

ICCPS

EU-US Institutional Panel

CPSWEEK 2010 STOCKHOLM

Future perspectives

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Embedded Systems and Control
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Outline

Embedded Systems

Embedded Systems and Control

Networked Embedded and Control Systems

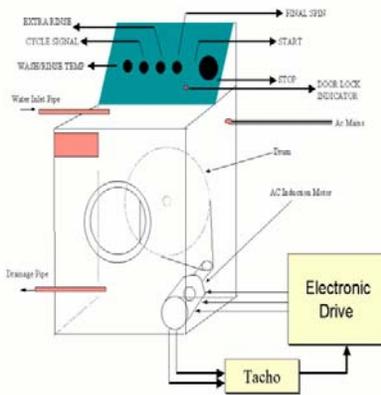
Complex System Engineering

Systems-of-Systems

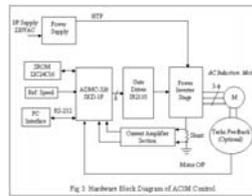
Embedded Systems Washing Machine Control

- Controlling a single system, implementing time-critical functionalities in a dedicated manner

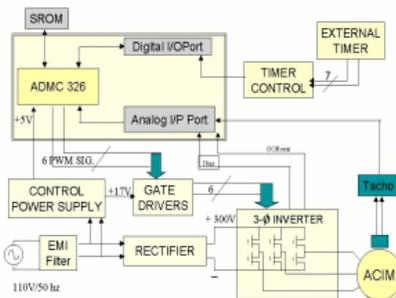
Block Diagram showing ACIM and Drive connected to the Washing Machine



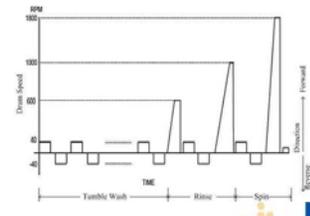
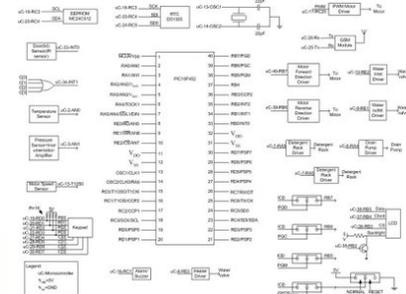
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Control Block Diagram of ACIM based Washing Machine



3



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Embedded Systems and Control

- Embedded Systems Design
- Computing Systems
- Middleware
- WSNs



133.5 M€/ 4Y

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4

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Embedded Systems: from pervasive to networked

- **Pervasive Embedded Intelligence**
 - Embedded systems everywhere
- **Increasing Connectivity**
 - Everything gets connected
- **The next step in optimisation:**
 - from single-system optimisation
 - to optimisation of a process composed of elementary, networked systems
 - or optimisation of a system taking into consideration external information (e.g., energy price signals)

Networked Monitoring and Control (Call 2)

- WSNs & Cooperating Objects
- Control of Large-Scale Systems
 - Processes
 - Plants
 - Smart Buildings
 - Traffic
 - ...



Complex Systems Engineering (Call 5)



As more and more heterogeneous systems get connected, the optimisation problems to be addressed become ever more complex

Complex
Networked
Heterogeneous
Embedded Intelligence

Multi-disciplinary
Self-configuring
Fault tolerant
Adaptive
Scalable
Evolving

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Embedded Systems and Control

- Computing Systems
- Embedded Systems Design
- Networked Embedded and Control Systems / Complex Systems Engineering

195.5 M€ / 4Y



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Systems-of-Systems

The next “dimension” of complexity



Societal focus!

- Aeronautics & Space
- ITS, including (Multi-modal) Traffic Control
- Air Traffic Control
- Electric Vehicles
- Power Grid
- Healthcare
- ...



SoSECE

Systems-of-Systems

The next “dimension” of complexity



National Centers for Systems of Systems Engineering (NCSOSE)

- *The design, deployment, operation, and transformation of meta-systems that must function as an integrated complex system to produce desirable results. These meta-systems are themselves comprised of multiple autonomous [NETWORKED] embedded complex systems that can be diverse in technology, context, operation, geography, and conceptual frame.*

Systems-of-Systems

The next “dimension” of complexity



- Systems of systems typically exhibit the behaviour of complex systems. But not all complex problems fall in the realm of systems of systems.
- Inherent to system of systems problems are several combinations of traits, not all of which are exhibited by every such problem:
 - * Operational Independence of Elements
 - * Managerial Independence of Elements
 - * Evolutionary Development
 - * Emergent Behaviour
 - Geographical Distribution of Elements
 - + **Heterogeneity of Systems**
 - + **Networks of Systems**
 - + **Interdisciplinary**

Maier’s criteria

WP 2011-12 (Call 7)



- **New paradigms for embedded systems [and networked] monitoring and control towards complex systems engineering [...and beyond]**

to push the limits of embedded systems, monitoring and control, and optimisation technologies

- Embedded Systems
- Networked Monitoring and Control
- Systems-of-Systems
- International Cooperation



International Cooperation



- Australia
 - Embedded Systems
 - Monitoring and Control
- Western Balkans
 - Monitoring and Control
- US
 - Systems-of-Systems



WP 2011-12 (Call 7)



- **Computing Systems**
 - to achieve breakthroughs in the transition to multi-core architectures across the whole computing spectrum (embedded, general-purpose and high-performance) across the underlying hardware, the system software (OS, tools, compilers, etc) and the programming paradigms.**
 - **Parallel and Concurrent Computing**
 - **Virtualisation**
 - **Customisation**
 - **Architecture and Technology**
 - **International Collaboration (USA, India, China and Latin America)**



WP 2011-12 (Call 7)

Publication: Sep 10
Deadline: Jan 11

- Computing Systems
- New paradigms for embedded systems, monitoring and control towards complex systems engineering

TBC

+95 M€ / 2Y



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WP 2013

- Focus on Computing, Complex Systems Engineering/Systems-of-Systems

+? M€

TBC



~50 M€ EU-funding / year

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