Emergent Technologies in Information and Communication (Present and Future Directions)

Dia da Escola de Engenharia
Grupo AE5 - TICs

Escola de Engenharia
Universidade do Minho

Oct 6, 2005

TIC Group

The TIC group started with six members from four departments, and now includes the following contributors:

- Adriano Moreira (DSI)
- António Ramires Fernandes (DI)
- Carlos Baquero (DI) (Coord)
- Cristina Santos (DEI)
- João Monteiro (DEI)
- José Mendes (DEI)
- Leonel Santos (DSI)
- Manuel João Ferreira (DEI)
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TE TIC URL

`http://wiki.di.uminho.pt/wiki/bin/view/TETIC/`

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In addition to an authoritative vision this is where the main research financing opportunities can be found.

Future and Emergent Technologies in FP6

The IST Future and Emergent Technologies (IST FET) in the current EC FP6 Programme, finances quality research in the supporting areas and was used as a guide to assess the potential and needs of Emergent ICT R&D in our School of Engineering.

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Using IST FET as a guide, our group summarized the Objectives and Focus/Approach of each area and started to identify local Competences in the School of Engineering.

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While more detailed information can be found in the TETIC group page, we proceed with a brief review of FET FP6 areas.

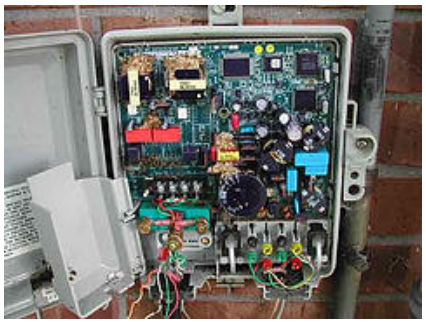
Future and Emergent Technologies

Areas

- CA (Advanced Computing Architectures)
- BIO-I3 and other NEURO-IT related initiatives
- CO (Complex Systems)
- COMS (Situated and Autonomic Communications)
- DC (The Disappearing Computer)
- GC (Global Computing)
- NANO (Emerging Nanoelectronics) EEng AE1
- PR (Presence Research)
- QIPC (Quantum Information Processing and Comm.) *
- RO (Beyond Robotics)

Advanced Computing Architectures

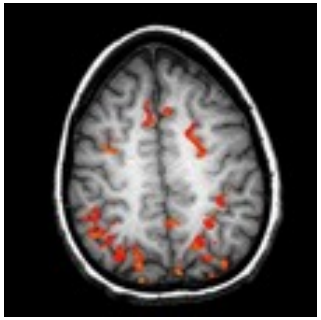
Objectives



Methods for enhancing re-programmability, reconfigurability, and re-usability of components, systems and products and hereby for enlarging the number of items produced for each design.
Methods and tools supporting fast system design, development, verification and testing, and on the other hand, on electronic architectures that support these.

BIO-I3 and other NEURO-IT related initiatives

Objectives



Reverse engineering of the brain could overcome the present obstacles to truly intelligent information systems. The objective is to explore new avenues in the design of intelligent information systems that attribute meaning to complex patterns of sensory stimuli and generate sequences of elementary actions that satisfy high-level goals.

The ultimate aim is to build systems that exhibit flexible, autonomous, goal-directed behavior in response to changes in internal and external conditions.

Complex Systems
Objectives

Understanding the properties of ‘complex systems’ with a large number of highly interconnected heterogeneous elements poses today a grand challenge for system research.
For such systems we can design components and their connections but the problem remains of how to guide them to achieve desired global behaviors, like dependability and adaptability, and how to predict and avoid undesired behaviors, like cascading failures in interconnected infrastructures.
In the life sciences, novel data acquisition techniques provide a wealth of data on living systems but we lack sufficient means to infer models from these data.

Situated and Autonomic Communications

Objectives

This area deals with new paradigms for the design of communication/networking systems where individual components and subsystems react and adapt to their local context and exhibit properties of autonomy, self-organization, wide distribution, technology independence and scale-free.

This encompasses a paradigm shift from architected networks to emergent aggregation of heterogeneous network capacity. Such shift is expected to induce cross-layer approaches, redefining traditional protocol stacking models.

The Disappearing Computer

Objectives

As an emerging area, this initiative aims to investigate “(...) how information technology can be diffused into everyday objects and settings, and to see how this can lead to new ways of supporting and enhancing people’s lives that go above and beyond what is possible with the computer today”.

Closely related areas, known as Ubiquitous Computing, Pervasive Computing and Ambient Computing, have recently attracted considerable attention from the scientific community worldwide

Global Computing
Objectives

“A global computer is a programmable computational infrastructure distributed at a worldwide scale and available globally.”.
The vision encompasses more than GRID technology (sharing of computer power and resources) since it requires the creation of novel computational paradigms, linguistic mechanisms and implementation techniques that will support the deployment and management of the aimed global computing environments.

Presence Research

Objectives

The aim is to convey the sense of being there as well as that of communicating, participating, acting, doing, influencing and changing things there - emotionally, cognitively, bodily and physiologically. Therefore, implicit rules, expressive and nonverbal communication, as well as motivational states are some of the essential features required in future systems for presence and interaction.
In addition, technologies for multimodal interaction (visual, acoustic, haptic, etc.), combined with high-quality, situation sensitive and bi-directional presence, are also a core requirement of future systems that would make it possible for people to experience and live different realities (virtual, augmented, and mixed), possibly as a different personality or at a different time.

Beyond Robotics
Objectives

Addresses “the development of physical mobile artifacts that could serve as companions to humans, function as bionic parts augmenting human capabilities, or act as autonomous microrobot groups.”
The development of hybrid bionic systems requires smooth integration of sophisticated robotic and information systems with human perception-action systems using bi-directional interfaces with the human nervous system.
Finally, the development of autonomous heterogeneous microrobot groups opens up interesting issues for their coordination, adaptation, self-organization and evolution to operate in open-ended, real environments in order to jointly attain a global task.

FET preparation for FP7

Preparation for the Framework Programme 7 is well under way, and a recent working paper can be found in

FET FP7, Working Paper

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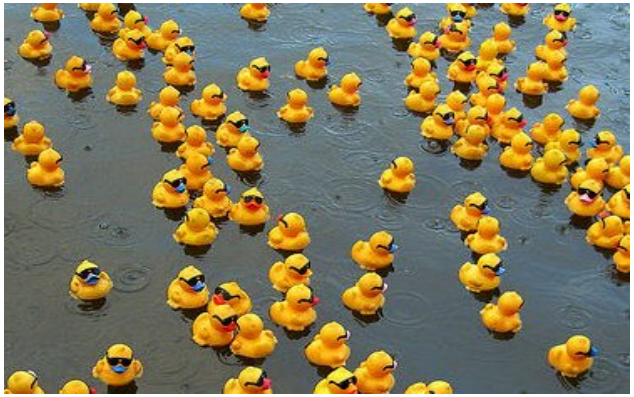
This paper reviews the present ICT driving forces and introduces some areas where FET in FP7 will foster new research.

FET FP7
Context



- In 3-4 years, seamless broadband networks from personal area to global area.
- Communication and computing embeds and hides in miniature artifacts and everyday objects.
- Enhanced interaction while hiding overall system complexity.
- Massively distributed systems with no centralized control.
- Dynamic ecosystems with self adaptation and statistical properties.

FET FP7

Composite revolution

- ICTs are playing a major role in combination with other sciences.
- Robust, adaptable and highly complex systems inspired in biology and evolution theory.
- Technological convergence between nano-, bio-, neuro- and cognitive sciences.
- ICTs will increasingly blend with the physical and biological world.
- Cross fertilization between scientists from different disciplines.

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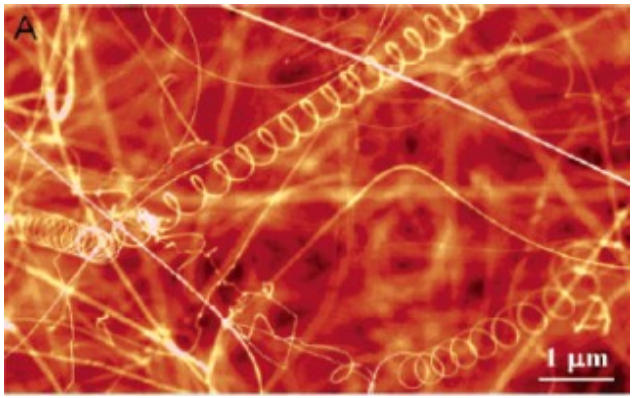
HFSP

Human Frontier Science Program. Financing interdisciplinary research (ICT included) applied to life sciences.
http://www.hfsp.org/home.php

FET FP7

Focus in Extreme Miniaturization and New Computing and Communications Frontiers



- Interfacing with living matter.
- Cost-effective fabrication for complex systems integrating nanometric scale devices.
- Intensifying efforts in quantum computing and communication systems.
- Coping with scaling, variability, energy-dissipation and reliability of architectures with billions of devices.

FET FP7

Focus in Harnessing the Complexity of Networked Computing and Communication Systems

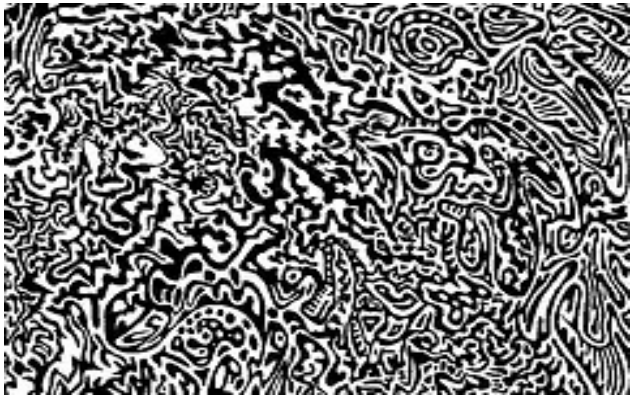
The central issues are on modeling, simulation, design and control of complex systems.

- Systems models in the presence of inconsistent, incomplete, or conflicting information.
- Revisiting SW engineering technologies to cope with evolution and dynamics and selfish interests of individual entities. Self-emergent behavior and bounded rationality.
- Billions of interacting elements involving uncertain operation and interactions.
- Radically new communication and networking paradigms, coping with huge scales and affected by social and human aspects. Bio-inspiration is expected to play a crucial role.

Today, we can no longer treat ICT systems as separate from their users. E.g. P2P user usage patterns.

FET FP7

Focus in Ever More Intelligent Systems for people centric services



To build artificial cognitive systems inspired by biology.

- Non-classical computation. Robust scalable self-constructing/repairing architectures adapting to context (Situated).
- Exploitation of emergent properties of large-scale complex structures (hardware and simulation) for cognitive processes.
- Attainment of high-level cognition by bottom-up organization.
- Effort on exploring complex structures responsible for assigning meaning to information.

ISTAG Grand Challenges

Vision

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This trend (in 7-10 years) includes complex networking of small powerful devices, “smart” and “hidden” devices in distributed self-regulating systems, closer connection with biological and life sciences both in “human augmentation” and biologically inspired computing.

ISTAG Grand Challenges

Projects

ISTAG identified a set of visionary projects

> *. . . leading to "concrete pictures of the future", focusing 8-10 years in the future, that will demand interdisciplinary research and engineering in many key areas and that exemplify application domains of particular promise for growth in Europe.*

ISTAG Grand Challenges

Overview of Projects

- The 100% Safe Car
- The Multilingual Companion
- The Service Robot Companion
- The Self-Monitoring and Self-Repairing Computer
- The Internet Police Agent
- The Disease and Treatment Simulator
- The Augmented Personal Memory
- The Pervasive Communication Jacket
- The Personal Everywhere Visualizer
- The Ultra-light Aerial Transport Agent
- The Intelligent Retail Store

ISTAG Grand Challenges

The 100% Safe Car

- Reduce/Eliminate traffic fatalities
- Overcome human driver limitations (vision, reaction)
- Networked approach, linking cars and local environment
- Gather collective knowledge in vicinity
- Detection of icy/oily roads, jams, incoming cars . . .

ISTAG Grand Challenges

The Intelligent Retail Store

- From barcodes to RFID tags
- Composition/Allergen queries
- Product comparing, alternative products
- Indoor navigation and paths to products
- Client behavior/preferences survey

Images and Resources

All images in this presentation are either public domain or creative commmons and have been obtained in www.flickr.com.

IST FET

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

TE TIC Group

http://wiki.di.uminho.pt/wiki/bin/view/TETIC