Information Society

Future and Emerging Technologies

Status of FP6 and FP 7 in FET IST

Pekka Karp

DG Information Society
European Commission

Plan of the Talk

- **FET in the IST work programme for 2003-2006**
- Preparation of the 7th EU Framework Programme

FET Proactive Initiatives in FP6 (WP2003-2004)

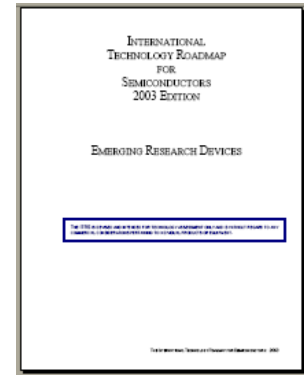
	Instruments
Call 1	
– Beyond Robotics (New)	IP, NoE
– Complex Systems Research (New)	IP, NoE
– The Disappearing Computer	IP, NoE
Call 3	
– Quantum Information Processing and Comm.	IP
– Emerging Nanoelectronics	IP, NoE
– Global Computing	IP, NoE
– Bio-inspired Intelligent Information Systems (New)	IP, NoE

Quantum Information Processing and Communications (II)

- Objective: Basic Research aimed at realising a **Fully Functional Multi-Qubit System**
  - Each IP to integrate theory, experiments, algorithms
  - Reach demonstration within the project (3-5 year)
  - Address current roadblocks: control decoherence, error correction, etc.
  - Explore applications of few qubit systems
  - Long term: build a general purpose quantum computer
- Constituencies: Physics, Computer Science

Emerging Nanoelectronics (I)

- **Context:**
  - Nanoelectronics at/beyond 10nm, non-CMOS
  - ITRS Emerging Research Devices section, >2009
- **Rationale:**
  - Non-CMOS electronics for integration into CMOS and later for independent technology
  - New developments in materials, functions.
  - New device functions, low cost, manufacturing, self-organisation
- **Scope:**
  - Devices, Circuits, Architectures, Self- or Directed assembly
- **Constituencies:** Electronics, Physics, Chemistry, Biology, Computer Science



INTERNATIONAL
TECHNOLOGY ROADMAP
FOR
SEMICONDUCTORS
2003 EDITION

EMERGING RESEARCH DEVICES

Emerging Nanoelectronics (II)
3 Directions

- **Hybrid electronics:**
  - Exploit novel materials, organic, bio-materials
  - Implemented on submicron CMOS platform
- **One-Dimensional structures**
  - Nanotubes: Carbon, others, namowires
  - Devices, interconnects, architectures, assembly
- **Single-molecule electronics**
  - Consolidate early experiments
  - Contacts! repeatability, experiment and modelling.
- **Integrated projects:**
  - consolidation: prototypes, modelling, merit criteria
  - devices, circuits, architectures, new research.

Global Computing II (I)

- Global Computer:
  - Programmable computing infrastructure
  - Distributed at world wide scale
  - Available globally
  - Multiple: Internet, GRID, VPN, Ubiquitous/Disappearing Computer, etc.
- Objective: Enable computation over “Global Computers”
  - Define Theories, languages, implementations, to design, deploy, use and manage Global Computers
  - Exploit scalability and programmability of services
  - Uniform services, variable guarantees (resources, mobility, etc.)
  - Scalability, security, distribution transparency, resource management

Global Computing II (II)

- Integrated Projects:
  Develop **theories**, build **systems** and **experiments**

  Tackle **scalability**, **security**, **distribution transparency**, **resource management**
- Foundational approach typical of Computer Science R&D
  - Theories, paradigms, SW design, programming languages, algorithms, v&v, autonomy, self-organisation, interoperability
- Constituencies: Computer Science, Networking

  GRID, SW Technologies, Embedded Systems, Complexity, Disappearing Computer

Information Society

Bio-Inspired Intelligent Information Systems (I)

- Rationale:
  - Increasing gap between system size/complexity and capabilities of system development/management
  - “Reverse Engineering of the brain” -> “true intelligence” in IT
- Objectives:
  - Explore new avenues in design of intelligent information systems
  - Attribute meaning to complex stimuli and generate actions towards high-level goals
  - Autonomous growth in perception, motor and cognitive abilities
  - Ultimately: Build systems with flexible, autonomous, goal-directed behaviour responding to internal and external changes.
- Constituencies: Engineering, Neurosciences, other

Information Society

Bio-Inspired Intelligent Information Systems (II)

- 1. Characterising large assemblies of interconnected neurons
  - Computational properties, structure and other physical constraints
  - Information processing in perception, motor or cognitive domains
  - Serve as model for new IT architectures and design
- 2. Mechanisms of evolution, development and plasticity
  - Support self-construction, self repair of artificial or hybrid info processing
  - Include HW and materials for interfacing with the nervous system,
  - HW for implementing sensors, processors, actuators in adaptive systems
- 3. Integrated control architectures
  - Generate and exploit world and self-awareness

Information Society

FET Proactive Initiatives in FP6 (WP2004-2005)

- **Call 4 (December 2004?):**
  - Advanced Computing Architectures
  - Presence and Interaction in Mixed Reality Environments
  - Situated and Autonomic Communications
- **Call 5 (in 2005):**
  - Creative Ambient Systems
  - Simulating Emergent Properties in Complex Systems
  - Atom-Scale Technologies –> FP 7
  - Towards Conscious Machines –> FP 7
- ***web consultation***: www.cordis.lu/ist/fet/id.htm

Advanced Computing Architectures

Research in computing architectures, compilers and operating systems to address AmI application requirements in 10+ year frame

- **Objectives:**
  - Increase performance of computing engines by 2 orders of magnitude while reducing power consumption
  - Portable compiler and operating system technology for high performance and code optimisation
  - Devise building blocks for integration in heterogeneous platforms
- **Scope:**
  - From small wireless systems to large networked servers
- **Multidisciplinary Integrated Projects**
  - Industrial participation is sought to link with application requirements
- **Network of Excellence:** research agenda, benchmarking & testing

Creative Ambient Systems

Living & being creative in interactive technology islands of ambient environments

- **Challenges:**
  - Programming ambient systems
  - Fostering individual and collective creativity of people living in ambient environments
- **Focus areas: methods & tools for:**
  - discovering the programming primitives of Ambient Systems and understanding/implementing their semantics
    - *System scaling, resource discovery, association & adaptation, context awareness*
  - Transforming the surrounding ICT resources into trusted personal and collective tools for creating customised interactive technology islands
    - *Design of customised environments, creating and moulding new forms of interaction, privacy / traceability / accountability in ambient environments*
- **Support the realisation of Challenging and visionary Scenarios**
- **Integrated Projects and STREPs**

Information Society

Presence & Interaction in Mixed Reality Environments

Convey the sense of ***being there*** and of
participating, acting, doing, influencing and changing ***things there***

- **Objective:**
  - To further the understanding of Presence in order to create novel ICT systems that match human cognitive and affective capacities and recreate the experiences of presence and interaction in mixed reality environments
- **Focus areas:**
  - Understanding different forms of Presence
    (i.e., aspects of perception, interaction, emotions and affect)
  - Design and development of essential ICT Building Blocks capturing different forms of Presence and based on a range of relevant HW and SW ICT technologies (rendering, 3D representation, tracking, haptics, light control, etc.)
  - Building novel Systems supporting Presence & Interaction
    (open system architectures integrating the essential building blocks, open source authoring tools, open APIs)
- **Support the realisation of Challenging and Visionary Scenarios**
- **Integrated Projects and Co-ordination Actions**

Simulating emergent properties in complex systems

Framework of mathematical and computational techniques
for simulation of complex systems

- **Objective:**
  - We can engineer components of systems: How can we predict aggregate behaviour?
  - How can we infer models from (often incomplete) data?
- **Research challenges:**
  - How to cope with uncertainty in simulation of engineered and natural systems?
  - How to describe systems acting on multiple scales?
  - How to integrate simulations on different levels?
- **STREPs**

Information Society

Situated and autonomic communications

A world pervaded by ubiquitous communication facilities
with self-organising and self-preserving functionalities

- **Objectives:**
  - **To define a self-organising communication network concept and technology that can be situated in multiple and dynamic contexts**
    - **ranging from sensor networks to virtual networks of humans**
    - **defining decentralised optimisation strategies**
    - **benefiting from cross-layer or non-layered approaches**
  - **To study how strategic needs of social or commercial nature impact on future communication paradigms, and how networks and applications can support society and economy, enabling a service oriented, requirement and trust driven development of communication networks**
    - **to develop** networking technologies **(hardware/software combinations)** that can evolve **and create maximal synergy with the other types of non-technological networks that constitute their context**
- **Integrated Projects and Networks of Excellence**

Atom-scale technologies

Single atom-level technologies for manipulating and processing information

- **Objective:**
  - Develop new experimental tools and methods and build technological components, devices and systems based on manipulation, control and operation of single atoms & molecules
- **Focus areas:**
  - Technology for manipulation and control of single atoms
  - Advanced devices & systems
  - Instruments for fabrication, measurement and characterisation
  - Optical processing and communication elements with atom storage
  - Logic circuits implemented in macromolecules
  - Biological imaging with artificial atoms
- **STREPs**

Towards conscious machines

To achieve flexible and human-like behaviour in autonomous agents such as service robots

- **Challenges:**
  - Adapt in a meaningful and useful manner to unforeseen environmental changes
  - Communicate and co-operate with humans on a given task
- **Objective:**
  - To build a system exhibiting observable abilities of consciousness, e.g.:
    - show ability to predict external events in unstructured and changing environments and respond to them correctly when they occur
    - show attention to certain stimuli and filter out others
    - have a ‘personality’ and capability of expression for interacting with humans in a meaningful way
    - show ability to analogy building and abstraction
- **Integrated Projects and Networks of Excellence**

Information Society

Plan of the Talk

- FET in the IST work programme for 2005-2006
- **Preparation of the 7th EU Framework Programme**

Information Society

The Roadmap to FP7

6th FP: 2003 | 2004 | 2005 | 2006

7th FP: 2007 – 2011 ...

Feb ’04
Financial Perspectives (2007-2013)

16 June ’04
Preparing the future: reinforcing European Research Policies

Early ’05
Proposal on FP

Adoption FP

Information Society

FP7: Milestones

- **Communication: EU Financial Perspectives 2007-2013**

  "Building our common future – Policy challenges and budgetary means of the Enlarged Union" — **10 Feb 04**
  - Substantial increase in research budgets
  - 6+2 research support axes
- **Communication on future orientations of FP7**

  "Preparing the future: reinforcing European research policies" — **16 June 04**
  - Preparing for FP7
  - No thematic contents!
- **Communication on FP7** — **early 2005**

FP7: 6+2 axes

- Collaboration → Collaborative Research
- Private/public partnership → Technological platforms
- Individual research teams → Basic Research Grants
- Human resources → Mobility and Life Long Learning
- Research Infrastructures → Access/Networking & support of new Infrastructur
- Co-ordination of national & regional research programmes and policies → European Research Area

\+

- Space (ESA)
- Security

ICT research maps into all 6+2 axes

Session 4
Intelligence and Cognition

Chair: *Rodney Douglas*

Rapporteur: *Georg Dorffner*

Panelists:
*Wlodek Duch, Anders Lansner, Doug de Groot, Bob French,
James Crowley, David Vernon, Alois Knoll, Marc DeKamps, Rolf Pfeifer,
Aude Billard, Jean-Albert Ferrez, Olivier Faugeras, Gosta Granlund,
Keith Van Rijsbergen, Tamas Roska,
Katerina Mania, Wolfgang Wahlster*

Intelligence and Cognition

- Intelligence is the property that a system exhibits when it interacts successfully with the world (in some economic sense).
- Cognition is the process that underlies intelligent behavior. It is the process that extracts structure from, and manipulates the external world.

Information Society

State of the art

- Artificial cognition has been relatively successful on well-structured problems, with no direct interface to the real world. (e.g. chess, knowledge bases).
- There has been much less success with problems involving real-world interaction (e.g. autonomous navigation).
- This real-world cognitive ability is exactly what we need to provide sophisticated ambient intelligence.

The hurdle to progress?

- Cognitive Science and Cognitive Psychology have had little commitment to physical implementation.
- Now, in Cognitive Neuroscience and robotics, the infrastructure is becoming crucial to understanding cognitive processing.

Information Society

The route to cognition

- One obvious difference between IT systems and biological cognition is the extent to which biology is self-programming, has adaptive configuration of sensors and effectors, and has extendable processing.
- It is possible that brain's ability to combine computation with development is central to its cognitive processing.
- Consequently, we have proposed a radical Grand Challenge that will explore the relationship between the processing material, its self-organization, and development, as a natural framework for cognition.

„Toward Natural Cognition“

- Goal: Build artificial cognitive systems inspired by biology, in particular neuroscience

- Assumptions:
  - Cognition is facilitated by embodiment
  - Structure of body, environment and body-environment interaction are inseparable

Information Society

Implementation

- Projects must take some inspiration and innovation from biology (in particular, neuroscience)
- Project should explore relationship between cognition and architecture
- Projects should take decisive step forward, without having to result in a full cognitive system
- Entire system does not have to be fully embodied
- Projects should be transdisciplinary, and offer a synergystic interaction with neuroscience.

Challenges

- For example:
  - Exploration of non-classical computation
  - Development of robust scalable self-constructing/repairing architectures
  - Exploitation of phylogenetic and ontogenetic development
  - Achievement of high-level cognition

Topics

- Analog processing
- Analogy making
- Materials issues (e.g. growing tissues)
- Body construction or development
- Morphology issues (e.g. facet eyes)
- Programming and configuration tools
- How much embodiment is sufficient?
- Nature vs. Nurture; top-down knowledge, innateness and learning
- Large scale implementation

Information on IST

- **IST on CORDIS**

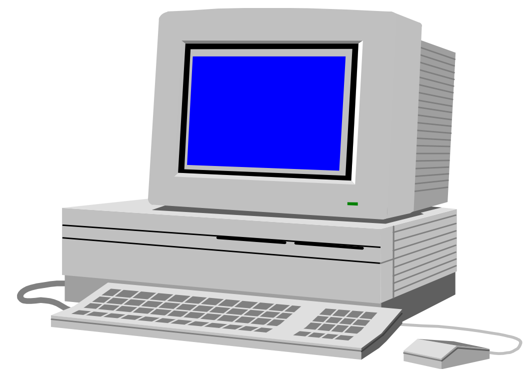
  http://www.cordis.lu/ist/

- **IST in FP6**

  http://www.cordis.lu/ist/fp6/fp6.htm

- **Future and Emerging Technologies**

  http://www.cordis.lu/ist/fet/home.html



IST helpdesk

Fax : +32 2 296 83 88

e-mail : ist@cec.eu.int