WIDE

Decentralized Wireless Control of Large-Scale Systems

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Dissemination Level

→	**PU**	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

Executive summary

This report describes location, attendance, didactical contents and impact, social events, and scientific outcome about the "3rd WIDE PhD School on Networked Control Systems", held in Siena on July 7-9, 2009. The school was attended by more than fifty students, from several universities and institutes around the world. The feedback from the attendees of the school was very positive, in terms of didactics, location and social event. The school was followed by a one-day hands-on satellite school on "An Introduction to WSN Programming using Contiki", attended by about ten participants.

Contents

1 Introduction

The organization of an international PhD school on "Networked Control Systems" was one of the core dissemination activities of the WIDE project. In the original workplan of the project, the PhD school was supposed to be linked to and co-located with a small "Joint EU-US workshop on Networked Control Systems". However, after the workplan was approved in March 2008, the Consortium became aware of an initiative for organizing the "1st IFAC Workshop on Estimation and Control of Networked Systems" (NecSys'09), that will be held on 24-26 September, 2009 in Venice (Italy), and decided to adjust the dissemination workplan differently, for two main reasons. First, because of the proximity of the location and of the date of the NecSys'09 workshop with the PhD school, organizing two workshops on the same topic in the same country at the same time did not sound useful. Hence, the Consortium members redirected their efforts towards NecSys'09: A. Bemporad (UNISI) and M. Johansson (KTH) joined the Technical Program Committee of NecSys'09, and the UNISI, HPL, and KTH teams submitted and had papers accepted for presentation at NecSys'09 (UNISI: "Decentralized Model Predictive Control of Dynamically-Coupled Linear Systems: Tracking under Packet Loss", HPL: "Kalman Filter for Systems with Communication Delay", KTH: "LQG and Medium Access Control"). Second, at the kickoff meeting two US speakers were already invited to give tutorial presentations on water management systems based on WSN (Prof. M. Lemmon and Dr. L. Montestruque), as well as a speaker from Australia (Prof. M. Cantoni), and four US speakers (Prof. S. Lall, Prof. P.R. Kumar, Prof. F. Bullo, Prof. M. Lemmon) lectured at the PhD School (plus a speaker from Japan, Prof. H. Ishii). Henceforth a strong EU-US liaison, which was the main goal of the planned workshop, was already partially achieved with the kickoff meeting and the PhD school. In alternative to the workshop, the school organizers (A. Bemporad, M. Heemels, M. Johansson) decided to organize a satellite school on "An introduction to wireless sensor network programming using Contiki", and to devote efforts to prepare a "Handbook on Networked Control Systems" on the basis of the PhD school, where each speaker of the school will contribute a chapter based on the delivered lecture.

Below, we report about the PhD school and the satellite school.

2 PhD school goals and attendance

The targets of the school were graduate students and researchers who wanted to learn the main concepts of networked control systems, therefore the lectures were very didactic, introducing the attendant from the main basic concepts to the state of the art in the field. The presentations were in a lecture style, providing explanations, insights and overviews. All lecturers were asked to be as much didactic as possible (possibly sacrificing the presentation of the most recent research results as is common in workshops) in favor of a clear and deep exposition of the basic issues. More in detail, the school has provided the basic understanding of the following aspects of networked control systems: fundamental issues, distributed estimation and consensus, cooperative control, distributed optimization, decentralized and hybrid model predictive control, simulation, stability, feedback over limited capacity channels, event-triggered and self-triggered control. Ten leading researchers in these domains were invited to lecture on these topics and provided lectures on different topics of networked control systems. The school was attended by 54 students. 43 out of 54 students came from universities/institutes not affiliated with the WIDE consortium, and 30 out of 54 from outside Italy.

The attendance was considered very successful, given a number of competing summer PhD schools on similar topics, such as the "DISC Summer School on Distributed Control and Estimation" held from 2-5 June 2009 in Noordwijkerhout (NL), the "Georgia Tech Summer School on Cyber-Physical Systems" held on June 22-26, 2009 in Atlanta (USA), and the Italian PhD School on "Robust and constrained control" held in Bertinoro (IT) on 13-18 July 2009.

3 Location

The school was located in the Department of Information Engineering of the University of Siena. The lectures were delivered in a big room "room C/D" (approx. 150 seats), which was equipped with laptop projector, Wi-Fi internet connection, LAN connections, air conditioning, video screens. The comments of both students and speakers were positive about the location, and about the choice to have coffee breaks at the bar of the Faculty of Engineering located next door, with the opportunity to sit at the tables during the breaks. The social dinner took place in downtown Siena (see Section 6 below), and the chosen location was particularly well appreciated.

4 Organization

The school was organized and coordinated by Alberto Bemporad (Dept. Information Engineering, University of Siena, Italy), Maurice Heemels (Dept. Mechanical Engineering, Technische Universiteit Eindhoven, The Netherlands) and Mikael Johansson (Dept. Electrical Engineering, KTH - Kungliga Tekniska Högskolan, Stockholm, Sweden). The company Resolvo s.r.l. took care of all organizational and administrative matters, such as participant registration, setup and maintenance of the school web site, preparation of the material, handling email exchange with attendees, provide information and give support to participants before and during the PhD School, follow the work of technicians, contact suppliers (for posters, gadgets, badges, coffee breaks, booklets with the slides made by lecturers), and prepare certificates of attendance. Ms. Ilaria Sbragi also contributed to the school, acting as an interface between the organizers and the company Resolvo s.r.l.

5 School program

The school was arranged over three days, in lectures of 45 min each hour, as reported in the following tables:

DAY 1, July 7, 2009

7.45	8.40	*Registration*	
8.40	8.45	*Opening*	Organizers
8.45	9.30	Fundamental issues in networked control systems	P.R. Kumar
9.45	10.30	*Coffee break*	
10.30	11.15	Fundamental issues in networked control systems	P.R. Kumar
11.15	12.00	Fundamental issues in networked control systems	P.R. Kumar
13.30	14.15	Distributed estimation and consensus	Luca Schenato
14.30	15.15	Distributed estimation and consensus	Luca Schenato
15.15	15.45	*Coffee break*	
15.45	16.30	Cooperative control	Francesco Bullo
16.45	17.30	Cooperative control	Francesco Bullo
17.30	18.15	Cooperative control	Francesco Bullo

DAY 2, July 8, 2009

8.45	9.30	Simulation of NCS	Anton Cervin
9.45	10.30	Simulation of NCS	Anton Cervin
10.30	11.00	*Coffee break*	
11.00	11.45	Distributed optimization	Mikael Johansson
12.00	12.45	Distributed optimization	Mikael Johansson
14.30	15.15	Decentralized and hybrid MPC	Alberto Bemporad
15.30	16.15	Decentralized and hybrid MPC	Alberto Bemporad
16.15	16.45	*Coffee break*	
16.45	17.30	Decentralized control	Sanjay Lall
17.30	18.15	Decentralized control	Sanjay Lall
20.00		*BANQUET*	

DAY 3, July 9, 2009

8.45	9.30	Stability and Control of NCS	Maurice Heemels
9.45	10.30	Stability and Control of NCS	Maurice Heemels
10.30	11.00	*Coffee break*	
11.00	11.45	Feedback control over limited capacity channels	Hideaki Ishii
12.00	12.45	Feedback control over limited capacity channels	Hideaki Ishii
14.30	15.15	Event-triggered and self-triggered control	Michael Lemmon
15.30	16.15	Event-triggered and self-triggered control	Michael Lemmon
16.15	16.30	*Closing*	

6   Web site, course material, and dissemination

A web-site for the school was set up at: `http://ist-wide.dii.unisi.it/school09`
The web site provided all the information about the school: location, program, registration proceedings, travel info and a help for hotel reservation.
The slides of the presentations were distributed to attendees in paper copy and are available in PDF format on the web site of the school.

As an outcome of the school, a "Handbook on Networked Control Systems" will be prepared on the basis of the PhD school in 2010, where each speaker of the school will contribute a chapter based on the delivered lecture.

7   Social event

During the school a social dinner was organized at the "Enoteca Italiana" in Siena, a restaurant in the medioeval fortress of Siena.

8   Questionnaire

The questionnaire (see Fig.3) was distributed during the last day of the school, and 35 forms were returned to the organizers. The attendees were asked to mark from 1 (=negative) to 5 (=positive) several aspects of the school, and here below is a summary of scores:

Aspect for Evaluation	1	2	3	4	5	Average Score
Notice of the course	0	1	1	15	18	4.42
Timing of the notice	1	0	0	8	26	4.65
Web information	0	3	5	16	11	4
Site	0	2	4	11	18	4.28
Audiovisual support	1	7	14	12	1	3.14
Documentation	1	3	8	14	9	3.77
Meals	1	4	10	11	9	3.65
Lecturers know their topics	1	0	0	4	30	4.77
The length of the lectures were appropriate	2	0	2	12	19	4.31
The course structure was appropriate	0	2	4	21	8	4
Lecturers were well coordinated and no overlaps were found	0	1	3	17	14	4.25
The course covered the main topics	0	1	2	18	13	4.26

The average vote given to "Audiovisual Support" was probably due to some network problems occurred during the remote lecture by Prof. Sanjay Lall, who could not travel to Siena for sudden family problems, but anyway managed to provide his talk via videoconference from Stanford University.

Also, attendees were asked to indicate the three most interesting lectures. The following were the top ranked:

- "Cooperative control" by Francesco Bullo

- "Distributed optimization" by Mikael Johansson

- "Stability and Control of NCS" by Maurice Heemels

- "Decentralized and hybrid MPC" by Alberto Bemporad

- "Event-triggered and self-triggered control" by Michael Lemmon

9 List of participants

The attendees of the PhD school are listed in the following table.

Name	Country	E-mail
Zapateiro Mauricio	Spain	mauricio.zapateiro@udg.edu
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Giulio Ripaccioli	Italy	ripaccioli@dii.unisi.it

Figure 1: Participants and lecturers

10   Poster

A poster for the PhD school was designed by Alberto Bemporad and is reported in Fig.2.

11   Satellite school

The satellite school "An introduction to wireless sensor network programming using Contiki" followed the NCS Phd school on July 10, 2009 in the same lecture room. The satellite school was a one-day hands-on sensor networking mini-course intended to provide an introduction to working with real sensor networks. The course provided a hands-on introduction to wireless sensor network programming in a state-of-the-art operating system and on real sensor hardware. The Contiki operating system (`http://www.sics.se/contiki/`), a pioneering operating system for wireless sensors, and the first operating system to support IPv6 communication, was used. The course introduced Contiki's architecture, programming abstractions, and communication primitives. A significant part of the course was devoted to hands-on exercises: participants learned how to sample sensors and download data via radio. In the hands-on part of the course the Contiki shell application was used, which allowed the participants to rapidly prototype and test new sensor network applications. This intensive course was already given by the speaker, Dr. Fredrik Österlind from the Swedish Institute of Computer Science (SICS) and one of the developers of Contiki, on several occasions previously, both to experienced sensor network researchers and to beginners in the field.

The satellite school was very successful, especially students enjoyed performing live experiments with wireless sensors. The school was attended by 16 attendants.
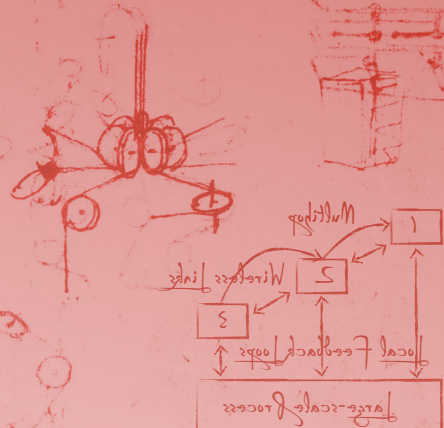
Figure 2: Poster of the school

EVALUATION QUESTIONNAIRE
3rd WIDE PhD SCHOOL ON NETWORKED CONTROL SYSTEMS

Please take a few minutes to answer the questionnaire below. We ask you to score each of them from 1 to 5 (5=positive, 1=negative). If you wish, please add your comments for each aspect.

Aspects for evaluation	Scores					Comments
	1	2	3	4	5	
Notice of the course (date, place, topics) *(You received enough information to decide your attendance)*						
Timing of the notice *(You got notice of the course with enough advance to plan your agenda)*						
Web information *(The website of the course provides enough information about the course)*						
Site *(The room facilities were appropriate to this kind of activity)*						
Audiovisual support *(Adequate, good working state)*						
Documentation *(The course documentation was appropriate and complete)*						
Meals *(The quality of the meals and coffee services was good)*						
In general, the lecturers know their topics						
The length of the lectures were appropriate						
The course structure was appropriate						
Lecturers were well coordinated and no overlaps were found (*please detail overlaps if any*)						
Considering the course length, the course covered the main topics (*please detail missing contents*)						
Please, identify the three most interesting lectures (*refer to lecture numbers 1 to 10*)						

Figure 3: Questionnaire