

New Paradigms in Monitoring & Control towards Complex System Engineering

**2nd Meeting of the M&C Cluster on
SMART BUILDINGS/SMART SPACES**

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OUTLINE

- Pervasive Networked M&C
- Issue on Large-Scale/Complex deployments
- New Paradigms in Networked M&C
- Conclusions

- Call 7 Objective 3.3
- PPPs

The Context

Embedded Systems & Control

Networked Embedded and Control Systems

Networked Embedded Intelligence

Networked Monitoring and Control

Pervasive

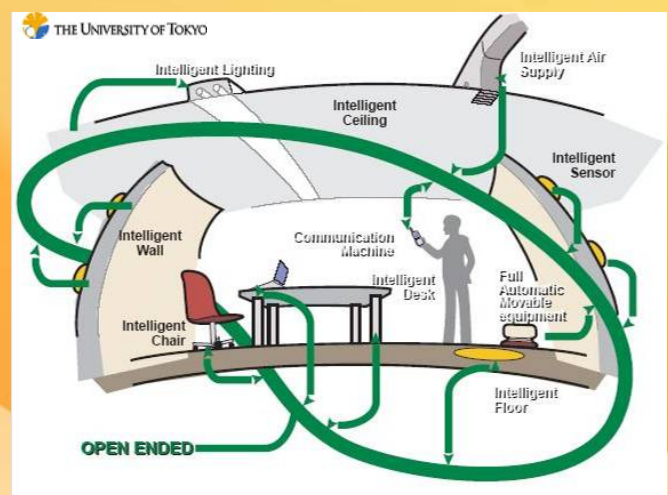
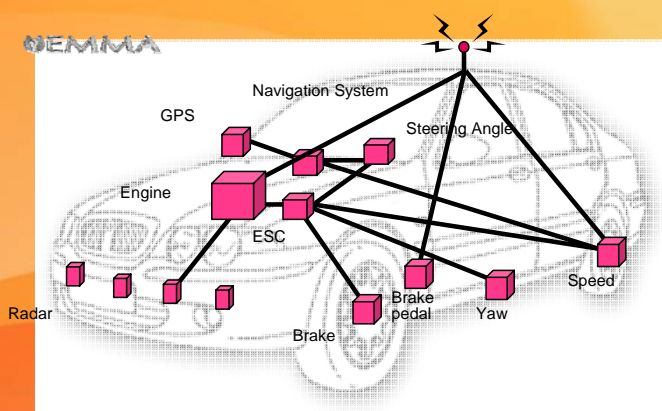
Networked Monitoring and Control

- Sensors everywhere: from temperature sensors, to accelerometers in our smart phones, to sophisticated CCTV systems for surveillance
- If, currently, most of these systems remain isolated, they are becoming increasingly networked
- The potential is clearly there to start capturing this “intelligence” to inform our decisions
- However, control/actuation need to be based upon reliable data – thus the underlying systems must be reliable (and available) themselves
- Security and Privacy concerns sometimes arise, and need to be addressed

Potential

- The potential and range of applications of Networked Embedded Intelligence/ Monitoring and Control is tremendous
- Technological challenges are numerous, but manageable
- More critical, a paradigm shift is needed to jump from isolated Embedded Systems into fully-networked, **cooperating** embedded solutions

Towards Networked, Cooperative Embedded Intelligence



- Embedded systems are ever more pervasive, permeating **all things** and **everything**: pervasive embedded intelligence
- The next step is to move towards **networked, cooperative embedded intelligence**

From **Monitoring** to effective **Control**

From (Heterogeneous) **Sensing** to...

understanding of the underlying phenomena
to...

modelling and simulation to...

informed data aggregation/fusion to...

expert systems to...

effective **control** (open or closed loop)

through **Cooperation**

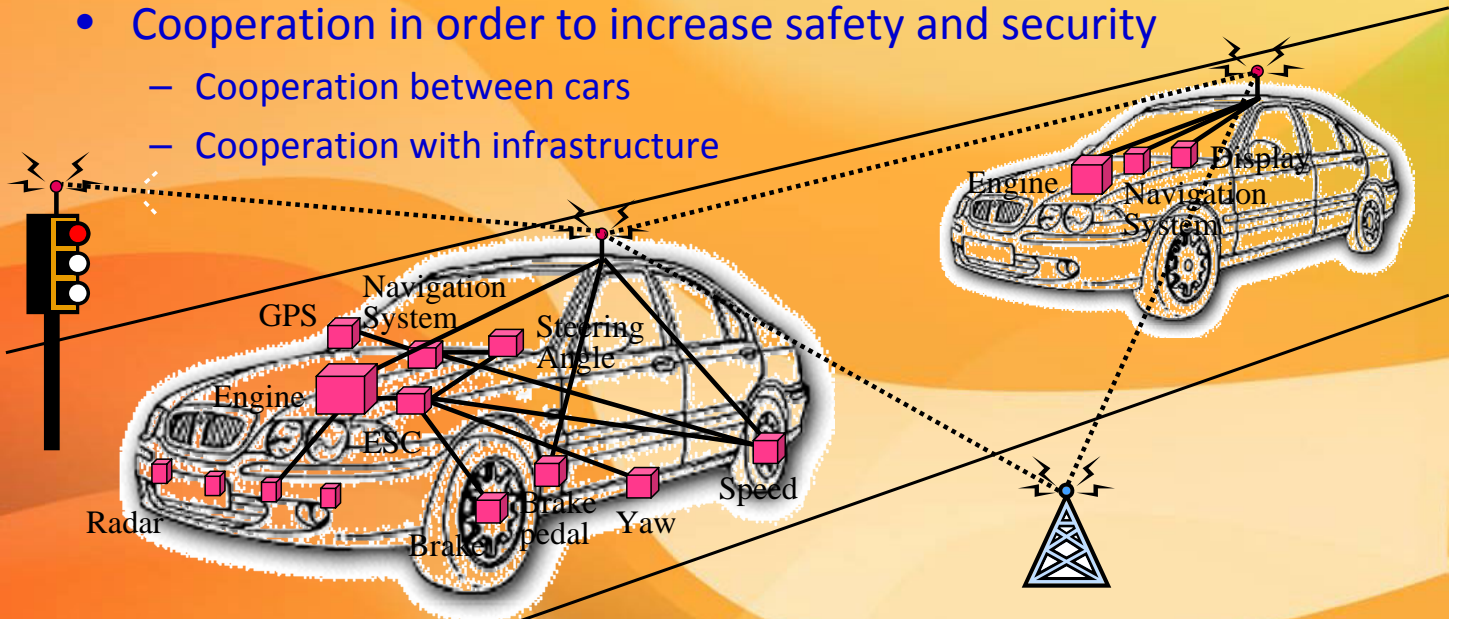
Cooperation: the most critical trend

- Making the most of Heterogeneity and “Diversity” in order to improve sensing... and eventually adaptation/actuation
- From piece-meal optimization of elemental (sub-)systems to cooperative optimisation of the overall system, or of composite systems
- The challenge is to strike a balance between autonomy and this “global” optimisation

Networked Vehicles:



- Many sensors and actuators in today's cars
- Cooperation in order to increase safety and security
 - Cooperation between cars
 - Cooperation with infrastructure



Cooperation q.s.

CONCLUSIONS

It is all about getting the right/necessary information and make it available at the right time to the right people/process in order to cooperatively optimize a system or composite systems!

FP7 Call 7

ICT Call 7

- Objective ICT-2011.3.3 New paradigms for embedded systems, **monitoring and control** towards **complex systems engineering**
- Objective ICT-2011.10.1 EU-Brazil Research and Development cooperation
 - b **Networked Monitoring and Control**
- **Publication: 28 Sep 2010**
- **Deadline: 18 Jan 2011**

Objective ICT-2011.3.3 Target outcomes

To facilitate the design and development of advanced Embedded Systems composed of any number of independent, mainly heterogeneous and interacting intelligent embedded components and sub-systems. Emphasis is on:

- a) Novel dependable and scalable architectures and tools mainly for energy efficient and energy-aware, heterogeneous embedded systems; projects may include, whereas relevant, enhancements of educational curricula.
- b) Secure composition concepts, methods and novel validation / verification / testing techniques and tools, including meta-modelling.

Objective ICT-2011.3.3 Target outcomes

To achieve stable and robust behaviour of (in particular closed-loop) real-life systems, actions should address the systematic engineering, through (embedded) intelligence, diagnostics, advanced control and optimisation techniques and the development of systems capable of dealing with complex, distributed and/or uncertain dynamics and/or very large amounts of sensory data and standardisation of configuration interfaces and exchange platforms. Emphasis on:

- c) Robust distributed estimation/prediction, cooperative networked control, synchronisation, and optimisation methods in industrial environments.
- d) Energy-aware, self-organising, monitoring and control systems including fault-adaptive methods for adjusting to/recovering from failures. Projects may include usage of wireless sensor/actuator networks in closing reliably the control loops. Research actions should demonstrate proof of concept.

Objective ICT-2011.3.3 Target outcomes

At a much higher and at global system level, actions should analyse and advance the management of behaviour of very large scale, or complex man-made systems towards the design, development and engineering of System-of-Systems (SoS). Emphasis will be on concepts, methods, architectures and tools towards building SoS addressing societal needs e.g. in distributed energy systems and grids, multi-site industrial production, emergency coordination and global traffic control. The work should demonstrate its potential use across more than one application sectors. Focus is on:

- e) Basic underpinning technologies such as large scale modelling and simulation to understand the operation and behaviour of the constituent systems of SoS and of their interdependencies and to allow them to work together for a common goal and/or a global end-to-end optimisation of behaviour. Concepts, methods, architectures or tools the management of dynamic properties as constituent systems of SoS change, are added or removed as the SoS structure and goals evolve.
- f) Coordination and support actions for elaborating strategic research and engineering roadmaps by bringing together the relevant stakeholders and elaborating representative case studies.

Objective ICT-2011.3.3 Target outcomes

- To facilitate and promote **international cooperation**, focus is on:

g) Analysis of international research agendas and preparation of concrete joint R&D initiatives for international collaboration, in particular with the USA mainly in the area of SoS and Western Balkan Countries (WBC), mainly in the monitoring and control area. Separate proposals per geographic area are expected.

Objective ICT-2011.3.3 Expected Impacts

- Improved industrial competitiveness through strengthened capabilities in advanced embedded systems, in **monitoring, control and optimisation of large-scale complex systems**, in areas like energy, transport, and production, and in engineering of SoS.
- New business eco-systems providing innovative products and services based on SoS.
- Reinforced European scientific excellence and technological leadership in the **design and operation of large-scale complex systems**.
- Wider educational and training activities in **systems and control engineering** in Europe at all levels.
- International cooperation with targeted geographical areas creating mutual benefits which will further European interests on focused technical topics.

Objective ICT-2011.3.3

- Funding schemes
 - a), b), c), d): IP, STREP
 - e): IP: It is expected that a minimum of one IP is supported.
 - f), g): CSA. Funding per CSA under g) should not exceed EUR 0.5 million
- Indicative Budget distribution
 - IP/STREP: EUR 46 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs
 - CSA: EUR 4 million

ICT-2011.10.1 EU-Brazil Cooperation

b) Networked Monitoring and Control

Target Outcomes

- Engineering of Networked Monitoring and Control Systems, emphasising the engineering challenges associated with **networked cooperative embedded and control elements**, including the integration of physical layers of networked devices, e. g. Wireless Sensor Networks, for **monitoring and control of complex large-scale systems** with a view to **improve system efficiency** in terms of energy and raw materials.

ICT-2011.10.1 EU-Brazil Cooperation

b) Networked Monitoring and Control

Target Outcomes

- Challenges to be addressed include, but are not limited to, scalability; self-configuration; availability; self-healing; context awareness; including location awareness; reconfigurability; adaptability; networking in harsh environments; mix of real-time, quasi-real-time and non-real-time constraints; and optimisation taking into consideration exogenous (e.g., price) signals, plus associated **programming development**, as well as **operations and management, tools and platforms**.

ICT-2011.10.1 EU-Brazil Cooperation Expected Impact

- Closer cooperation between materials, equipment and component suppliers; solution providers; system integrators; manufacturing and processing plants; and R & D institutes on both sides of the Atlantic.
- Strong involvement of industry participants interacting closely with research organisations and users.

ICT-2011.10.1 EU-Brazil Cooperation Expected Impact

- Increased knowledge and skills at the frontier of smart component and smart systems integration with complex systems engineering, with a view to increased **efficiency and effectiveness of processes, plants and complex large-scale systems**, contributing to the competitiveness of the industry involved, increased attractiveness to investments and putting research organisations in leading positions.

ICT-2011.10.1 EU-Brazil Cooperation

Expected Impact

- Contributing to **environment protection and energy efficiency** through smart solutions for energy management and distribution, energy-efficient buildings/facility management, utility management and **networked embedded intelligence**.

Background Information

European research on the web:

cordis.europa.eu/fp7/home_en.html

ec.europa.eu/comm/research/future/

Information Society and Media:

cordis.europa.eu/fp7/ict/programme/home_en.html

Embedded Systems and Control

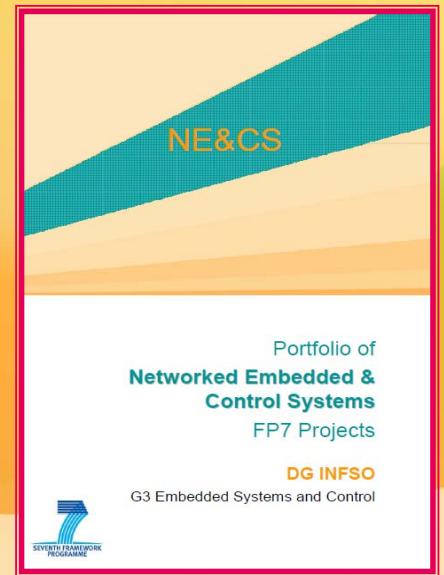
cordis.europa.eu/fp7/ict/necs

Further information

Embedded Systems and Control

cordis.europa.eu/fp7/ict/necs

ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/necs/booklet-necs_en.pdf



PPPs

Energy Efficient Buildings

Economic Recovery Plan

- The EC proposed on 26 November 2008 a « **comprehensive plan to drive Europe's recovery from the current economic crisis** »
- Endorsed by EU council on 12 December 2008
- **€200 billion initiative**
 - (€170 billion National budgets + €30 billion EU and EIB)
 - **short-term measures** to boost demand, save jobs and help restore confidence
 - "**smart investments**" yield higher growth and sustainable prosperity in the longer-term

Economic Recovery Plan Smart Investments

- **Public-private partnerships** to boost clean technologies through **support for innovation**
- 3 initiatives
 - **Green Car** (€5B)
 - **Energy Efficient Buildings** (€1B)
 - **Factories of the Future** (€1.2B)

Information on the Research PPPs
ec.europa.eu/research/industrial_technologies/



Public-Private Partnerships Budget Contributions 2011

(M€)	Green Car	Energy efficient Buildings	Factories of the future	Total
NMP	10	40	80	130
ICT	30	20	80	130
ENERGY		20		20
ENVIRONMENT	5.5	5.5		11
TRANSPORT	50			50
Total 2011	95.5	85.5	160	341

Thank you for your attention!

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