Objective ICT-2009.3.3

New paradigms for **Embedded Systems, Monitoring and Control** *towards complex systems engineering*

Rolf Riemenschneider
Project Officer

European Commission
Information Society and Media

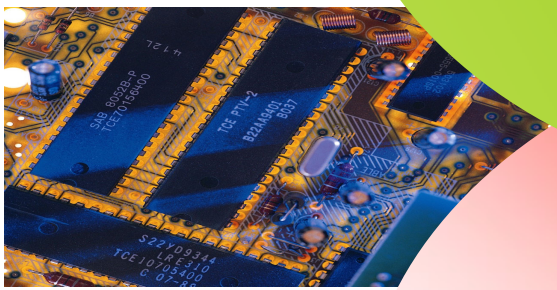
Unit G3 – Embedded Systems and Control
Overview

- **Unit's Mission: Invisible pervasive electronics and software that bring system intelligence.**
- **Market Size** : ~ €188 bn with av. growth of 8% until 2020.

Computing

New paradigms and tra

- **European Leadersh**
  with ARM-based mic



Embedded Systems Design

Theory & Methods for Platform-Based Design

- **Safety-critical architectures and tools.**
- **X-by wire for aerospace, automotive.**

Networked Embedded Systems

Large-Scale complex Monitoring and Control Systems

- **European Strength:**
  Leadership in manufacturing + process control.

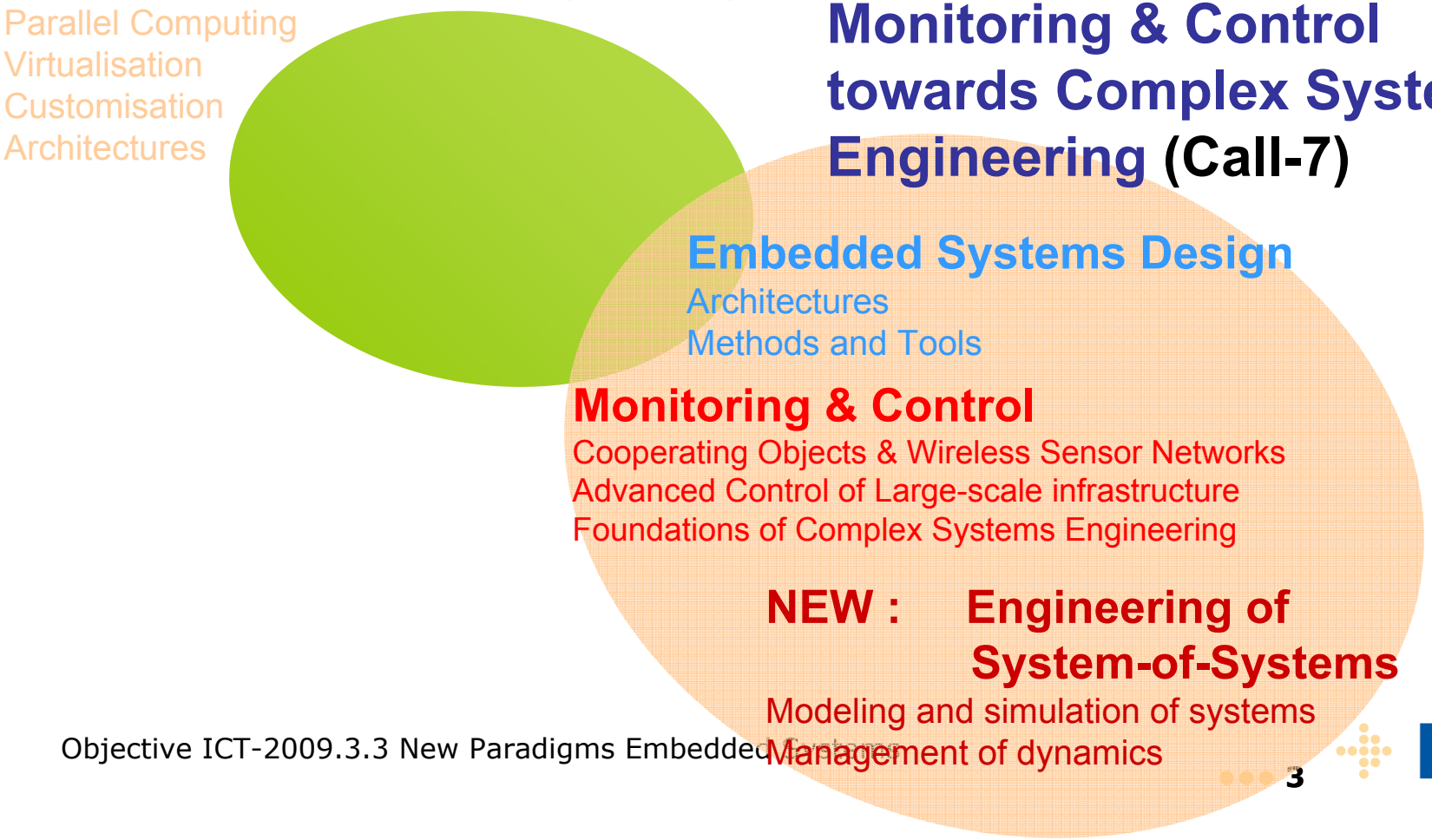
European Commission
Information Society and Media

New portfolio approach

in Embedded Systems & Control

Workprogramme 2011-2012

New paradigms for Embedded Systems, Monitoring & Control towards Complex Systems Engineering (Call-7)



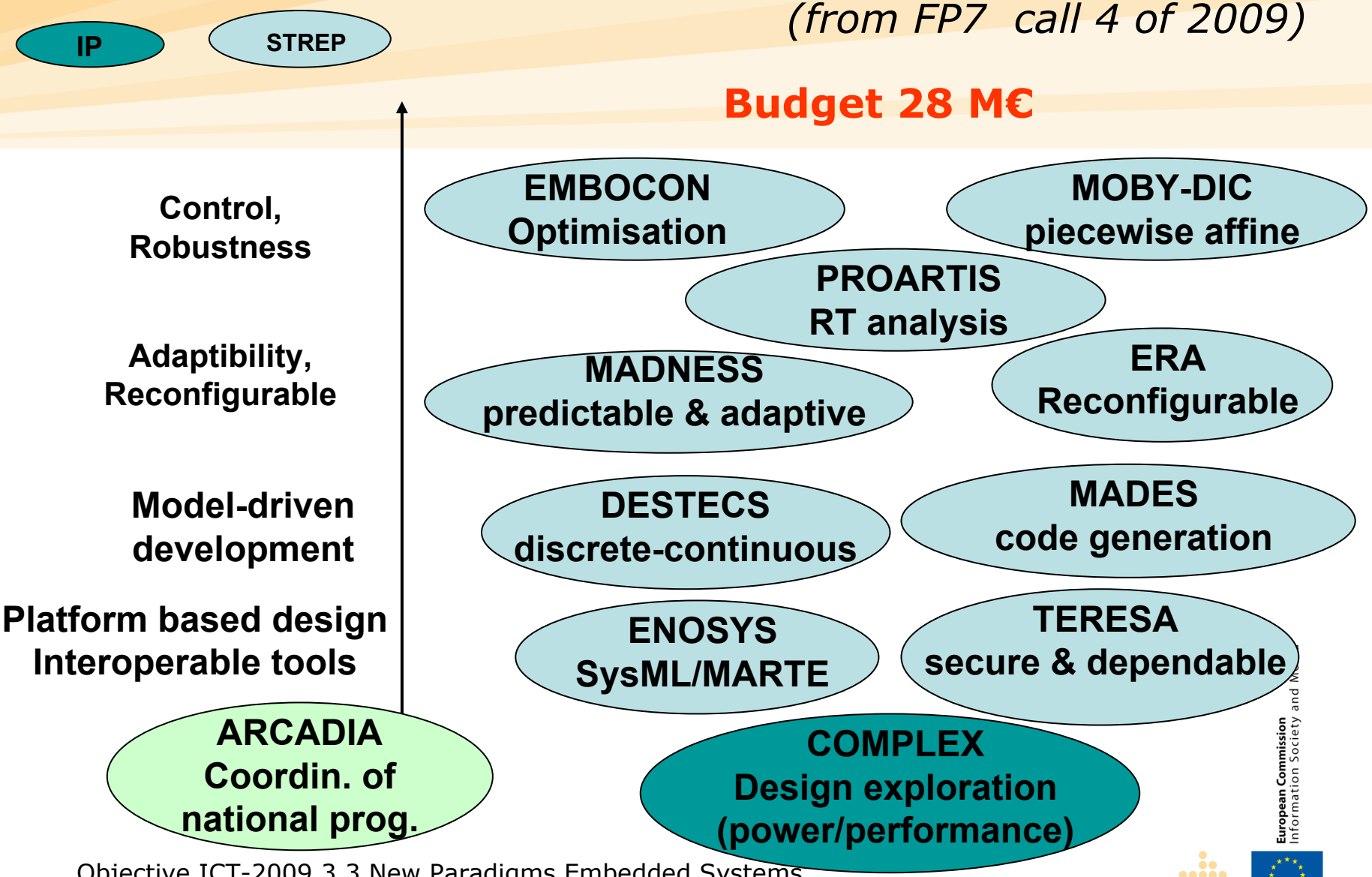
European Commission
Information Society and Media

Target outcomes of "*New paradigms for embedded systems (EmS) …*" **Objective 3.3** in FP7-ICT Call7

- Design of advanced heterogeneous Embedded Systems (EmS)
- Monitoring & Control (M&C) techniques dealing with large number of distributed sensory data
- Engineering of System-of-Systems (SoS) addressing societal needs
- Facilitate international cooperation

Portfolio of **Embedded Systems Design** projects

(from FP7 call 4 of 2009)



1st Target outcome group:
Design of advanced heterogeneous embedded systems

Draft

- *EmS composed of any number of independent, mainly heterogeneous embedded components and sub-systems*
- *Complementing **ARTEMIS JU** System Design*
  - *More application-specific, down-stream research*
  - *Part of foundational R&D in SRA*

a) Architectures and design tools mainly for energy efficient / energy-aware EmS
   - Key issues are heterogeneity, scalability, dependability, and adaptability.
   - *NEW*: Adaptability, predictability of non-functional properties.
   - Systems to satisfy high performance, reliability and power-awareness.

b) Secure composition, methods & verification techniques and tools incl. meta-modelling
   - Modeling and validation environments for complex RT systems
   - Synthesize embedded software from domain-specific models (e.g. Matlab, SystemC, UML, SDL, etc.)

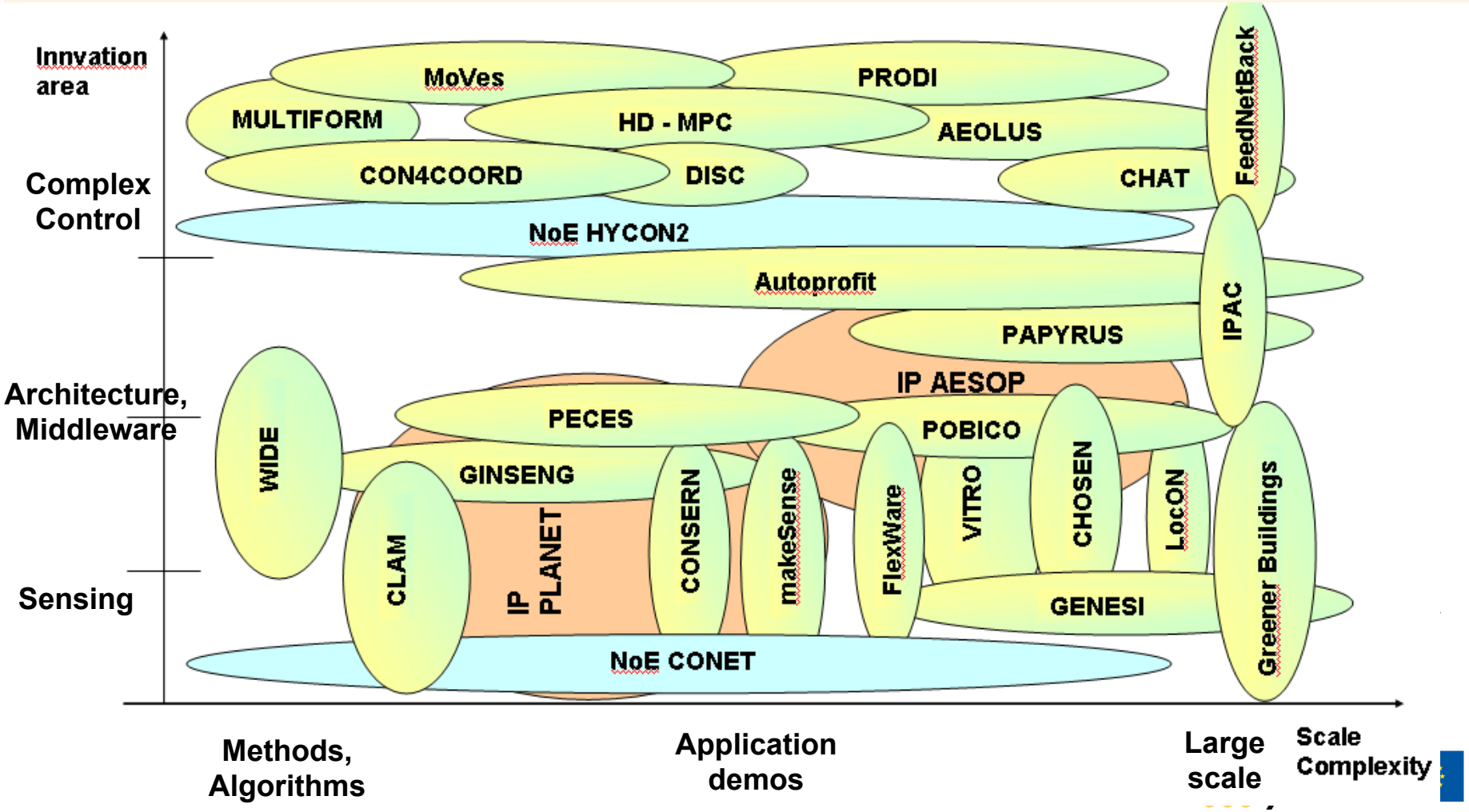
- **Instruments: STREP and IP**

Objective ICT-2009.3.3 New Paradigms Embedded Systems

European Commission
Information Society and Media

Portfolio of M&C projects

(from FP7 call 3-5 as of 2010)



2nd Target outcome group:
Monitoring & Control (*M&C) dealing with large number of distributed sensory data*

- **Key issues include :**
  - To achieve stable and robust behaviour on (closed loop) real life systems [complex systems]
  - Systems capable of dealing with complex, distributed and/or uncertain dynamics and very large amounts of sensory data [scale]
  - Standardisation of configuration interfaces and exchange platforms [industrial monitoring]
- **Instruments: STREP and IP**

2nd Target outcome group:

M&C dealing with large number of sensory data

Draft

- **Target outcomes :**

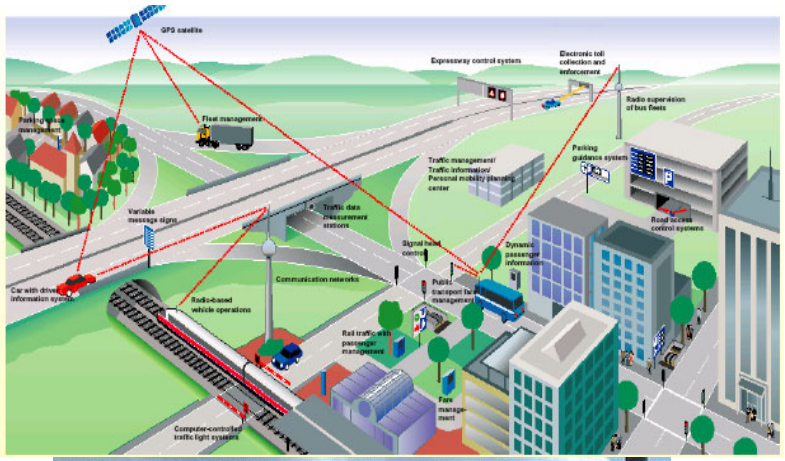
  c) Networked control in industrial environments
  Robust distributed estimation / prediction, cooperative networked control, synchronisation, optimisation

  d) Energy-aware, self-organising monitoring and control systems
  - **Failure-safe**: Fault-adaptive methods for adjusting to / for recovering from failure
  - **Wireless sensor/actuator networks**: research on reliably closing the loop
  [complements Obj.2.1 b) – *Cognition, control in complex robotic systems*]

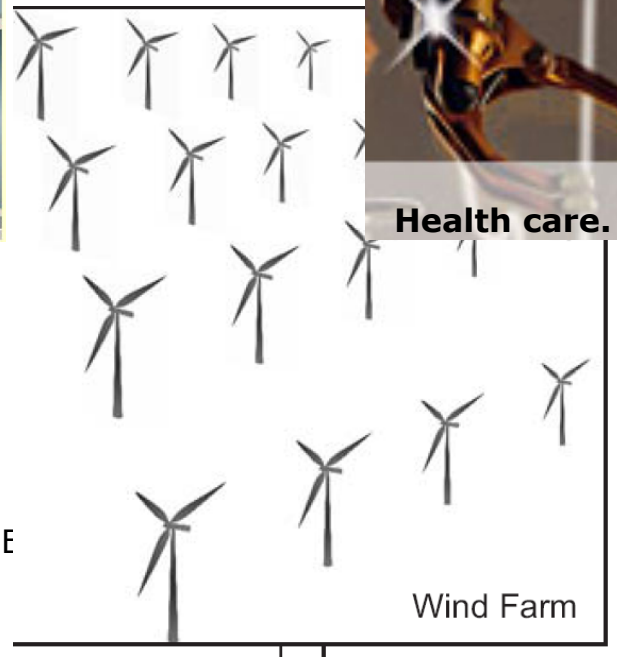
- **Instruments: STREP and IP**

***NEW*: System of Systems (SoS) Paragidm :**
Paving the way to FP8

Connection of autonomous systems from different domains
Better use of existing resources
Facilitate global goal(s)



Health care. *Courtesy: Otto Bock*



digms E

SoS: Paradigms for complex system design

Draft

- ***Interconnection*** of constituent systems
  - Interoperable
  - Heterogeneous: different mechanisms, different speeds, different models (behaviour, time), …
  - Autonomy versus cooperation
  - Dependability of safety critical systems with constituent systems having differing levels of safety criticality

- **Dynamics/evolution**
  - Management of dynamic properties (changes in configuration, goals)
  - Control under uncertainty due to unanticipated changes in configuration or behaviour

3rd Target outcome group: Engineering of System-of-Systems (SoS) addressing societal needs

Draft

Target outcomes:

- Engineering of System-of-Systems (SoS)
  - *Concepts, methods, architecture and tools. Demonstrate its potential use across several application sectors such energy systems and grid, multi-site industrial production, emergency coordination and global traffic control.*

e) Modeling and simulation of high level behaviour and interaction of the constituent systems;

Management methods of system dynamics

f) Strategic roadmap and case studies

- Facilitate international cooperation

g) Analysis of research agendas and joint R&D initiatives with USA for SoS

IP (e) and CSA (f,g)

g) 4th Target outcome group:
To facilitate and promote international cooperation

- **Analysis of international research agendas**
  - **to align research agendas in the field of embedded systems**
- **Preparation of concrete joint R&D initiatives**
  - **In particular with USA mainly SoS (*target outcome* *e), f*))**
  - **In particular with Western Balkan Countries, mainly in M&C (*target outcome* c)**
- **Instruments: CSA**

Expected Impact

- Significantly increased productivity of embedded systems development
- Improved competitiveness of European companies by reducing costs and time to market
- Emergence and growth of new design tool vendors and high-tech companies (in particular SMEs)
- Reinforced European scientific and technological leadership in the design of complex embedded systems

Instruments and Budget

- Design of advanced heterogeneous ES **– STREP & IP**
  a) Architectures and tools for energy efficient ES
  b) Composition & verification methods and tools
- M&C techniques dealing with large number of sensory data **– STREP & IP**
  c) Robust control and optimisation in industrial environments
  d) Energy-aware self-organising M&C systems, including fault- adaptive methods in case of failures
- Engineering of System-of-Systems (SoS) addressing societal needs
  e) Modelling and simulation of high level behaviour and interaction of the constituent systems; Management of dynamics of SoS **– min. one IP**
  f) Strategic roadmap and case studies **– CSAs of max 3 Mill.**
- Facilitate international cooperation – **2 CSAs of max € 1 Mill.**
  g) Analysis of research agendas and joint R&D initiatives with USA for SoS (1 CSA) and with Western Balcan Countries for M&C (1 CSA).

Budget: 50 M€

CP 46 M€ of which 50% to IPs; 30% to STREPs

CSA 4 M€

For Further Information

ICT:

http://cordis.europa.eu/fp7/ict

Embedded Systems Design :

http://cordis.europa.eu/fp7/ict/esd/home_en.html

Networked Embedded and Control Systems
http://cordis.europa.eu/fp7/ict/necs

ICT2010 Conference, Brussels, 27-29 September 2010
http://ec.europa.eu/information_society/events/ict/2010/index_en.htm

E-Mail : Alkis.Konstantellos@ec.europa.eu
Philippe.Reynaert@ec.europa.eu
Rolf.Riemenschneider@ec.europa.eu

European Commission
Information Society and Media