Distributed Real Time Cyber Physical Systems (of Systems)

First Semester

9 CFU

Teachers

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Objectives and Aquired Knowledge

- The Distributed Real time Cyber Physical Systems course aims at providing solid knowledge and competences to

- conceive, define and design

- complex cyber physical systems which are at the basis of emerging fields as Internet of Things, Smart Factories and Critical Infrastructures.

- In particular focus is put on the distribution and coordination aspects of the constituent systems of an SoS and on time management issues.

Program at a glance

- **Introduction and fundamentals on architecting distributed and real-time cyber physical systems**

- **Design frameworks and techniques for conceiving, modeling and designing cyber-physical systems**

- **Laboratory on cyber-physical systems (of systems)**

Content (1)
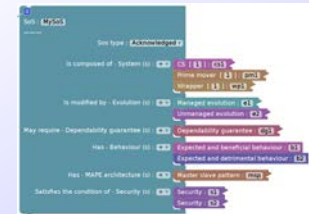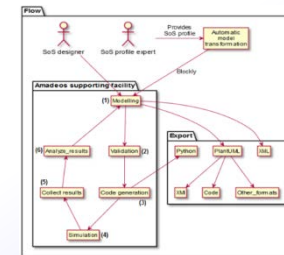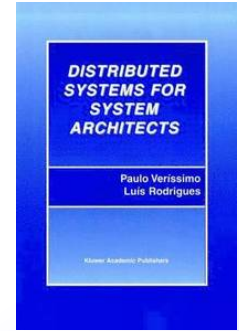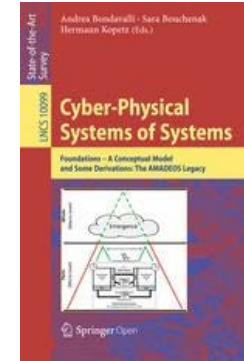
➢ Introduction and fundamentals of Cyber-Physical Systems

➢ - interface and stigmergy

➢ - emergence

➢ Distributed systems:
- System models
- agreement: algorithms and protocols
- Blockchains

➢ Real-time systems:
- Real-time aspects
- Time, clocks and resilient time keeping
- Scheduling in real-time systems

Contents (2)

- ➢ Standard frameworks for designing SoS
- ➢ The role of Modelling and Model-Driven Engineering
- ➢ SysML, Blockly,
- ➢ Design frameworks
- ➢ tools and alternatives

Contents (3)

➢ Cyber-Physical Systems Lab: requirements engineering, modeling, implementation (with a little of robotics)

- Lab presentation, introduction, arrangements
- Requirements analysis and definition: Kilobots platooning
- Python with examples
- Blockly4SoS and examples
- Modeling of platooning with Blockly4SoS
- Kilombo (Kilobots simulator): how to use, analysis of examples, how to program
- Kilobots usage : howTo on Kilobots
- implementation of the platooing.

Teaching Material

- Course Book:

- **Cyber-Physical Systems of Systems** *Foundations – A Conceptual Model and Some Derivations: The AMADEOS Legacy*

- Editors: Andrea Bondavalli, Sara Bouchenak, Hermann Kopetz
ISBN: 978-3-319-47589-9 (Print) 978-3-319-47590-5 (Online)

- The book is published in *open access* form by Springer, meaning that it is freely available for download at

- https://link.springer.com/book/10.1007%2F978-3-319-47590-5
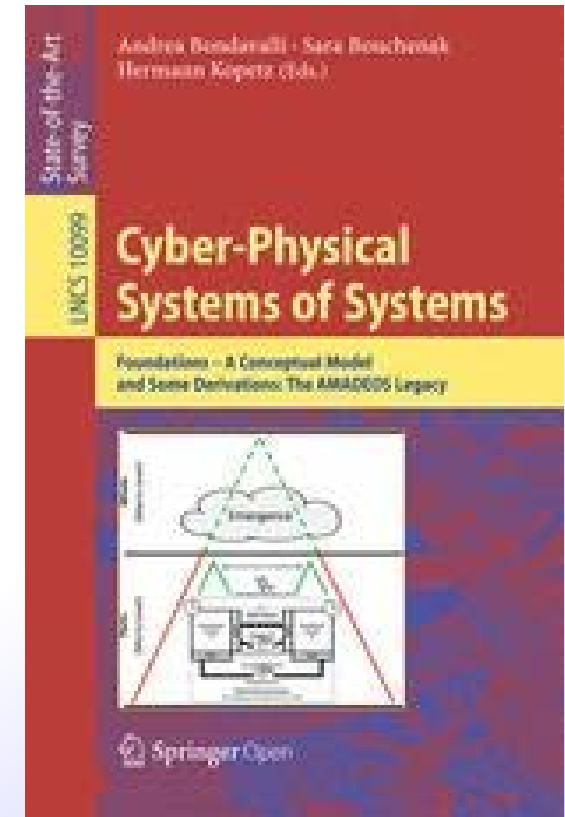
Teaching Material

- Additional material:
- Avizienis, A.; Laprie, J.-C.; Randell, B.; Landwehr, C. "Basic concepts and taxonomy of dependable and secure computing" IEEE TDSC, Vol. 1 Page(s): 11- 33, 2004.
- Siewiorek, D.P, Swarz R."Reliable Computer Systems: Design and Evaluation", 3rd edition, A. K. Petres, Ltd., 1998
- Hermann Kopetz: Real-Time Systems: Design Principles for Distributed Embedded Applications, second edition, Springer, 2011
- Paulo Verissimo, Luis Rodrigues: Distributed Systems for System Architects, Springer, 2001.
- Andrew S. Tanenbaum, Maarten van Steen: Distributed Systems: Principles And Paradigms, Pearson Prentice Hall, 2006.

- More material and the course foils are available of the Course website

Modalities for the Exam and WebSite

I) preparation of a project

(individual assignement at the end of the lectures and valid for the entire academic year – a relation describing the work done MUST be delivered at least one week before the exam)

II) Interview (registration on the official unifi webiste mandatory)

Condition for being admitted to the interview is the **acceptance of the project description**

Course WEBSite: http://e-l.unifi.it
You are required to sign on (passwd: sos)