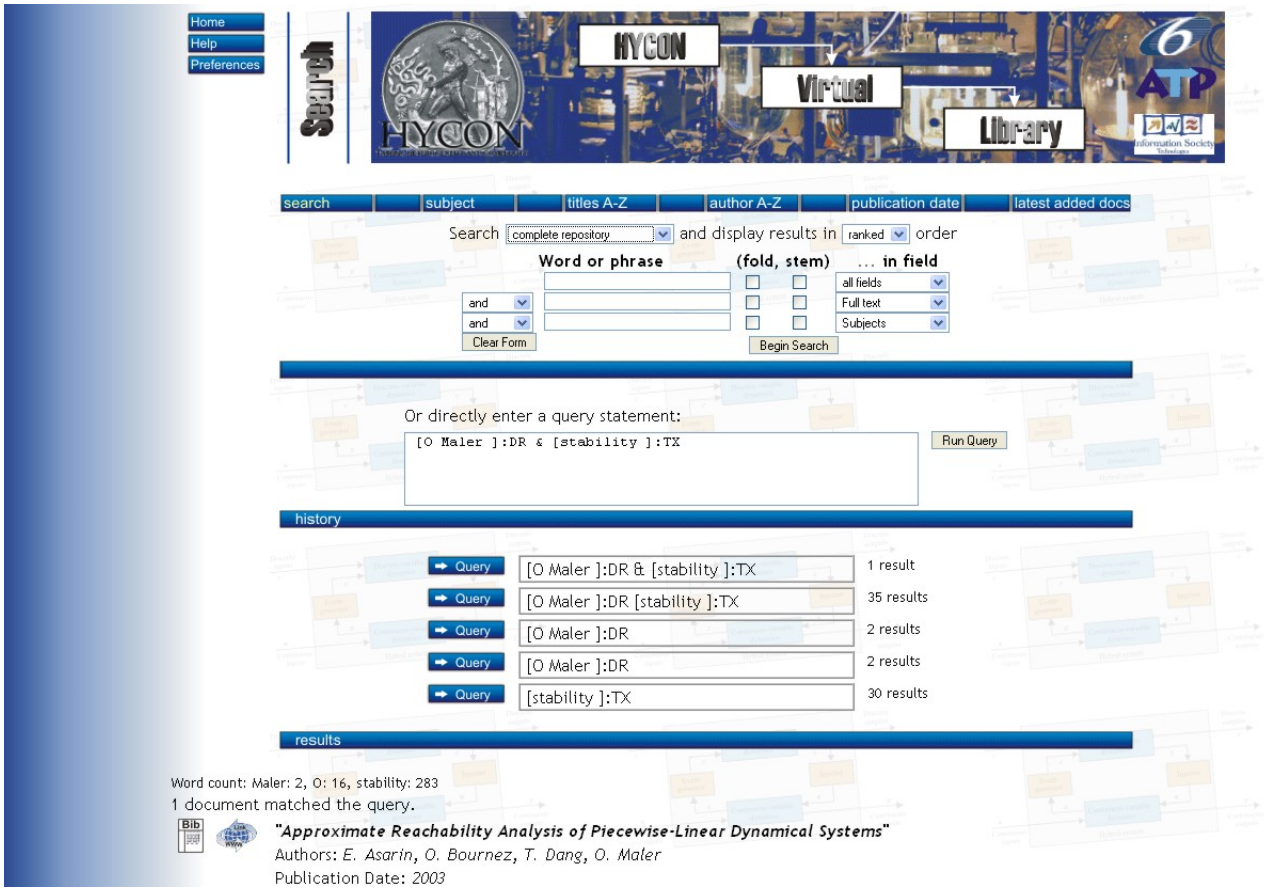

Figure 2.8.2: Screenshot of the preliminary user interface of the annotated bibliography

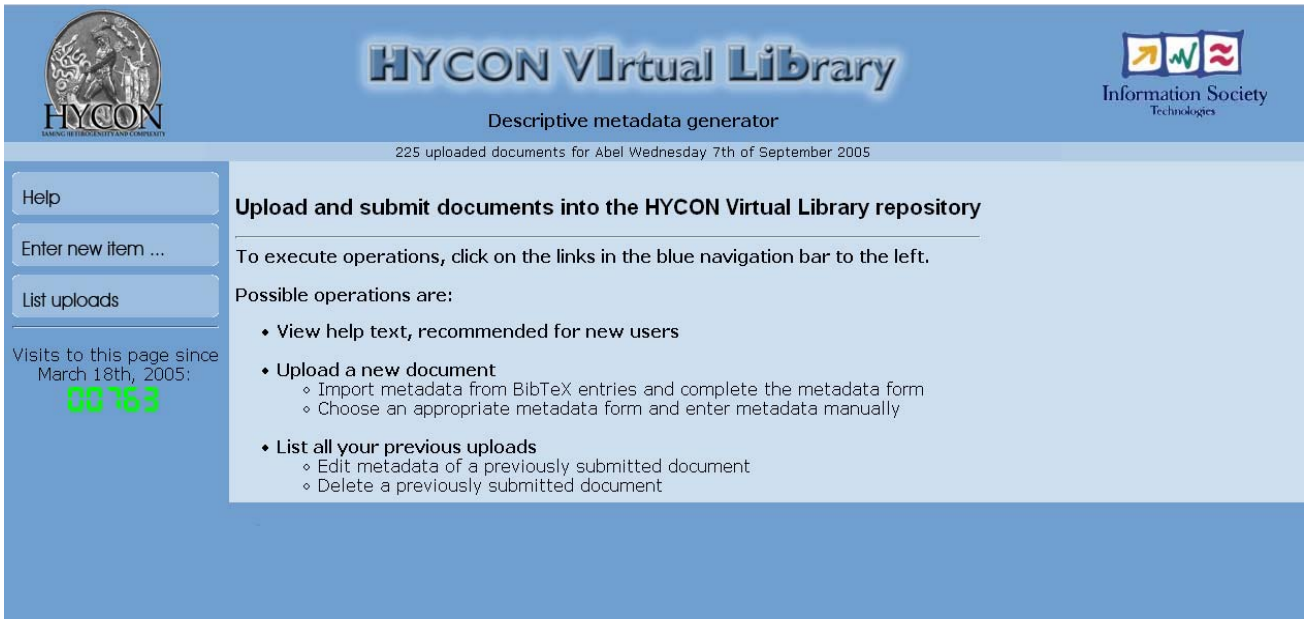

Figure 2.8.3: Screenshot of the preliminary on-line user interface of the HYCON descriptive metadata generator (HYDRA)

4) Complemetary to the activities described before a major item on the agenda of WP5 was the involvement in the organization and the hosting of the "**First HYCON PhD School on Hybrid Systems**" at the University of Siena, Italy from July 19-22, 2005. This was a integrated objective of WP5 and WP1, for which WP5 partner UNISI took over the responsibility. This **PhD school was a complete success**. 157 PhD students and researchers from all over Europe attended the lectures and took the opportunity of listening to

the didactical lectures and getting a broad overview on methods and open problems related to hybrid systems. At the end of the event all participants were asked to give feedback on the organization and execution of the event by filling in a questionnaire. The **feedback from the questionnaire was extremely positive** and will help for the organization of future PhD schools. The presentations of all lecturers will be compiled and made available on-line by month 15 as promised in the work plan(D5.5.5, formerly D5.3.4). More details about the school will be reported in a future deliverable of WP1.

5) As planned **WP5 held a second meeting on July 18th, 2005** at the university of Siena which can be accounted as a great success for intensify the integration inside the WP5. The agenda of this meeting covered the following topics:
HILIB – progress towards the first version of the annotated bibliography
Discussion of the first draft of the taxonomy on hybrid systems
Presentation and discussion of the future work plan of WP5 for M19 – M30.

Many WP5 partners contributed to the discussion with their valuable experience especially regarding the first two items of the agenda. The results of this meeting will be implemented in the following third reporting period.

6) Moreover WP5 took part in the **implementation of previous reviewer recommendations** by re-implementing and adjusting its **homepage** to the new common design of the Internet appearence of HYCON. This effort contributed to the second recommandation "HYCON – an identity to build". Furthermore the **inter-work-package co-operation** was intensified by sharing the technical infrastructure of the annotated bibliography with WP4d. WP4d evinced great interest in using this infrastructure to disseminate knowledge on hybrid systems theory applications in the field of the automotive industry to its industrial partners. For WP5 this co-operation is also highly attractive as we expect a faster growth of the size of the annotated bibliography's repository as well as an increased interest of researchers in using the annotated bibliography.

7) An important issue of this reporting period was the **definition of the future WP5 work plan** which fixes and describes the actions that will be carried out until month 30. This work plan has been drafted by the WP leader (RUB) and was presented to all partners at the second WP5 meeting. The applied strategy for the resource allocation over the period from M19-M30 clearly differs from the attempt persued at the starting of HYCON. It connects all alocated MM-resources to specifically defined subtasks. Either a single partner or a small group of partners will take the responsibility for delivering the results of each of these subtasks. As mentioned in the last periodic progress report the distrubution of resources will be concentrated on less partners than in the period from M1-M18, such that all participating institutes have a stronger involvement in this work package.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions

According to the work plan all milestones have been accomplished in this reporting period. These are:
M5.1.2: Workshop for the discussion and extension of the first draft of the taxonomy and glossary
M5.2.1: Creation of working group for the compilation of the annotated bibliography
M5.3.3: HYCON Summer School in Sienna
No deliverables were due for this reporting period.
In this reporting period **WP5 performed exceptionally well** and there were no problems encountered, Thus no deviations from the work plan were necessary. As mentioned earlier, the task structure of WP5 has been adapted to better reflect the activities and the intentions of this work package. However, the overall objectives and the progression of the work of WP5 were not affected by this.
We anticipate the straight continuation of the excellent work of WP5 for the next reporting period (Progress as planned).

2.9 WP6 – WP leader: Manfred Morari and Alberto Sangiovanni Vicentelli

	WP6 – Industrial bridging	PPR1						PPR2											
N°	**Tasks**……..Months	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
6.1	Engaging industrial partners and associates																		
6.2	Identifying case studies and pilot projects																		
6.3	Training programs																		
6.4	Promoting open domain software																		
N°	**Deliverables (D) / Milestones (M)**																		
M6.1.1	Creation of the initial group of industrial partners and associates			X															
D6.1.1	Intellectual Property Rights policy for Industrial Partner/Associate Agreements									S									
M6.4.1	Distribution of the open domain software to industrial partners and associates									X									
D6.2.1	Inventory and description of case studies and industrial pilot												S						
M6.2.1	Distribution of the NoE deliverables to industrial partners and associates												X						
M6.3.1	Definition of the aims and structure of the seminar programme												X						

(i) Major progress and achievements

In this reporting period Task 1 "*Engaging industrial partners and associates*" and Task 2 "*Identifying case studies and pilot projects"* had been the focus of this WP.

Task 6.1 "Engaging industrial partners and associates"

Two main activities were pursued:

- Analysis of Intellectual Property (IP) issues;
- Promoting, formalizing and finalizing HYCON affiliation by industries.

Analysis of Intellectual Property issues for the consortium. IP issues are becoming essential in any collaborative project. In the US, IP policies vary widely among different companies and industrial segments. There have been several cases of IP infringement accusations involving industrial partners and even Universities. The policy of several companies has changed considerably hardening IP rules and pursuing vigorously licensing opportunities. This approach has created an unfavourable climate to research collaborations. We are aware that IP policies are often totally unknown to research centers and Universities. In particular, in the European Community, IP regulations are often different from country to country. This WP was intended to clarify the policy of the European Community for Networks of Excellence and other collaborative projects. We spend considerable time analyzing the rules and distilling them for use of the HYCON partners. We believe this work will be of use to a number of different projects. We have been asked by several organizations to distribute the results of this Task that were collected in the deliverable D6.1.1 "*Intellectual Property Rights policy for Industrial Partner/Associate Agreements*. In particular it describes:

- A mechanism for Project – Industry partnership;
- A future IPR management procedure and examples of best practices;
- The contract rules on IPR that regulates the responsibilities, obligations and rights of partners (contractors) and third parties;
- A first model of Non Disclosure Agreement to be a common document and reference for project members when dealing with industry;
- For a better industry dissemination of technology and know-how, two templates were prepared to gather information on partner's patents to future research collaboration to be offered to industry.

Activities linked with dissemination and use of RTD (Research and Technology Development) results are essential parts associated to the life cycle of Community RTD projects. Therefore, proper documentation of the RTD results is in the partners' interest. It is important to have standard tools for describing and detailing the activities planned for the use of the results achieved during RTD projects and ensuring the link with the objectives on which the project was selected. They cater for results from basic research, social actions or upstream RTD projects as well as applied, near-market or demonstration projects.

In addition to the dissemination of the rules regulating the IP management, we formed an *Industrial Property Use and Dissemination Committee* – IPUDC- that should cover all issues related to knowledge generated inside the NoE and its exploitation.. The Intellectual Property activities within the IPUDC address issues such as:

- What are the results (knowledge including information) of the project? What are the potential applications?
- Are the results commercially, socially or scientifically usable?
- What are the dissemination and use goals for the knowledge generated in HYCON and what are the possible ways of achieving these goals?
- What information is useful for attracting potential collaborators?

Promoting and formalizing HYCON affiliation by industries. In general, industry demonstrated a significant interest in the research activities pursed by HYCON. In some cases, HYCON research projects have been developed with tight collaborations with the industry. Hence, there was a clear need for a formalization of interactions with the industry and made the interaction public. The goal of the industry engagement activity was not only receiving generic expressions of interests, but more importantly was to understand the specific expectations from HYCON, the desired degree of involvement, the kind of

collaboration each industry was interested in. To this purpose, the affiliation procedure included a questionnaire to be complied by the industry where interests and commitments are expressed.
The adopted procedure guarantees that no industrial interest is frustrated and that each contributor is participating in the most convenient form according to its capabilities and financial strength.
In particular, after extensive consultation with industry, four different types of affiliations were identified and proposed:

- HYCON Connected Company: receiving information on HYCON activities
- HYCON Associate Member Company: attendance to HYCON events
- HYCON Full Member Company: contribution to HYCON research
- HYCON Premium Member Company: resources and financial support to HYCON research

The current status of industry affiliation to HYCON is reported in the table below:

Class of affiliation	Company	Address	Application domain
HYCON Premium Member Company	ABB	Zurich, CH	WP4a
HYCON Premium Member Company	Drivetrain Innovations	Hortsen, NL	WP4c
HYCON Premium Member Company	Ford Motor Corporation	Aachen, G	WP4c
HYCON Premium Member Company	Swedish Defence Research Agency	Stockholm,S	WP4b, WP4c
HYCON Full Member Company	Bombardier Transportation	Västerås, S	WP4a
HYCON Full Member Company	Ericsson EAB	S	WP4d
HYCON Full Member Company	Selenia Communications	Genova, I	WP4d
HYCON Full Member Company	Thales Italia	Chieti, I	WP4d
HYCON Associate Member Company	Ferrari Gestione Sportiva	Maranello, I	WP4c
HYCON Associate Member Company	Micron Technology		all WP4
HYCON Associate Member Company	Pirelli Labs	Milano, I	all WP4
HYCON Associate Member Company	The MathWorks	Cambridge, UK	all WP4

Most of the affiliated industry requested the highest levels of affiliations, while no one applied for the lowest one. HYCON affiliation by Centro Ricerche Fiat, CNH, Magneti Marelli Powertrain, and Renault is in the final stage of approval by the companies.

Task 6.2 “Identifying case studies and pilot projects”.

Task 6.2 has as goal the identification of a number of pilot case studies, which are distinct from the benchmarks considered in WP2, and concern actual industrial problems to their full extent and complexity. The scope is to create a database of such case studies that are connected to industrial reality and are not limited to academic laboratory exercises.
In the first release of deliverable D2.1.1, the Direct Torque Control (DTC) of Induction Motors case study was proposed. Direct Torque Control (DTC) is a state of the art control methodology for induction motor drives that features favourable control performance and implementation properties. In DTC, the core of the control system is the inverter switching table, and any efforts to enhance the system's performance aims at improving its design. This issue is addressed in this case study definition, where we propose the investigation of novel hybrid control techniques for the DTC problem. The developed schemes can be compared to the

current industrial standard through simulations (as a first step), using a highly reliable MATLAB/Simulink model of the drive that were made available by ABB.

Task 6.3 "Training programs" and Task 6.4 "Promoting open domain software".

Progress has been made on both tasks. In particular the specific needs and requirements for training programs have been assessed through the industry questionnaire. The software development in WP3 is on-going. The tools are continuously changing but are available to the public to the extent that this is meaningful.

(ii) Progress versus plan, description of problems – if any, deviations, corrective actions-if any

The status of milestones and deliverables due in period M7-M12 is as follows.

- Planned milestones and deliverables that have been finalized:
  - M6.1.1 "*Creation of the initial group of industrial partners and associates*": achieved at M6, with companies' informal affiliation.
  - D6.1.1 "*Intellectual Property Rights policy for Industrial Partner/Associate Agreements*": delivered in M9 as planned.
  - D6.2.1 "*Inventory and description of case studies and industrial pilot*": delivered in M12 as planned
- Additional milestones and deliverables that have been finalized:
  - M6.1.2 "*Procedure for formal affiliation of industry*": additional milestone of Task 6.1 introduced in M6 and describing the affiliation procedure of industry to HYCON by means of an official affiliation letter and a questionnaire where interests and commitments of industry are expressed.
  - D6.1.2 "*Report on industry affiliation and industry involvement at M12*": additional milestone of Task 6.1 introduced in M12 and describing the status of industry affiliation to HYCON.
- Planned milestones and deliverables that have not been finalized as yet:
  - M6.2.1 "*Distribution of the NoE deliverables to industrial partners and associates*": to be performed when all the deliverables due by M12 will be released.
  - M6.3.1 "*Definition of the aims and structure of the seminar programme*": more interaction with industry is required to define the aims of the seminar programme. Then, the courses and lectures that can be offered from academia will be surveyed. Within the next six months demand and supply of training programs will be matched with the final negotiations and actual execution left to the parties that are directly involved. Rescheduled at M18.
  - M6.4.1 "*Distribution of the open domain software to industrial partners and associates*": promotion to the industry at large will have to be delayed until a stable state of development is reached which we expect to be in about 8 months. Rescheduled at M20.

3. KEY EVENTS DURING THE REPORTING PERIOD

- HYCON Workshop on Automotive Applications of Hybrid Systems, PARADES, 26-27 May 2005
- First HYCON PhD School on Hybrid Systems, 19-22 July 2005, University of Siena
- Executive Committee - 18 July 2005, University of Siena
- Governing Board meeting -19 July 2005, University of Siena
- Executive Committee - 16 September 2005, IHP, Paris

4. LIST OF DELIVERABLES (INCL. THEIR STATUS

http://www.ist-hycon.org/index.php?p=Deliverables

Di.j.k = deliverable **k** of **task i.j** in the workpackage **WPi**
S= Submitted, A= Accepted, R= Rejected.
Add.= Additional, P.= Postponed.

Updated September 28, 2005

WP	Deliverable Number	Deliverable title	Due on month	Delivery Date	Status
WP1	D1.1.1	Report of the mission and the size of the institute drafted	03	15/01/2005	A
	D1.1.2	Inventory of possible funding sources	06	15/05/2005	S
	D1.2.1	Report on criteria for the choice of EIHS structure	06	15/05/2005	S
	D1.3.1	Report on criteria for the choice of EIHS location	06	15/05/2005	S
	D1.3.2	Inventory of equipment, installations and infrastructure at the disposal of the NoE	09	28/07/2005	S
	D1.4.1	Examples of Statutes and Bylaws	09	29/07/2005	S
	D1.5.1	Ideal Profile of the Manager and Call for Applications issued by the Gov. Board	P. M13		In preparation
	D1.7.1	1st HYCON PhD School on Hybrid Systems	Add.	28/09/2005	S
WP2	D2.1.2	Web based Interactive Environment	08	08/06/2005	S
WP3	D3.2.1	Report on available tools for hybrid systems and interchange formats	06	19/05/2005	S
	D3.2.2	Specification of demonstrator site functionality	09	30/06/2005	S
	D3.3.1	An Architecture for Data Interchange of Switched Linear Systems	11	15/09/2005	S
	D3.4.1	Specification of the simulation interface	11	15/09/2005	S
	D3.5.1	Frameworks for hybrid co-simulation	11	22/09/2005	S
WP4a	D4a.1.1	Report on task force goals and responsibilities	07	15/04/2005	A
	D4a.2.1	Draft Survey Report on Modelling Tools, Benchmarks and Control Methods	13	19/09/2005	S
WP4b	D4b.2.2	Report on the Case Studies for the Strategic Area "Large Transitions of Processing Plants"	12	13/09/2005	S
WP4c	D4c.1.1	Hybrid models of automotive powertrains and braking systems	12	27/09/2005	S
	D4c.1.2	Hybrid models of GDI SI engines suitable for control design	12	27/09/2005	S

WP4c	D4c.1.3	Hybrid models of HCCI engine suitable for control design	12	28/09/2005	S
	D4c.2.1	Formulation of hybrid control problems for vehicle dynamics and engine control	12	28/09/2005	S
	D4c.3.1	Hybrid models representing implementation details of control algorithms	12	28/09/2005	S
	D4c.3.2	Comparison of techniques for representing & binding variability in hybrid models	P. M18		In preparation
	D4c.4.1	Proceedings of the First HYCON Workshop on Automotive Applications of Hybrid Systems	Add.	27/09/2005	S
WP4d	D4d.1.1	Report on control problems in wireless communications	09	15/06/2005	S
	D4d.1.2	Report on distributed control over wireless networks	10	29/07/2005	S
WP5	D5.4.4	Proceedings of the special session at HSCC	18	08/06/2005	S
WP6	D6.1.1	Industrial Property Rights policy for Industrial Partner/Associate Agreements	09	11/07/2005	S
	D6.1.2	Report on industry affiliation and industry involvement at M12	Add.	28/09/2005	S
	D6.2.1	Inventory and description of case studies and pilot projects (I)	12	21/09/2005	S
WP7	D7.3.1	Definition of monitoring and reporting tools	03	15/06/2005	S
	D7.3.2	Contractual Management plan	06	15/06/2005	S
	D7.2.1	Financial reports	12		In preparation
	D7.3.3	Activity report and audit certificates	12		In preparation
WP8	D8.6.1	FP7-Embedded and immersed decision making: New roles for systems and control in the 21 st century	Add.	31/12/2004	A
	D8.1.1	Report on dissemination activities at M12	12	28/09/2005	S
	D8.2.1	JPA work analysis of deviation to original plans and recommendations	P. M18		In preparation
	D8.2.2	Report on the scientific and technical risk and recommendations	P. M14		In preparation
	D8.5.1	Report on synergy actions with other projects	12	24/09/2005	S

5. MANAGEMENT, CO-ORDINATION , RESOURCE

5.1 Project Co-ordination and management activities/issues

Project management has not encountered any major obstacles during the reporting period. Project management and coordination have been smoothly conducted. The Governing Board and Executive Committee meeting discussions were constructive.

D7.3.1 - on the definition of monitoring and reporting tools (re-submitted) - and D7.3.2 - on contractual management plan and financial reports - state clearly the necessary instruments for implementing the project.

Contractual issue: 3 institutions are joining the HYCON consortium.

5.2 Project Workplan and proposed changes

The project Work plan has been carried out as planned. Technical progress during the reporting period has been excellent, achieving the stated goals and milestones.

Some postponed deliverables:

- D1.5.1 (at M13 instead of M12)
- D4c.3.2 (at M18 instead of M12)
- D8.2.1 (at M18 instead of M12)
- D8.2.2 (at M14 instead of M12)

Some advanced deliverables:

- D5.4.4 (at M9 instead of M18)
- D4a.2.1 (at M12 instead of M13)

Some additional deliverables:

- D1.7.1 – Report on the First HYCON PhD School on Hybrid Systems
- D4c.4.1 – Brochure of the HYCON Workshop on Automotive Applications of Hybrid Systems
- D6.1.2 - Report on industry affiliation and industry involvement at M12

The project participated actively in numerous international technical meetings and conferences, including the IFAC World Congress in Prague.

For the coming period there are no important changes that we would like to propose.

5.3 List of items to be amended in Contract incl. Annex 1

- List of HYCON Partners and HYCON Light Associations
- List of researchers and PhD students involved in HYCON from 15 September 2005
- Detailed JPA activities M13-M30 (Part 9)
- Project resources M13-M30 (Part 10)

5.4 Effort consumption – Persons-Months allocated by HYCON – M1 to M12

Total Effort consumption - M1 → M12

JPA	1 FIST	2 CNRS	3 UCL	4 ETHZ	5 RUB	6 UNID	7 DLR	8 UMD	9 US	10 SUP	11 INRIA	12 UPAT	13 UAQ	14 UNIPI	15 UNISI	16 PARA	17 TUE	18 UT	19 TUD	20 KTH	21 ULIN	22 LTH	23 UCAM		
WP1	0,7	1,25	0	1	1	2	0	2	0	1	0	1	1,1	7	7	0,7	0	0	0,75	2	0	0	0	**28,5**	
WP2	0	3,5	0	3,75	1	2	0	1	22	0,25	1	0,5	0,5	2	2	2	0	0	0,2	0	0	0	2,5	**44,2**	
WP3	0	0	0	3,75	0	11	2	0	0	0	0	1,5	0	0	5	1,5	10	1	0	0	3	0	0,5	**39,25**	
WP4a	0	5	0	15	0	0	0	0	7	3	0	0	0	0	0	0	0	3,5	2,45	9	0	7	0	**51,95**	
WP4b	0	0	7	0	0	10,5	0	6	5,5	0	0	0,75	0	0	0	0	0	0	0	0	0	6	0	**35,75**	
WP4c	0	1	0	3	0	8	0	0	0	0	2	1,5	4	4	6,5	11,5	18	0	2,4	7	0	12	2	**82,9**	
WP4d	0	0	0	0	0	0	0	0	0	0	0,5	2,5	11,4	6	4,5	2,2	0	0	0	13	7,5	2	0	**49,6**	
WP5	0	2	1	0	17,6	5	0	0	2,5	0,75	1	0,75	0,5	3	3	0	0	1	0	2	0	0	0	**40,1**	
WP6	0,8	0	0	5	0	1,25	0	0	0	0,25	0	0	1,5	4	0	5,4	0	0	0,15	2	0	0	0	**20,35**	
WP7	4,95	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0,2	0	0	0	0	0	0	0	**8,15**	
WP8	0	13	0	1,5	1	0,75	0	0	0	0	0	0	0	0	0,5	0	1	0	0	2	0	0	0	**19,75**	
	6,45	**28,75**	**8**	**33**	**20,6**	**40,5**	**2**	**9**	**37**	**5,25**	**4,5**	**8,5**	**19**	**26**	**28,5**	**23,5**	**29**	**5,5**	**5,95**	**37**	**10,5**	**27**	**5**	**420,5**	**420,5**

Effort consumption - funded - M1 → M12

JPA	1 FIST	2 CNRS	3 UCL	4 ETHZ	5 RUB	6 UNID	7 DLR	8 UMD	9 US	10 SUP	11 INRIA	12 UPAT	13 UAQ	14 UNIPI	15 UNISI	16 PARA	17 TUE	18 UT	19 TUD	20 KTH	21 ULIN	22 LTH	23 UCAM		
WP1	0,7	1	0	0,25	1	1	0	1	0	1	0	1	0,6	4	3	0,5	0	0	0,75	1	0	0	0	**16,8**	
WP2	0	1,5	0	2,5	0	1	0	1	10	0,25	1	0,5	0	1	1,5	1	0	0	0	0	0	0	2	**23,25**	
WP3	0	0	0	2,5	0	8,5	2	0	0	0	0	1	0	0	3	1	3	0,5	0	0	2	0	0	**23,5**	
WP4a	0	4	0	9	0	0	0	0	1	2	0	0	0	0	0	0	0	1,5	2	3	0	2	0	**24,5**	
WP4b	0	0	3	0	0	2	0	3	0,5	0	0	0,5	0	0	0	0	0	0	0	0	0	1	0	**10**	
WP4c	0	1	0	2	0	0	0	0	0	0	2	1	1	2	2,5	7	3	0	2	3	0	4	0	**30,5**	
WP4d	0	0	0	0	0	0	0	0	0	0	0,5	1,5	4,4	2	1,5	1,2	0	0	0	5	2,5	0	0	**18,6**	
WP5	0	1,5	0,5	0	11,5	0,5	0	0	0,5	0	1	0,5	0	1	1,5	0	0	0,5	0	1	0	0	0	**20**	
WP6	0,8	0	0	2	0	0,25	0	0	0	0	0	0	0,5	2	0	3,9	0	0	0	1	0	0	0	**10,45**	
WP7	4,95	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0,2	0	0	0	0	0	0	0	**6,15**	
WP8	0	7	0	0,75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**8,75**	
	6,45	**17**	**3,5**	**19**	**12,5**	**13,25**	**2**	**5**	**12**	**3,25**	**4,5**	**6**	**6,5**	**12**	**13**	**14,8**	**6**	**2,5**	**4,75**	**15**	**4,5**	**7**	**2**	**192,5**	**192,5**

5.5 Summary of partner contributions during the reporting period

#1 FIST

WP1

Within the WP1 FIST contributed to the deliverables concerning the European institute. We provide documents on the future possible legal structures, a initial business plan showing the institute's main functionalities and sources of funding as well as analysed the main issues regarding intellectual property.

WP6

At WP6 FIST contributes to the deliverable related to the Intellectual property. Our contribution consists on the outlines a common IP policy for the consortium, best practices and mechanisms of IP management, model agreements and dissemination of new technologies.

WP7

Contract management
FIST ensured that all contractors sign the accession forms to the European Commission

- As the link between contractors and the European Commission, FIST is in close contact with the Commission for all administrative procedures including audits, reporting and review, amendment and so on.
- FIST guaranteed that all participants have received the contract and its annexes and the consortium agreement. Each document has been sent individually to each participant.
- FIST has provided a helpdesk solution for all Contractors for all administrative and legal matters to respond to all pertinent questions in the Project. In addition answer direct calls from participants
- The project deliverables are sent almost every month to the commission on registered mails.

- **Financial Management**

The main activities on the financial management are:

- Collection of banking information from each participant and transferred the part of the EC contribution as described in the consortium agreement and following the decision of the consortium to each participant.
- The creation and transfer of several short notices on various aspects such as eligible costs and cost models, personnel costs, consumables, durable equipment, receipts, travel and subsistence and audit certificates. These short notices are available on the website.
- Send to partners letters confirming the payments and financial documentation and information needed to complete Audit Certificates and Form C.

New partners procedure
FIST has prepared the documents requested for new Partners and has helped its completion. FIST is organizing a vote to the inclusion of a new contractor to HYCON Project.

Transfer of EC Contribution
After authorization by the Scientific Coordinator, FIST transferred budget allocations to HYCON partners - 1,575,000.00 euro were transferred.

Audits and financial reporting
FIST has prepared a set of documents and examples for preparing the financial reporting and audits. Guidelines are prepared for this purpose.

FIST brings a helpdesk to the participants for the preparation of the audit certificates.

FIST actively contributed to two deliverables by providing a standard consortium contractual management procedure as well as guidelines on the management procedure. FIST has also contributed to the Website HYCON by providing information on the desirable functionalities of the management part of the site.

Meetings
FIST has participated to main consortium meetings such as : First review meeting in Brussels on April 2005; Governing Board and executive committee meeting in Siena June 2005; Executive committee meeting Paris on the update of the JPA September 2005

#2 CNRS

WP1

The group LSS-CNRS has participated in the activities of WP1 by contributing to various deliverables. We actively contributed to the creation of EIHS by talking part in the ongoing discussion. The International Curriculum Option for Doctoral Studies in Hybrid Systems has been signed by the Université Paris Sud. The LSS-CNRS worked out the proposal to host the EIHS in our place. Le Centre d'Excellence DigiteoLabs, le Pôle de Compétitivité System@tic et SUPELEC support this action. Potential managers will be suggested in the complete proposal.

WP2

The scope of WP2 is the creation of a common platform for hybrid systems modeling and control methodologies.

LAAS-CNRS has been involved in the review process of the benchmark model guide (WP2.1 : Definition of the model-guide requirements of Development and implementation of a Benchmark model guide). We have been concerned with the definition of the model-guide requirements with respect to the description of the hybrid system in relation to control objectives and operating constraints. In the first case it has been the design of hybrid feedback laws for nonlinear systems to guarantee performance and robustness issues. In the second case it has been the verification of safety
critical properties for the system.

LAAS-CNRS has also contributed to this activity through the definition of a benchmark example. This benchmark has been submitted to WP4a as a contribution of WP2 to WP4a. Within WP2 it has been an example of verification of safety critical systems. A paper presented at IFAC World congress has been derived from this benchmark.

WP4a

The LSS-CNRS group has actively contributed to WP4a, with applications in the area of hybrid control problems related to the generation, transmission and conversion of electric energy.

The group has set up a hybrid control problem of power systems and has presented this problem in the framework of a case study for "Power generation and transmission networks - Voltage control and stabilization". A detailed description can be found in the deliverable D4a.2.1.

The group has also proposed a benchmark problem for the power flow control of a doubly - fed induction machine coupled to a flywheel. In this problem we consider a doubly - fed induction machine, controlled through the rotor voltage and connected to a variable local load, that acts as an energy - switching device between a local prime mover (a flywheel) and the electrical power network. The control objective is to optimally regulate the power flow in the face of unpredictable loads that commute on and off the system preserving (some kind of) stability. The problem is of interest because: (i) the system is highly nonlinear, (ii)

its zero dynamics is unstable, (iii) the switching times and their duration are unpredictable and their effect can only be measured through auxiliary variables, e.g., voltage or instantaneous power drop.

WP4c

The LSS-CNRS group has actively contributed to WP4c, with application in the area of automotive control. The project is covered by the task 4c.1 – “Hybrid Models for Automotive Powertrains”. In this contribution we are interested in the anti-lock brake strategies that are based on wheel deceleration thresholds. We modify the standard approach in order to study the existence and stability of limit cycles which is determined by properties of the Poincaré map, we are also interested in the conditions that wheel deceleration thresholds must satisfy if we want the algorithm to work properly. This study leads us in a first time to a simplified five phase ABS algorithms which is valid since we don't take in account changes of road conditions, that's why we introduced the eleven-phase ABS strategy which is robust with respect to discontinuous transition of road characteristics. Our work is placed in a context where the vehicle brakes on a straight line and the speed is high.

The following deliverable is a part of this contribution: D4c.1.1 “Hybrid models of automotive powertrain and braking systems”. Contribution through the report "Hybrid modelling of anti-lock brake systems"

WP5

This WP5 Knowledge Management is targeted at improving the transfer and the active dissemination of knowledge in the domain of hybrid systems.

The partner CNRS has participated in the activities of WP5 by contributing to the elaboration of taxonomy and a glossary on hybrid systems. We participate also on the classification of hybrid systems, by analysing many of our publications, by distinguishing the classification of physical items and the classification of abstracts concepts (models, systems, control structures). We define precisely the terminology terms we proposed for the elaboration of the classification scheme. Finally we have uploaded some of our publications on the Virtual Library of hybrid systems. This virtual library is still in progress, we have proposed many modifications.

WP8

The LSS-CNRS group is leading the activities of the WP8, which focuses during the reporting period on the management of the network. The group has coordinated the activities of all partners. The coordination involves:

- Organization of Executive Committee and Governing Board meetings.
- Building, maintaining and updating the Website of HYCON.

A proposal has been submitted and funded by Region Ile de France for contributing to the HYCON communication and visibility.

#3 UCL

During the months M1-M12, our research team has mostly participated in the WP4b (Industrial controls). There have also been some small contributions to WP5.

WP4b

In the context of WP4b we have developed a hybrid automaton model of a PVC production plant with parallel lines and have presented this model as a case study for Large Transitions in Processing Plants. A detailed 80-pages description can be found in the deliverable D4b22
http://astwww.bci.uni-dortmund.de/hycon4b/docu/HYCON_Deliverable_D4b22.pdf

This case study consider a hybrid chemical plant which consists of several interacting parts: two batch reactors, three supply pumps (reactant, cold water and hot steam) and a storage tank. The aim of our research study is to maximize the plant productivity in the presence of process disturbances and model uncertainties. We have developed a dynamic model of the considered chemical plant based on the hybrid automaton formalism. Each component is represented by a hybrid automaton and the overall process is a combination of several automata. A simulator of the chemical plant is developed and implemented in Matlab; the Stateflow toolbox is used to describe the discrete modes of the hybrid automaton and is coordinated with the Simulink toolbox which is used to describe the continuous dynamics of each mode. Productivity maximization is solved by means of a static cyclic continuous time scheduling. The feedback loop for on-line scheduling strategy is used to reduce the sensitivity of the schedule of the considered hybrid chemical plant with respect to uncertainties and disturbances.

WP5

Our participation in WP5 included the preparation of a presentation for the first workshop of WP5. Related to the Hycon WP5 activities we are also preparing two special sessions on joint spectral radius and hybrid systems for the forthcoming conference CDC in Sevilla.

Members of the UCL team have participated in one or more of the following events organized by HYCON:

Kick-off meeting - 22-23 October 2004, IHP, Paris
Governing Board meeting-22-23 October 2004, IHP, Paris: Minutes
Executive Committee meeting - 8 March 2005 from 14:00 at ETH Zurich: Presentations
First Review Meeting - 26 April 2005, Brussels: Agenda, PPR1, Presentations
First HYCON PhD School on Hybrid Systems, - 19-22 July 2005, Siena
Executive Committee - 18 July 2005, from 16:30 in Siena- Presentations
Governing Board meeting -19 July 2005, from 10:30 in Siena

#4 ETH Zurich

ETH Zurich participates as a node to the Network of Excellence HYCON through the activities of two groups. The Power Systems Laboratory, led by Prof. G. Andersson, and the Automatic Control Laboratory that is headed by Prof. M. Morari. These groups will be referred to hereafter as ETH1 and ETH2 respectively.

The contributions of the ETH Zurich to the activities of the network are spread throughout the whole NoE, and cover all four sections of the Joint Program Activities (JPAs). More specifically, the ETH2 group is active in

- Integration, by participating in WP1, 2 and 3,
- Research, by leading WP4a and actively participating in WP4c,
- Spreading of Excellence, by (co-) leading the industrial bridging activities of WP6, and
- Management area by participating in WP8.

The ETH1 group is taking part in the research activities of WP4a. In the sequel we analyze these contributions to each workpackage.

WP1

The group ETH2 has participated in the activities of WP1 by contributing to the deliverable D1.3.2, “Inventory of equipment, installations and infrastructure at the disposal of the NoE”. With its contribution the ETH made available to the NoE and to the (under creation) European Institute of Hybrid Systems (EIHS) its vast research resources in terms of scientific literature, computational resources, hardware and experimental facilities and building infrastructure. Moreover, the ETH2 group has been an active participant in the efforts to define the role and mission of the EIHS in such a way that a sustainable and lively institution is created.

WP2

The scope of WP2 is the creation of a common evaluation platform for hybrid systems modeling and control methodologies. ETH has contributed to these activities through the definition of a number of benchmark examples for assessing the performance of hybrid control methodologies to problems related to the management of electric energy. These benchmark examples were mainly created for the needs of WP4a, but can be used by all the participants of the network to test and compare their tools and methods.

WP3

The ETH2 group has actively participated in the activities of WP3 and contributed to the following tasks of the workpackage:

- Task 3.2, “HYCON Demonstrator Site”
- Task 3.3, “Standard data format and toolboxes for switched linear dynamic systems”
- Task 3.4, “Model sharing among simulation tools and component libraries”

The specific contributions are found in the following deliverables:

- D3.2.1, “Report on available tools for hybrid systems and interchange format”. ETH2 has contributed by reporting on the Multi-Parametric Toolbox and HYSDEL packages. These tools are used for the modeling of and control design for hybrid systems.

- D3.3.1 “Report on toolbox design”. Our group contributed by providing detailed description of the structure and implementation of the interchange format between various toolboxes.

- D3.4.1, “Definition of the Dynamic Simulation Interface”. We provided a detailed description of how the simulation interface can be connected with HYSDEL.

WP4a

The ETH2 group is leading the activities of the WP4a, which focuses on the hybrid control problems related to the generation, transmission and conversion of electric energy. This implies that the group has coordinated the activities of the involved partners. The coordination involves the organization of meetings, the definition of the workpackage’s tasks, deliverables and milestones, and the structuring of the research activities along three different focus areas (Modeling and Simulation, Power Systems, and Power Electronics). Moreover, ETH2 has assumed the responsibility of coordinating the activities of the Power Electronics focus area. ETH1 has been actively involved in the first two focus areas and ETH2 in all three. Therefore, the node at ETH has contributed to all the tasks, deliverables and milestones of the workpackage. More specifically, the tasks that are currently under work or have been accomplished so far are:

- Task 4a.1, “Define task force goals and responsibilities”
- Task 4a.2, “Report on simulation, benchmarks and control methods”

The specific contributions are found in the following deliverables:

- D4a.1.1, “Report on Task Force Goals and Responsibilities”. The ETH2 group coordinated the contributions of the partners and compiled them into this report. Both the ETH1 and ETH2 groups contributed with their planned research activities to the contents of the report; ETH1 in the focus areas “Modeling and Simulation Tools” and “Power Generation and Transmission Control”, and ETH2 in all three focus areas (i.e. the above two plus the “Power Electronics Control”).

- D4a.2.1, “Draft Survey Report on Modeling Tools, Benchmarks, and Control Methods”. The ETH2 group coordinated the contributions of the partners and compiled them into this report. The ETH1 and ETH2 groups contributed to its contents by (i) reporting on the available tools for modeling and simulation of hybrid systems, (ii) defining benchmark examples for the application of hybrid methodologies to control problems in power systems and power electronics, and (iii) describing the control approaches that will be used to tackle the defined problems.

WP4c

The ETH2 group has actively contributed to WP4c, with application in the area of automotive control. Currently two projects are covered by the task 4c.1 – “Hybrid Models for Automotive Powertrains”. These activities aim to investigate specific non-linear and hybrid phenomena arising in automotive applications. Systematic methods for identification, analysis and control are developed and their applicability automotive applications are under examination. The following deliverables are part of this contribution.

- D4c.1.1 “Hybrid models of automotive powertrain and braking systems”. Contribution through the report “Control and State Estimation of Mechanical Systems with Backlash: A Hybrid Approach”. Furthermore, a mechanical benchmark system has been constructed to provide facilities to test identification and control algorithms.
- D4c.2.1 “Formulation of hybrid control problems for vehicle dynamics and engine control. Contribution through the report: “Application of Model Predictive Control for lateral vehicle stabilization”, where different model-simplifications are investigated for the prediction in an optimal control framework.

WP6

The ETH2 group is (co-) leading the efforts of WP6 on industrial bridging. Our group, apart from the coordination of the efforts of the workpackage, has also contributed in the following tasks

- Task 6.1, “Engaging industrial partners and associates”.
- Task 6.2, “Identifying case studies and pilot projects”.

The specific contributions are found in the following deliverables:

- D6.1.1, “Intellectual Property Rights policy for Industrial Partner/Associate Agreements”, where a detailed IPR policy was established, and
- D6.2.1, “Inventory and description of case studies and industrial pilots that are linked to industrial application methodology and that are derived from thorough discussion with industrial board/associates (aiming at 2 case studies and 1 pilot p.a. approved by half of the Executive Committee)”, where a case study of specific industrial interest was proposed.

WP8

The ETH2 group has actively participated in all the meetings regarding the management of the network, and has contributed with detailed plans and proposals to the planning of the JPAs for the second part of the ongoing first period, as well as for the next 18 months. This amounts to a contribution to the tasks:

- Task 8.2, “Analysis of the Joint Programme of Activities carried out during the period and its deviation to the original plans including recommendation for next period. Report on risk analysis”.
- Task 8.4, “JPA work plan for the next 18 months”.

The detailed contributions can be found in the deliverables

- D8.4.1, “Updating of next 18 Months JPA work program”

#5 RUB

The NoE partner RUB participated in the activities work packages WP1, WP2, WP5 and WP8 during the first 12 months of the project HYCON. The following passage presents the activities in the order of the work packages.

WP1

For WP1 partner RUB participated in the review of documents related to the installation of the EIHS. We actively contributed to the development of the concept of EIHS by talking part in the ongoing discussion. Furthermore RUB participated in the negotiations and the elaboration of the “CONVENTION OF INTERNATIONAL INTERUNIVERISTY COOPERATION”.

WP2

For WP2 partner RUB started to prepare a possible benchmark problem by setting up a model of a flexible process plant which is situated at the Department of Automation and Computer Control. In addition, RUB participated in the creation of some reports by reviewing the circulated documents and adding comments.

WP5

The major resources of partner RUB were focused on the activities of WP5, where RUB took over the role of WP leader. The following list of items contains the essential activities to which these resources where attributed to:

- Specification and clarification of the detailed work plan including all intermediate steps for implementing the objectives of WP5
- Organization of the 1st WP5 workshop from February 10th-11th, 2005
- Organization of the 2nd workshop hosted by the university of Siena, July 18th, 2005.
- Implementation of the WP5 homepage (and re-implementation of this page according to the common HYCON layout in June 2005) hosted at and maintained by the Institute of Automation and Computer Control.
- Elaboration of a suitable structure for and an example version of the taxonomy of hybrid systems to be elaborated by WP5
- Coordination of the extension of the taxonomy by all WP partners. Merging of individual results into a first draft.
- Evaluation of applicability of several existing software for the implementation of the annotated bibliography.
- Setting up of the technical infrastructure of a WEB server for hosting the annotated bibliography
- Adaptation of the software package Greenstone digital library, to satisfy the requirements for the annotated bibliography
- Input of the largest number of documents into the database of the annotated bibliography.
- Elaboration of the work plan form month 19 – 30 for WP5.
- Preparing and giving a lecture at the 1st HYCON PhD. School on quantised systems.

Section 2.8 of the progress report describes in more detail the results of these activities and their importance for the project HYCON.

As for all work package leaders, RUB took part in activities related to WP8 these activities are

- Participation in all 3 ExCom meetings of HYCON (Zurich, Siena, Paris)
- Participation in all GovBoard meetings of HYCON (Paris, Siena)
- Participation in the first HYCON review (Brussels, April 26th)
- Preparation and specification of the work plan for month M13-M30 of WP5. Coordination of future resource distribution among WP5 participants.
- Contribution to the periodic progress reports 1 and 2.
- Coordination of the activities of WP5
- Participation on the annual review in Brussels, October 5th-6th.

#6 UNIDO

WP1

Continuous involvement in the discussion, essential contributions to the criteria for the decision process, active participation in the formation of the ICO.

WP2

Development of a case study (multi-stage evaporation system) which may serve as a benchmark example for the HYCON community, and thus can be included into the benchmark repository.

WP3

(1) Coordination of activities of work package 3, in particular with respect to:
   - the organisation of four meetings in Dortmund (2005-01-17, and 2005-04-20), Zurich (2005-03-08), and Siena (2005-07-19).
   - the installation of a website for WP 3 at http://wp3.hycon.bci.uni-dortmund.de.
   - the preparation of the following documents and milestones:
     - D3.2.1 Report on available tools for hybrid systems and interchange formats
     - D3.2.2 Specification of demonstrator site functionality (report)
     - D3.4.1 Definition of Modelica interface (report)
     - D3.5.1 Report on the feasibility of a co-simulation platform (done by TUE)
     - M3.1.1 Specification of the required standard documentation
     - M3.2.1 Two tools deposited in the HYCON Tool Repository
     - Report on future plans for the work of WP 3 during the period M13 to M30

(2) D3.2.1, D3.2.2, and M3.1.1 were essentially done by UNIDO.
(3) Tasks of WP 3.3 were delegated to UNISI.
(4) Different web technologies were compared and a web content management system called Typo3 was chosen to be the platform for the HYCON Tool Repository and the HYCON Demonstrator Site.
(5) Development of the HYCON Tool Repository and redesign of the Tool Repository according to the taxonomy of WP 5 and the new HYCON web layout.
(6) Realization of first steps towards the HYCON Demonstrator Site (main server, connection Matlab/PHP, etc.).
(7) Analysis of the legal situation with respect to possible infringements of The MathWorks' patents and copyrights by the application of the S-function interface.

WP4b

(1) Coordination of the activities of work package 4b, in particular with respect to:
- the organization of two meetings in Dortmund (January 28, 2005) and Siena (July 18, 2005)
- the installation of a website for WP 4b at: 'astww.bci.uni-dortmund.de/hycon4b'
- the preparation of the following documents:
  - M4b.1.1: Choice of 3 case studies for safety-related discrete controls
  - M4b.2.1: Definition of a benchmark for large transitions in the processing industries

- M4b.4.1: In depth-look on the dissemination activities and future recommendation
- M4b.1.2: Documentation of the case studies for the area safety-related discrete controls
- D4b.2.2: Report on the case studies for the area large transitions of processing plants
- Report on future plans for the work of WP 4b during the period M13 to M30

(2) Development of two case studies (including simulation models):

- Area 'Large transitions of processing plants': optimization task for a multi-stage evaporation system
- Area 'safety-related discrete controls': verification task for a discretely controlled one-stage evaporator

(3) First application of own techniques for control design to (parts of) the case studies 'multi-product batch plant' (proposed by UMD) and 'multi-tank pilot plant' (proposed by UVA)

WP5

Contribution to the taxonomy for hybrid systems such that the publications of UNIDO in the area of simulation, optimization, and verification of hybrid systems can be included into the publication database.

WP6

Interaction with the leading chemical companies BASF and Bayer, involvement of Bayer into the project by means of the case study on coupled evaporators. Participation in general discussions, e.g. on the separation of the industrial panel according to the application areas.

#7 DLR

WP3

- Participation at 3 meetings in Dortmund (2005-01-17, and 2005-04-20), and Siena (2005-07-19).
- Selected a benchmark model (with the partners of WP3).
- Decided to change the tool integration of hybrid descriptions in Modelica by basing it on the S-Function interface of Simulink (with the partners of WP3).´
- Contribution to the report "D3.4.1 Definition of Modelica interface" (with the partners of WP3).
- Started implementation of the S-Function interface in Modelica according to the report D3.4.1

#8 UMD

WP1

In the first period we contributed to the discussion on the mission and size of the EIHS as well as on criteria for the choice of the institutes structure and location (D1.1.1, D1.2.1, D1.3.1). Furthermore we provided some information on possible funding sources in Germany (D.1.1.2) and the resources concerning equipment and infrastructure of our work group (D.1.3.2).

WP2

We applied and assessed the results of work package 2 to work package 4b, e.g., we used the HYCON benchmark model guide to provide a coherent description of our case study suggested in work package 4b.

WP4b

We proposed a case study for the area ”Large transitions in processing plants” in WP4b. The application is multiproduct batch plant using two parallel reactors to produce different types of colour pigments. The control problem is to produce a desired amount of each product while minimizing operating cost and guaranteeing safety and quality requirements. We provided a description of the system including the model equations. A reference solution to this control problem is presented in [3, 4] which is based on a hierarchical hybrid control approach. In addition, we supported other groups considering our example system.

We considered other case studies proposed for ”Large transition in processing plants” and ”Safety related discrete controls” and picked out two case studies which seem to be challenging and appropriate to our techniques. We have started to investigate the three-stage evaporator proposed by UNIDO and the PVC production line proposed by UCL. It is planned to apply different techniques to these systems.

Meetings
We participated in the following HYCON meetings:

- HYCON kick-off meeting, October 22-23, 2004, Paris
- GovBoard meeting, July 19, 2005, Siena
- WP2 meeting, July 19, 2005, Siena
- WP4b meeting, January 28, 2005, Dortmund
- WP4b meeting, July 18, 2005, Siena.

Two PhD students attended the HYCON PhD School on Hybrid Systems (July 19-22, 2005) in Siena and courses of Control Training Site - Formation en Automatique à Paris - Graduate Paris School on Control (CTS-FAP, 2005) in Paris.

Publications
A hierarchical control approach to hybrid systems has been presented. A new approach to the computation of reachable sets of continuous or hybrid systems has been proposed. An optimal control problem for a class of discrete-time hybrid automata under safety and liveness constraints has also been addressed.

#9 US

WP1

Participation in the discussion, active participation in the Joint PhD Program leaded by the Univ. of PISA. Participation in the decision of Institute of Hybrid System location decision panel.

WP2

US-UVA had a leading role in WP2. The main activities carried out:

Task 2.1.1. Definition of the model guide requirements (active participation, and coordination of task)
Task 2.1.1, with a duration of 4 months, is finished.

6. Benchmark examples recompilation of benchmark proposed by partners.
7. Development of a questionnaire to guide benchmark developers.
8. Guidelines for control architecture to be used in the benchmark implementation step.
9. Qualitative and quantitative assessment criteria for benchmarking activities have been proposed.
10. Document “Milestone 2.1.1: Qualitative and quantitative criteria for benchmark activities”

Task 2.1.2. Design and implementation of an interactive environment to assist the designer of a benchmark.

3. Design and implementation of a web based environment to help benchmark developers (carried out by US-UVA mainly)
4. Preparation of Document: “Deliverable D2.1.2 Web based interactive environment”

Task 2.2.1. Preparing the installation and models for the benchmark exercises M1 and I1.

US is in charge of benchmark I1 (Solar Cooling System) and the activities performed had been the preparation of the solar platform and the web based server for performing tests, the development of models and the data collection for identification. This task started ahead of time at M10.

WP2 General activities

3. WP2 website design, implementation and maintenance.
4. WP2 Meeting organization: Two specific WP2 meeting were hold, one in Zurich (March.2005) and the other one in Siena (July 2005).

WP4a

Task 4a.1: Survey available tools for power system modelling and simulation: The group has contributed analysis the existing tools related to power generation when non-conventional power sources are used (such as renewable energies or fuel cells). The main field on which the group has been working is related to power generation combining several types of generators, ranging from fuel cells to renewable energy generators such as wind turbines or solar plants.

Task 4a.3 Define power system control benchmarks of different granularity: The group has proposed a power system case study both for modelling and simulation and control purposes. The system to be studied is a generation system composed of two generators connected to the grid with intermediate buffer storage. One of the generators is a photovoltaic field and the other is a fuel cell fed with hydrogen. Energy can be stored as hydrogen

Contribution to Deliverable D4a.1.1 "Report on available tools for power system modelling and simulation" and the document "Case studies for the focus area Power Generation and Transmission Control".

WP4b

- Participation in the two meetings in Dortmund (January 28, 2005) and Siena (July 18, 2005)
- Development of two case studies (including simulation models):
  - Fuel Cell (proposed by US)
  - Batch crystallisers and continuous recycle of sugar plants. (proposed by UVA)
- First application of own techniques for control design to (parts of) the case studies to a 'multi-tank pilot plant' (proposed by UVA)

WP5

Contribution to discussions: revision of the preliminary version of the classification scheme of the domain of hybrid systems, introducing new terms and its definition, referred to our publications and changing the positions of some terms in that classification scheme. Classification of our documents according the merged EXCEL classification sheet, introducing some new terms and entering some of our documents into the repository of the HYCON virtual library trough the submission interface sent by the WP5 coordinator.
Contribution in the organization of a tutorial session (and paper at the European Control Journal) at the *Joint 44th IEEE Conference on Decision and Control and European Control Conference.*

WP6

Interaction with the companies PROCISA and TELVENT. Participation in general discussions.

#10 SUPELEC

For the twelve first months, Supelec has been involved in the activities of five workpackages of HYCON in the fields of 'intregating', 'research' and 'Spreading of Excellence'.

WP1

In this workpackage, we contributed to the discussions that led to the elaboration of the various deliverables and specifically to the report on criteria for the choice of the EIHS location. Based on this report, we helped the CNRS to work out the proposal to host the Institute in Gif-sur-Yvette near Paris. With the partnership of the Université de Rennes, we also participated to the setting up of the 'International Curriculum Option of Doctoral Studies in Hybrid Control Systems' initiated by the Universita di Pisa and that may be considered as the first step to the elaboration of the European curriculum on hybrid systems.

WP2

Our contribution to this workpackage was limited to the review of the report about the 'Web based interactive environment'.

WP4a

We contributed to the various activities of this workpackage. More specifically we coordinated the part of the report (D4a21) about the modelling and the simulation tools. We also took part to the specification of the benchmarks of the focus area: power electronics and of the exchange program.

WP5

We contributed to the elaboration of the taxonomy of hybrid systems. Based on the first proposal of the Rhur Universitat Bochum we proposed modification of the structure and the addition of specific terms. Based on this taxonomy we began to enter publication into the database.

WP6

Our contribution consisted first in finding French companies that are interested in HYCON activities and want to commit themselves to support them. We also contacted the members of the IAB in order to develop the communication about the IAB.

#11 INRIA

In the reporting period M1-M12, the INRIA research team participated to the activities of workpackages WP2, WP4c, WP4d and WP5. A list of the main contribution to each workpackage follows.

WP2

Task 2.1.1 - Definition of the model guide requirements: Revision of the "Model description guide". Revision of the Milestone 2.1.1: "Qualitative and quantitative criteria for benchmark activities". Attended WP2 progress meetings: Zurich 09/03/05, Siena, 19/07/05.

WP4c

Task 4c.1 - Hybrid models for automotive control: Contribution to the writing of the deliverable D4c.1.1 "Hybrid models of automotive powertrains and braking systems"; Development of observability tests and computationally efficient state observers for automotive powertrains affected by backlash; Various contributions on the analysis and control of nonsmooth Lagrangian mechanical systems; Revision of the deliverables D4c.1.1, D4c.1.2, D4c.1.3, D4c.2.1, D4c.4.1; Participation to the "HYCON Workshop on Automotive Applications of Hybrid Methodologies", Rome, 26-27 May, 2005; Attended WP4c progress meetings: Zurich 10/03/05.

WP4d

Task 4d.1 - Survey of control problems in wireless communications: Contribution to the writing of the deliverable D4d.1.2 "Report on distributed control over wireless networks"; Development of the mathematical framework of partial difference equations for studying consensus protocols in systems of mobile agents linked through wireless networks; Attended WP4d progress meetings: Siena 18/07/05

WP5

Task 5.1 - On-line handbook on hybrid systems: Participation to the activities of the working group for the taxonomy and glossary definition (see M5.1.1)

Task 5.2 - Virtual library: Participation to the activities of the working group for the elaboration of an annotated bibliography (see M5.2.1). Test of the HYCON virtual library (first release)**;** Participation to the 1st WP5-Workshop, Bochum, February 10-11, 2005

Other contributions:

- Participation to the HYCON Kick-off Meeting, Paris, October 22-23, 2004.
- Participation to the meetings of the Governing Board:
- Paris, 23 October 2004.
- Siena, 19 July 2005.
- Participation to the meetings of the Executive Committee:
- Zurich, 8 March 2005.
- Siena, 18 July 2005.
- Paris, 16 September, 2005.
- Preparation of the lecture "Identification Algorithms for Hybrid Systems" given by G. Ferrari Trecate within the context of the 1st HYCON PhD school on Hybrid Systems, Siena, July 19-22, 2005.
- Participation to the joint meeting "SICONOS WP2 – HYCON WP3", Eindhoven, August 10, 2005.

#12 UPAT

WP1
Involvement in the formulation of the goals and mission of EIHS and the identification of possible funding sources. Contribution to Deliverables D1.1.1, D1.2.1 and D1.3.1. UPAT signed the convention of cooperation for the HYCON PhD program. Submitted application to host the EIHS.

WP2
Unfunded development of a possible benchmark for control over networks, in conjunction with the work on WP4d. Participation in Siena WP2 meeting.

WP3
Familiarization with MPT toolbox in view of the discussion on PWA systems. Application to the control of a micro-capacitor. Participation in Zurich and Siena meetings.

WP4b
Proposal of a possible case study (industrial furnace). Participation in Dortmund meeting (January 28, 2005).

WP4c
Development of hybrid vehicle dynamics models, analysis and controller design. Contribution to Deliverable D4c.2.1. Participation in Zurich and Siena WP4c meetings.

WP4d

Development of methods for control of systems over networks. Development of a hardware implementation of systems controlled over MOTE networks, that can serve as a benchmark in the future. Contribution to Deliverables D4d.1.1 and D4d.1.2. Participation in Zurich and Siena WP4d meetings.

WP5
Contribution to the development on the taxonomy for hybrid systems. Contribution of UPAT publications in the area of hybrid control. Participation in the Bochum meeting.

WP6
Extended an invitation to NLR (The Netherlands) and ATMEL Hellas (Greece) to become industrial affiliates of HYCON.

#13 UAQ

WP1

Continuous involvement in the discussion, contributions to the criteria for the decision process, active participation in the formation of the ICO, presentation of a proposal for hosting technical activities of the EIHS at UAQ.

WP2

Involvement in the discussion and contribution to the general outline of WP activities.

WP4c

- Participation to the WP4c workshop in Rome, May 27 2005, where Elena De Santis gave a presentation on “Digital Idle Speed Control of Automotive Engines using Hybrid Models”
- Contribution to deliverable D4c.1.1 - Hybrid models of automotive powertrain and braking systems
- Contribution to deliverable D4c.2.1 - Formulation of hybrid control problems for vehicle dynamics and engine control
- Contribution to deliverable D4c.3.1 - Hybrid models representing implementation details of control algorithms
- Cooperation with PARADES through regular meetings and joint works
- 2 project works for students on hybrid models for idle speed control in automotive engines

W4d

(1) Coordination of the activities of work package 4d, in particular with respect to: the organization of two meetings in Zurich (March 7, 2005) and Siena (July 18, 2005); the development, upgrading and maintainance of a website for WP4d at: http://www.diel.univaq.it/dews/hycon; achievement of milestones; the preparation of the following documents:

- Minutes of the two WP meetings and two planning reports
- D4d.1.1 (report): *Report on control problems in wireless communications*
- D4d.1.2 (report): *Report on distributed control over wireless networks*
- Periodic progress reports (PPR1 and PPR2)
- Planning document for the work of WP 4d during the period M13 to M30

(2) Research activities, with three published papers in joint authorship with KTH;

(3) Contributions to all chapters of deliverables D4d.1.1 and D4d.1.2;

(4) Student mobility, with one student working at KTH for a final year project on the subject of control of wireless networks (TCP over wireless) in the frame of the ERASMUS program, and two students currently working in cooperation with PARADES on wireless sensor networks;

(5) Establishing relations with research units within the NoE NEWCOM, for proposals of future joint initiatives, such as a joint workshop on wireless sensor networks, that is being planned;

(6) Development of a test-bed for remote monitoring through sensor patches: a gateway has been developed, along with a software platform that allows to access the sensor patches from a webpage.

(7) Joint half-day seminar with Parades on "Modelling and simulation tools for wireless sensor networks", that was held in L'Aquila on May 31, 2005

(8) 6 project works for students on both theoretical aspects and experimental activities on routing and distributed processing in wireless sensor networks and TCP over wireless.

WP5

Contribution to the taxonomy for hybrid systems and participation to the WP workshop that was held in Bochum on 10-11 February 2005.

WP6

Involvement of industries in the IAB: among those, Thales, Selenia Communications (Selex), Micron Technologies, Siemens CNX. Prosyst has demonstrated interest and has been invited to join Representatives of the above companies have participated to the WP meetings and are closely interacting for ongoing research activities, especially on distributed monitoring and control over heterogeneous wireless networks. Selex has promised to put mm efforts in the WP4d activities

#14 UNIPI

WP1

Coordination of activities, particularly regarding:

- Establishment of the mission statement and size of the institute as an initially small viable institute that is projected to grow and mature with time so as to become an instrument of dissemination and education on hybrid systems, with a particular interest in industries
- An inventory of the equipment, installations and infrastructure at the disposal of the network was prepared and reported in D.1.3.2.
- Continuing work on the International Curriculum Option for Doctoral Studies in Hybrid Systems. At present the Executive Governing Board is making its decisions as to the financial structure, organizational structure, location, and bylaws and statues of the EIHS. The Consortium has carried out several activities to detect the most appropriate shape and location of the European Institute for Hybrid Systems (EIHS) and organized the first HYCON PhD School on Hybrid Systems.
- Criteria for the choice of the most suitable structure and location of EIHS were adopted by the Executive Committee. A call for proposals for hosting EIHS was launched and five applications came from CNRS (Paris), UAQ (L'Aquila), UNIPI (Pisa), UNISI (Siena) and UOP (Patras). The applications were presented by each node at the ExCom meeting in Siena on July 19, 2005. In view of the importance of the decision, and of the number of applicants, the ExCom decided that the case needed further study. An agile committee of three people was elected to interact directly with the proposers to gain more insight in the implications of different choices. The final choice of the hosting institution(s) will be discussed at the Ex.Com meeting in Paris on September 16, 2005.
- Regarding the structure and statute of EIHS, several examples were surveyed in D.1.4.1 and presented at the Ex.Com. meeting in Siena. The Consortium is oriented towards a non-profit association model.
- In terms of dissemination activities, the 1st HYCON PhD School on Hybrid Systems was held in Siena on July 19-22, 2005. The school was extremely successful, in terms of didactics, of logistics, and of social events, as also witnessed by the outcome of a questionnaire distributed at the end of the school.

WP2

- Participation to WP2 meeting in Zurich
- Participation in the definition of the Idle Speed Benchmark

WP4c

- Participation to the First HYCON Workshop on Automotive Applications of Hybrid Systems, held in Rome (Italy) on May 26-27, 2005. Antonio Bicchi gave an invited presentation, prepared with Emilio Vitale, Dean of Engineering and professor of Automotive Design in Pisa, on *Technological Innovations in the Motorcycle Industry*. Giordano Greco gave a presentation on *Hybrid Model of an Electronically Controlled Limited Slip Differential,* joint with Antonio Bicchi, Massimo Guiggiani, and Giovanni Tonietti
- A research activity already ongoing with Ferrari GeS on F1 race cars stabilization by hybrid control methods, was presented to the HYCON community (with technical limitations due to confidentiality agreements). The work is aimed at developing a suitable control strategy to be applied to the electronically controlled limited slip differential of a sports car in order to optimize both handling and stability under severe driving conditions. In this period, we developed a dynamic model of the F1 car and a hybrid model of the differential. These were validated through simulations, while a hybrid/adaptive control strategy is currently under investigation.
- Ferrari GeS has been involved in the activities of HYCON, and is negotiating entering the Industrial Board.
- Contacts and joint research programs with other automotive industries (Marelli, Piaggio) have intensified thanks to the HYCON organization and umbrella.

WP4d

- Participation to Wp4 Meeting held in Zurich on 7 March 2005.
- Participation to Wp4 Meeting held in Siena on 18 July 2005. In both meetings a presentation on current activity of UNIPI in Wp4d has been given.
- Contribution to deliverables D4d1.1: “Report on control problems in wireless communications” and D4d1.2: “Report on distributed control over wireless networks”. In particular, UNIPI contributed in the study of “Distributed systems and coordination of agents” and “Fundamental limitations of networked (quantized) systems”

WP5

- Participation to the 1st WP5-Workshop, held in Bochum, on February 10-11, 2005.
- Participation at the first part of the 2nd HYCON WP5-Workshop, held in Siena, on July 18, 2005.
- Participation on the elaboration of the classification scheme of hybrid systems, collaboration on testing the document submission interface of the preliminary version of the HYCON virtual library.

WP6

- Participation to the Wp6 Meeting held in Siena on 18 July 2005.
- The University of Pisa is actively collaborating with Ferrari GeS SpA, Maranello (MO)

#15 UNISI

WP1

Coordination of activities of work package 1, in particular with respect to:

- the organisation of the ExCom and Gov. Board meetings in Siena (2005-07-18 and 19).
- the preparation of the following documents:

    - D1.1.1 Report on the mission and the size of the EIHS
    - D1.1.2 Inventory of possible funding sources
    - D1.2.1 Report on criteria for the choice of EIHS structure
    - D1.4.1 Examples of Statutes and Bylaws
    - D1.6.2 1st HYCON PhD School on Hybrid Systems
    - Report on future plans for the work of WP 1 during the period M13 to M30
- Organization of the 1st HYCON PhD School on Hybrid Systems in Siena, July 19-22, 2005

WP2

- Development of a case study (automatized table soccer) which may serve as a benchmark example for the HYCON community, and thus can be included into the benchmark repository.
- Work on the Solar Plant benchmark.
- Organisation of the WP2 meeting in Siena (2005-07-19).
- Participation to WP2 meetings in Zurich (2005-03-08) and Siena (2005-07-19).

WP3

- Coordination of activities of work package 3.3, in particular with respect to:
- the organisation of two meetings in Zurich (2005-03-08) and Siena (2005-07-19).
- the preparation of the following documents and milestones:
    - D3.3.1 An Architecture for Data Interchange of Switched Linear Systems
    - M3.2.1 Two tools deposited in the HYCON Tool Repository (Hybrid Toolbox deposited)
- Participation to WP3 meeting in Zurich (2005-03-08).

WP4c

- Research carried out in collaboration with Ford Research Laboratories (Dearborn, MI) on hybrid modelling and control of DISC (direct injection stratified charge) engines and on hybrid modelling and control of semiactive suspensions. Contribution to the related deliverables and milestones (M4c.1.1 and M4c.4.1)
- Participation to WP4c meetings in Zurich (2005-03-08) and Rome (2005-05-26 and 27).

WP4d

- Contribution to several activities of WP4d. In particular one graduate student and two master students from UNISI were sent to KTH for several months to carry out a joint research project related to WP4d.
- Organisation of the WP4c meeting in Siena (2005-07-18).
- Participation to WP4c meetings in Zurich (2005-03-07) and Siena (2005-07-18).

WP5

- Contribution to the taxonomy for hybrid systems such that the publications of UNISI in the area of modeling, optimization, control, and verification of hybrid systems can be included into the publication database.
- Organisation of the WP5 meeting in Siena (2005-07-18).
- Participation to WP5 meetings in Bochum (2005-02-10 and 11) and Siena (2005-07-18)

#16 PARADES

During the second reporting period (M7-M12), PARADES contributed to the activities of WP1 (as node), WP2 (as node), WP3 (as node), WP4c (as leader of the workpackage), WP4d (as node) and WP6 (as co-leader of the workpackage). PARADES contributions to each workpackage are listed below.

WP1

- Participation to the definition of the mission statement and size of the EIHS.

WP2

- Definition of the benchmark "Idle Speed Control" including Matlab-Simulink models.
- Participation to WP2 meeting held in Siena on July 2005.

WP3

- Contribution to deliverable D3.2.1, "Report on available tools for hybrid systems and interchange format". Review of the tools SIMULINK-STATEFLOW, SILDEX, HYVISUAL, SCICOS, CHARON, CHECKMATE, MASACCIO, SHIFT, HYSDEL and ARIADNE. Report on the Interchange Format proposed in the COLUMBUS project.
- Development of ARIADNE, a tool for Hybrid Systems verification.

WP4c

- Coordination of workpackage WP4c "Automotive Control".
- Preparation of the documents:
    - D4c.1.1 - Hybrid models of automotive powertrains and braking systems
    - D4c.1.2 - Hybrid models of GDI SI engines suitable for control design
    - D4c.1.3 - Hybrid models of HCCI engine suitable for control design
    - D4c.2.1 - Formulation of hybrid control problems for vehicle dynamics and engine control
    - D4c.3.1 - Hybrid models representing implementation details of control algorithms
    - D4c.4.1 - Proceeding of the "First HYCON Workshop on Automotive Applications of Hybrid Systems"
    - M4c.4.1 - In depth look at the dissemination activities, recommendations for the future
- Organization of the "First HYCON Workshop on Automotive Applications of Hybrid Systems" held in PARADES, Rome (I), on May 26-27, 2005. The workshop was attended by HYCON partners and representatives from automotive companies: DTI, Elasis, Ferrari, Ford, Renault, and Scania. Editing of the proceedings of the workshop (also collected in the deliverable D4c.4.1 "*Proceeding of the First HYCON Workshop on Automotive Applications of Hybrid Systems*").
- Development of a hybrid model of a new common rail fuel injection system conceived by Magneti Marelli Powertrain for Diesel. Contribution to deliverable D4c.1.3 through the section "*Hybrid modelling of the Common Rail*".
- Development of a multi-rate hybrid control strategy for common rail pressure regulation in fuel injection systems. Contribution to deliverable D4c.2.1 through the section "*Control of the high-pressure pump in common rail injection systems*".
- Synthesis of a hybrid algorithm for on–line identification of the actual engaged. Detailed description of the behaviour of the driveline by a hybrid model. Contribution to deliverable D4c.2.1 through the section "*Actual engaged gear identification: a hybrid systems approach*".
- Seminars on the application of hybrid systems techniques to automotive control problems given at Magneti Marelli Powertrain, CNH, and Ferrari Gestione Sportiva.
- Preparation and participation to the WP4c meetings in Rome, May 2005, and Siena, July 2005.

WP4d

- Analysis of 802.15.4 IEEE Standard for ad-hoc wireless networks, e.g. Wireless Sensor Networks (WSN), with very limited node resources.
- Contribution to deliverable D4d.1.1 "Report on control problems in wireless communications".
- Meetings with partners in L'Aquila and Siena, July 2005.

WP6

- Coordination with ETHZ of workpackage activities.
- Preparation of the documents:
  - M6.1.2 - Procedure for formal affiliation of industry
  - D6.1.1 - Industrial Property Rights policy for Industrial Partner/Associate Agreements
  - D6.1.2 - Report on industry affiliation and industry involvement at M12
- Analysis of Intellectual Property issues for the consortium. Evaluation of the following procedure:
  - mechanism for Project – Industry partnership;
  - future IPR management procedure and examples of best practices;
  - model of Non Disclosure Agreement for project members when dealing with industry;
  - promotion of partner's patents to industry.

  Templates for IP agreements have been proposed in deliverable D6.1.1.
- Promotion of HYCON in industry and definition of a procedure for the affiliation of industry in HYCON. A model of affiliation based on four different types of affiliations (HYCON Connected Company, HYCON Associate Member Company, HYCON Full Member Company, HYCON Premium Member Company) is proposed. Preparation of an affiliation letter and questionnaire.
- Promotion of the affiliation in HYCON of
  - Drivetrain Innovations BV, The Netherlands
  - Ford Forschuñgszentrum Aachen GmbH, Germany
  - THALES ITALIA SpA Land & Joint Systems Division, Italy
  - Pirelli Labs S.p.A., Italy
  - Ferrari Gestione Sportiva, Italy
- Preparation and participation to the WP4c meeting in Siena, July 2005.

WP7

· Participation to the kick-off meeting (Paris, 9/2004) and the ExCom and Governing Board meetings (Zurich, 3/2005 and Siena, 7/2005).

#17 TUE

WP3

Taking part in preparation of the following deliverables:
- D3.5.1 Report on the feasibility of a co-simulation platform: After investigating three standards for co-simulation, the S-function framework was selected as the platform for WP3.4.
- D3.4.1 Definition of Modelica interface (report): Our contribution to this report is two-folded: an introduction of the S-functions and the implementation of the S-function client in the Chi language.
- M3.4.2 Implementation of the Dynamic Simulation Interface: The main functionality of an S-function client and the API interfaces for the S-function callback methods were implemented.

WP4b

There is a continuous involvement and essential contributions to a number of deliverables.

WP4c

Continuous research on hybrid power-trains and hybrid energy management systems. Intensifying the interaction with the industrial partners Ford Automotive Research (Aachen, Germany) and DTI (Eindhoven, The Netherlands). Besides these, a longstanding and still very fruitful sub-theme in the Eindhoven automotive research activities, is the research around cvt's (continuous variable transmission).

WP5

Taking a major part in the scientific organization/secretariat of the first HYCON PhD Summer School that took place in Siena, Italy between 19/07/05 and 22/07/05.

Remark
At both Electrical and Mechanical Engineering at the TU/e a number of specific experimental facilities of hybrid nature are present. A description of these set-ups is available at the HYCON website, and these may be used by HYCON partners.

#18 UT

During the reporting period M1-M12 the UTwente has contributed to WP3, WP4a and WP5.

WP3

As a part of WP3.4 and WP3.5, simulation of the Behavioural Hybrid Process Calculus (BHPC) within Modelica was investigated. The following procedure was chosen: specifications are developed in BHPC and then they are translated to Modelica. For that purpose a restricted version of BHPC was defined. Furthermore, a draft version of a rigorous algorithm for the translation of the specification in the restricted version of BHPC to Dymola was defined and tested by hand-translating several simple examples (bouncing ball, thermostat). Currently, a translation of parallel composition and superposition is explored.

During HYCON Workpackage 3 meetings it was proposed to use Simulink (a part of Matlab) S functions http://www.mathworks.com/access/helpdesk/help/toolbox/simulink/sfg/.
Preliminary research shows that application of the S-function is a viable solution for co-simulation of BHPC, where continuous-time behaviour is simulated by Simulink, and discrete behaviour is simulated inside an S-function. Currently this is explored as a part of HYCON WP3.4 (WP3.5 is added to WP3.4).

WP4a

The port-Hamiltonian framework for geometric network modeling of complex physical systems has been worked out for the case of networked power systems. Typical example is an electric drive consisting of a power converter and an electrical machine, coupled to each other by a transmission line. It has been shown how all the sub-systems (components) can be modeled as a port-Hamiltonian system, and that the coupling of these port-Hamiltonian components results in a another port-Hamiltonian system. In general, this is a mixed finite-dimensional and infinite-dimensional port-Hamiltonian systems, since components such as the transmission line are modeled by PDEs, allowing full treatment of e.g. time-delays. Another aspect that has been emphasized is the consideration of multi-modal components (such as power-converters), ideally modeled as complementarity port-Hamiltonian systems. Various examples have been worked out in the report.

WP5

A contribution has been made to the first draft of the taxonomy of hybrid systems, which will form the conceptual basis for a classification in the virtual library to be developed by WP5. First an extension was made to the first draft of the taxonomy as submitted by RUB, together with a description of atomic terms. After the merging of several contributions by RUB, in order to assess the resulting structure, a set of documents was classified according to the taxonomy. Both the structure of the taxonomy and the implementation in EXCEL were tested and evaluated, leading to several recommendations.

#19 TUD

TUD has been involved in WP1, WP2, WP4a, WP4c, and WP6 with the bulk of the effort targeted at WP4a and WP4c.

WP1

Here the main contribution consisted in giving input for and feedback on the draft deliverables for the work package, in particular for/on D1.1.1, D1.1.2, and D1.3.2. In addition a lecture on ``Models of hybrid systems'' has been given by Bart De Schutter for the 1st HYCON PhD School on Hybrid Systems, Siena, Italy.

WP2

The contribution of TUD to WP2 mainly consisted in giving feedback on the HYCON Benchmark Model-Guide Description (Task 2.1) and the milestone report M2.1.1.

WP4a

The group at TUD has focused on multi-agent control of large-scale electricity networks. We have first looked at several ways to model electricity networks at a generic level (related to other transportation networks). Next, we have investigated the issues that arise in distributed control of large-scale electricity networks, and we have proposed an hierarchical, multi-agent control framework for large-scale electricity networks. In this framework the network is divided into several possibly overlapping subnetworks, each being controlled by a local controller. The actions of the local controllers are then coordinated via one or more supervisory control levels. We have also continued our work on model predictive control that will be the basis for the local controllers in the proposed hierarchical multi-agent framework.

TUD has also contributed a case study on power transmission networks to the WP4a Survey Report on Modelling Tools, Benchmarks and Control Methods. Furthermore, Bart De Schutter is also the coordinator of the focus area ``Power Generation and Transmission Control'' of WP4a, and he has edited the corresponding chapters of the WP4a Survey Report.

WP4c

The activities of TUD within WP4c have focused on two topics:
- comparative assessment of PWA-MPC methods for adaptive cruise control,
- validation of fault-tolerant controllers for Advanced Driver Assistance Systems (ADAS).

The aim of the first activity is to define a benchmark set up for the design of a model predictive controller (MPC) for a piecewise affine (PWA) system applied to adaptive cruise control (ACC) for a Smart. We have considered both a simple and a more complex model of the system, and built up a common framework aimed at assessing and comparing several algorithms that solve the PWA optimal control. Currently, we are working out this assessment.

The second activity has focused on fault-tolerant controllers for ACC. In practice, often an extensive range of field test are used for this purpose, which is an expensive and time-consuming procedure. We have proposed some methods based on randomized algorithms, formal analysis, and simulations to determine the

critical scenarios at which the limits of performance of the fault-tolerant controller are reached. The resulting methodology allows to still make reliable statements about the safe performance of fault-tolerant controllers for ACC systems using a number of tests that is several order of magnitude smaller than the Chernov bound.

Both activities have resulted in contributions to deliverable D4c.2.1. The first activity also contains a Modelling component (related to Task 4c.1).

WP6

TUD has been involved in (further) engaging industrial partners and associates (Task 6.1). In particular, Siemens (in The Hague, The Netherlands) and TNO Automotive (in Helmond, The Netherlands) have been targeted.

#20 KTH

WP1

KTH contributed the discussion on the EIHS, particularly, the International Curriculum Option of Doctoral Studies in Hybrid Systems, which KTH participates in. Two lectures of the First EIHS School on Hybrid Systems in Siena were given by KTH and six students participated in the School.

WP4a

KTH contributed to "Report on Tasks and Responsibilities of the Workpackage 4a: Energy Management" and coordinated the writing of the first of three benchmarks within the power electronics focus area as a part of the draft survey report. Ulf Jönsson and Henrik Mosskull participated in the first workpackage meeting in Zurich. Stefan Almer and Ulf Jönsson participated in the second meeting. Research was done on sampled data method for analysis and design of switched mode power converters.

WP4c

KTH contributed through two research projects at KTH in close collaboration with Scania. The interest in the project "Modelling of complex systems" is in building whole vehicle multi-domain models out of submodels. The work includes development of methodologies for sensitivity analysis of complex hybrid models with respect to errors in components and submodels. The second project is entitled "Vehicle control by using preview information" where methods to meet higher safety demands and obtain reduced fuel consumption by the use of real-time road information for vehicle control are investigated. These projects contributed to the corresponding tasks and deliverables in WP4c.

WP4d

KTH is co-leader of the workpackage with UAQ. KTH participated with several researchers at the WP4d meetings in Zurich and Siena. KTH contributed to the deliverables on control problems in wireless communications and on distributed ad-hoc wireless sensor networks. The research activity has been mainly focused on wireless automation and radio resource management for networked control applications.

WP5

KTH contributed to the lecture material of the summer school and to the proceedings of the special session on hybrid systems at ECC-CDC 2005.

WP6

KTH successfully invited a number of companies to be affiliated to HYCON.

WP8

KTH edited the deliverable on report on synergy actions with other projects.

#21 ULIN

WP3

(1) Participated in work meetings:
- HYCON Kick-off, Paris, October 22, 2004
- WP3-meeting, Dortmund, April 20, 2005
- Developed a Matlab implementation of an identification tool for piecewise affine systems (to be finalized within M3.3.3).

WP4d

(1) Participated in work meetings:
- HYCON Kick-off, Paris, October 22, 2004
- WP4d-meeting, Zürich, March 7, 2005

(2) Contributions to reports and deliverables:
- the preparation of the following documents:

- D4d.1.1: Report on control problems in wireless communications

(3) Developed a semi-decentralized strategy for uplink radio resource management, which is central for control of wireless networks.
(4) Modelled flow control mechanisms and queue management including packet scheduling, which can be seen as decentralized control for downlink radio resource management.

WP6

Interactions with industrial partner Ericsson regarding distributed control for radio resource management.

#22 LTH

WP4a

Lund has been involved in the preparation and discussion of case studies for power generation and power electronics. We participated in the two WP4a meetings in Z\"urich in January and July 2005.

Our research has mainly been focused on DC/DC converters, where LTH is using a piecewise affine controller designed using dynamic programming. A primary design criteria is the ability of the system to sustain large changes in operating point due to load and/or source variations. Harmonics at stationarity are studied using linearized time-periodic models.

WP4b

A case study devoted to a new chemical reactor has been formulated in cooperation with Alfa Laval AB, one of the world-leading companies for plate heat exchangers. The Open Plate Reactor (OPR) combines good mixing with high heat transfer capacity into one operation. With the new concept, highly exothermic reactions can be produced using more concentrated reactants with lower amounts of by-products. To utilize the full potential of the new reactor concept, new control systems need to be developed.

There are six control modes that cover all aspects of the feedback control of the OPR. During start-up the process will travel along its nonlinear dynamics and it is important that closedloop feedback control can

adjust to the large variations in dynamics to ensure safe operation. In the continuous operation mode, the process operates in steady-state and the dynamics can be easier approximated to reduce control complexity. During product grade transitions, the dynamics will change, however not as significantly as during start-up.

WP4c

Contribution to "D4c.1.2 - Hybrid models of GDI SI engines suitable for control design" A physical model of the switch-type Exhaust Gas Oxygen sensor (EGO) has been developed. The model seems to reproduce the main effects of significance to catalyst operation. Of particular interest is the perturbation in sensor characteristics that is observed when the exhaust gas contains non-equilibrium concentrations of hydrogen or carbon monoxide.

Contribution to "D4c.1.3 - Hybrid models of HCCI engine suitable for control design" Homogeneous Charge Compression Ignition (HCCI) is a new principle for combustion engine design that can be viewed as a hybrid of the spark ignition (SI) and compression ignition (CI) engine principles. As in an SI engine, a homogeneous fuel-air mixture is created in the inlet system. During the compression stroke the temperature of the mixture increases and reaches the point of auto-ignition, just as in a CI engine. Interesting control challenges with HCCI engines are the open-loop instability and the need for good timing control of the combustion.

WP4d

We got no funding from HYCON for this, but had strong activity. For example, we organized the "Workshop on Control for Embedded Systems", Lund, 13-16 June, within the NoE ARTIST-2 and participated in the workshop "Future of control and computing systems", May 2005, which was organized by T. Abdelzaher, J. Hellerstein, and D. Tilbury and was sponsored by the US National Science Foundation (NFS).

Our current work has focused on the modeling and nonlinear control-design of server systems, where queue length control and utilization control have been considered so far. The work also includes the instrumentation and experimental verification on an experimental web-server platform, where we have ongoing activities.

One part of our research relates to sensor switching strategies, i.e., from a network of sensors determine which sensor(s) to use at a certain time instant as well as the observer and estimator gain design for the resulting switched discrete time systems.

WP6

We are using our contacts with the DYNASIM, who are making simulation software based on the modeling language Modelica, to formally get affiliated with HYCON.

#23 UCAM

WP2

Submission of inputs for identification of suitable benchmark problems. Submission of Air Traffic Control problem and of Exhaust Gas Catalyst Purging problem. Submission of input to deliverable D2.1.2. Review of deliverable D2.1.2.
Participation in WP2 meetings in Zurich (09.03.2005) and in Siena (19.07.2005).

WP3

Integration of nonlinear stochastic hybrid air traffic simulator written in JAVA with Monte Carlo Markov Chain optimal decision maker written in MATLAB.
Participation in WP3 meetings in Zurich (09.03.2005) and in Siena (18.07.2005).

WP4b

Visit by Ion Necoara (TUD) to Eric Kerrigan and Jan Maciejowski (UCAM), 22.08.2005 – 22.11.2005, to collaborate on control of max-plus algebra systems. (Visit not charged to HYCON.)
Participation in WP4b meeting in Siena (18.07.2005).

WP4c

Modelling and analysis of exhaust after-treatment supervisory control problem. Particular focus on diesel particulate filters, using level-set methods. (Activity not funded by HYCON.)
Participation in WP4c meeting in Zurich (09.03.2005).

WP7

Participation in Governing Board meetings in Paris (22.10.2004) and Siena (19.07.2005).

5.6 Implementation of the previous Review Recommendations

1) IAB – an opportunity to exploit

- Intensive actions in WP6 have been conducted in order to structure the bridge between the academia and industrial world in our domain of expertise. This leads to the *Charter for the Idustrial Advisory Board of HYCON*:

"The Industrial Advisory Board of the HYCON Network of Excellence (NoE) consists of selected representatives of companies working in the area of interest of HYCON. In particular, one representative from each company who signed the letter of agreement indicating their degree of involvement with HYCON (*) will be selected. The members of the IAB are allocated to one of the four industrial segments pursued by HYCON (Industrial Control, Energy, Automotive, and Communications). The IAB will meet separately according to the grouping at dates selected by the corresponding Work Package Leaders. Their role will be of providing feedback on the particular research directions and of facilitating the interaction between industry and HYCON on the specific topics of interest.

The Industrial Advisory Council (IAC) of the HYCON Network of Excellence (NoE) is formed by selected members of the IAB. We envision one or two participants per industrial segment. IAC will play a fundamental role in providing

- Directions for research, application domains, industrial relevance, industrial needs and strategies,
- Feedback on deliverables, milestones, research planning and management.

The IAC consists of 4 to 8 members chosen by the IAB and the Executive Committee of HYCON in concert with the European Community Officers and will operate under a Chairman elected by the IAC itself.

The IAC shall meet at least once per year shortly before the review meetings for the NoE to provide feedback at a critical juncture of the life of the NoE. The IAC will convey their findings to the Executive Committee in written form (either document or presentation).

This structure has been conceived to operate for the maximum benefit of the European Community and the HYCON NoE as it will be operating at two important levels: technical and strategic. Often Industrial Advisory Boards are tilted towards either strategic objectives (but then lack of an important operational function) or technical objectives (but then they lack strategic relevance). Our approach is highly innovative. "

(*) This is detailed in the Work Plan M13-M30

- The interactions between the WP4a,b,c,d and the industrial collaborators are for instance demonstrated by:

- The presence in the meetings of representatives of industrial companies that acted as critics to the contributions of the partners and offered an industrial perspective of the control problems considered.

- The extension of the WP4's outreach to other potential industrial collaborators. For this we can refer for instance to the (planned for September 14) visit of the coordinator of the Power Electronics Control Focus Area to STMicroelectronics in Grenoble, France, aiming at investigating the potential for future interactions on the field of hybrid control of dc-dc converters, and the contacts established with NETCOM S.A., a leading power supply manufacturer in Athens, Greece.

- The WP4a,b,c,d partners have acted to identify the interests of their industrial collaborators. In coordination with wp6, a questionnaire was sent, through which the industrial partners asserted their interest and defined their degree of affiliation with HYCON.

2) HYCON – an identity to build

The interactions between HYCON and the international scientific community are of pronounced importance. For this, the partners have decided on the following future dissemination actions:

- The submission of a special conference session on Energy Management related hybrid control problems. The targeted conference is the American Control Conference (ACC) to be held in June 2007, with a submission deadline in September 2006.

- The submission of a special journal issue on the same subject. Automatica, a leading publication of the International Federation of Automatic Control (IFAC), was selected as the targeted journal. The submission will incorporate the feedback coming from the reviewers of the conference session.

- The invitation of academics and researchers will increase the visibility of HYCON and provide valuable feedback on the research directions of the WPs.

- The organization of the 2nd PhD School.

- The organization of the Joint CTS-HYCON Workshop on Nonlinear and Hybrid Control, Paris, July 2006

- The design of an HYCON poster to be available at CDC-ECC'05.

- The HYCON Website has been completely redesigned. A few new illustrations will be implemented soon.

To be completed

3) Application areas – ensure either full support or decrease number of areas

We have decided to fully support **all the applications areas**. In particular the WP4d Leaders and all the members of this WP have considerably worked in order to better define the main tasks and the resources that will be used for achieving them. The concise deliverables D4d.1.1 and D4d.1.2 together with the future plans M13-M30 demonstrate the quality of this line of direction of this very promising research area. Two ISC Members have positively reviewed D4d.1.1 and are currently reviewing D4d.1.2.

4) Integration of work flow – link between user cases, benchmarking and tools

Below is a list of interactions between the WPs. The ExCom wishes to pointing out that this recommendation is more a matter of not having shown clearly these interactions in the previous review rather than a real lack of them.

	WP2	**WP3**
WP1	The collection of HYCON benchmarks will constitute part of the HYCON Institute experimental infrastructure	The tool repository and the demonstrator stie ultimately become a part of the business of the EIHS
WP4	Some of the case studies coming from the sectors covered by WP4a, WP4b, WP4c and WP4d will eventually constitute a HYCON benchmark. A number of potential benchmark is coming out from each of the WP4. Benchmarks are not only the case study itself but also the benchmarking exercise, which include setting up the conditions for the exercise and a posterior analysis and evaluation. A call for new HYCON benchmark has been added in the new work-plan from M13-M30 as a mean of integration of WP2 with the rest. The work carried out by the WP4a partners will directly contribute to the activities of WP2. The WP4a partners have jointly defined benchmark examples to study the hybrid control of power systems and power electronics, which can be directly included in the performance evaluation platform of WP2.	Experiences with the case studies lead to new challenges for theory and for the development of tools. The tools are integrated into the repository and the demonstrator site and their interaction and integration into a tool chain is promoted by the work on tool integration, e.g. the interface for PWA systems enables the interaction between tools for identification and for controller synthesis. The WP4 partners are using and comparing a number of hybrid modelling and simulation tools. Therefore, their activities are closely related to the ones of WP3. The WP4 partners will be both receiving input from the tool integration efforts of WP3 and giving feedback by jointly assessing the performance of the various modelling and simulation tools.
WP5	WP2, as the other will contribute to dissemination and the rest of the objective of WP5	See WP 3
WP6	Benchmarks are contemplated as an excellent mean of integration with industry. Some of the benchmarks will be proposed directly from industry. This is already happening in WP6 in connection with the WP4a sector.	The demonstrator site aims at promoting the use of the tools by users from industry. In particular, e-learning modules could support this. However, at the current level of funding, these are hard to realize.

WP4c and WP5: WP4c wants to employ the technical infrastructure of the annotated bibliography to disseminate their results to industry.

5) Management – reinforce operational coordination of the project

The coordination of the project has been reinforced (integration aspects and operational tasks).

6) Deliverables – provide missing M6 deliverables at M9

Done

6. EXPLOITATION / TECHNOLOGY IMPLEMENTATION PLAN

N/A