

The FuturICT Knowledge Accelerator: Creating Socially Interactive Information Technologies for a Sustainable Future

Coordination action (CA)

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ABSTRACT

The ultimate goal of the FuturICT Flagship is to understand and manage complex, global, socially interactive systems, with a focus on sustainability and resilience. Revealing the hidden laws and processes underlying societies constitutes the most pressing scientific grand challenge of our century and is equally important for the development of novel robust, trustworthy and adaptive information and communication technologies (ICT), based on socially inspired paradigms.

Integrating **ICT**, **Complexity Science** and the **Social Sciences** will create a paradigm shift, facilitating a symbiotic co-evolution of ICT and society. Data from our complex globe-spanning ICT system will be leveraged to develop models of techno-socio-economic systems. In turn, insight from these models will inform the development of a new generation of socially adaptive, self-organised ICT systems.

FuturICT as a whole will act as a **Knowledge Accelerator**, turning massive data into knowledge and technological progress. In this way, FuturICT will create the scientific methods and ICT platforms needed to address planetary-scale challenges and opportunities in the 21st century. Specifically, FuturICT will build a sophisticated simulation, visualization and participation platform, known as the **Living Earth Platform**. This platform will power **Crisis Observatories**, to detect and mitigate crises, and **Participatory Platforms**, to support decision-making for policy-makers and citizens.

In this Coordination Action, we propose activities to develop our scientific vision and roadmap, secure stakeholder commitment, establish the FuturICT legal and operational infrastructure, and build on our remarkable success in uniting previously fragmented research communities. Through these activities, the Coordination Action will allow Europe to grasp this unique opportunity for groundbreaking progress in science and ICT, with great impacts for society, governance and industry by launching the FuturICT Flagship in 2013.

MISSION

Information and communication technologies (ICT) form a complex, dynamic, global system, composed of billions of entities interacting over multiple spatial and temporal scales. This system is now deeply interwoven with our society, which too is complex with the combination transforming our world in ways that are hard to predict. Revealing the interactions, hidden forces, laws, and complex processes underlying societies constitutes the most pressing scientific grand challenge of our century. Therefore, the ultimate goal of the FuturICT Flagship is to understand and manage our global society, our global ICT system, and their interaction, with a focus on sustainability and resilience.

The ambition of FuturICT is to trigger a scientific paradigm shift by bringing the currently fragmented fields of **ICT**, **Complexity Science** and the **Social Sciences** to create the beneficial co-evolution of social and information systems. FuturICT will develop a new generation of cooperative, self-organised ICT systems, which in turn will facilitate a novel data-centred scientific approach to global techno-socio-economic systems and vice versa.

The FuturICT Flagship will leverage data from our global ICT systems to build a sophisticated simulation, visualisation and participation platform. This **Living Earth Platform** (LEP) will act as ‘Knowledge Accelerator’ and ‘cognitive extension’, by turning massive amounts of diverse data into knowledge, combining theoretical approaches and supercomputer scenario simulations, with reality mining and experimental approaches (including web experiments). The data processed by this novel facility will be of a previous unimaginable scope, integrating the best knowledge of all relevant computational, engineering, natural, and social sciences. The framework of the LEP will also develop new methods and tools for a better understanding of techno-socio-economic systems. The LEP will integrate several practically relevant **Demonstrator Areas** that are addressed by **Crisis Observatories**, which will detect warning signs of potential disasters. In this way, we may use these simulation-empowered policy explorations in **Decision Arenas** to find ways to mitigate these crises through **Contingency Planning**. Eventually **Participatory Platforms** will be developed to support the integration of diverse knowledge and promote social, economic, and political inclusion as well as many new business opportunities. Finally, the **Innovation Accelerator** will help people from industry, politicians and scientists to find the best experts for projects, support the communication and flexible coordination in large-scale projects, co-creation, and quality assessment. The Innovation Accelerator will also form the basis of an innovative management of FuturICT. The overall concept is diagrammatically illustrated in Figure 1 showing ICT at its core.

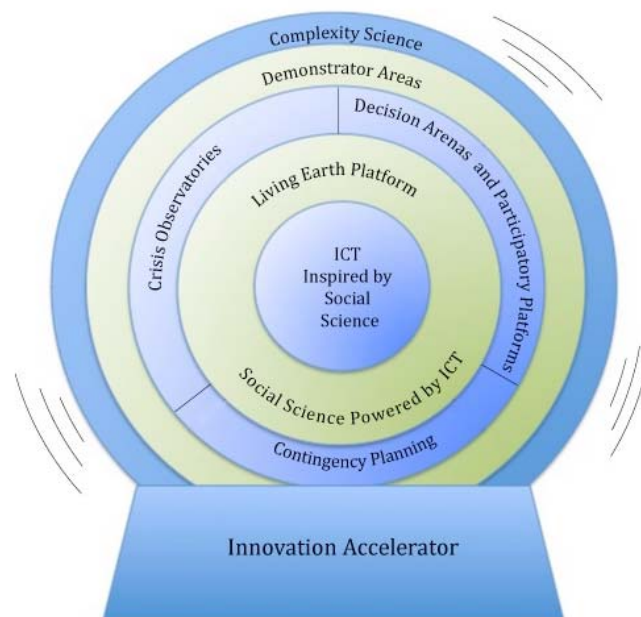


Figure 1: Schematic illustration of the FuturICT concept.

FuturICT will use the current and future global ICT infrastructure to create a ‘nervous system of the society’ that will provide real-time information about relevant events, social processes and structures, but with a strong focus on preserving privacy. It will collect and analyse a multitude of heterogeneous, dynamic data sources ranging from crowd sourced sensor information through digital media, social networks and blogs, to public infrastructure. Examples of the derived information are shifts in collective opinions and social attitudes, changes in consumer behaviour, emergence of tensions in communities, demographics, migration, mobility patterns, or health trends. This nervous system will facilitate social awareness and lead to the construction of the Living Earth Platform as described earlier. The Flagship will thus develop a novel, data driven computational social science that builds on the real-time information provided by the nervous system to enable the comprehensive, real-time description of the techno-socio-economic dynamics on various temporal and spatial scales up to global scale.

FuturICT will make the global ICT system socially interactive by allowing it to adapt to social needs, react to unforeseen events and in general to increase systemic resilience of the society. The system will be able to shuffle resources (e.g., information sources, bandwidth and distributed computing resources) to enable better monitoring and management of an emerging crisis situation to promote and support interaction in and between communities. It will also provide emergency ‘slow down and ask human’ mechanisms, preventing the system from accelerating a crisis leading to a systemic failure. The adaptation will be directed by high level, human-formulated goals and implemented by bottom-up, self-organised processes leveraging the systems’ social awareness and ability to comprehend complex social phenomena.

FuturICT will develop a novel complex systems science of ICT-society co-evolutionary dynamics to provide a theoretical underpinning of the above paradigm shifts. This new science will comprise models, theories and tools for the analysis of complex, dynamic interactions between society and socially adaptive ICT. It will also lead to novel methods enhancing trust, stability and reliability in self-organised ICT infrastructures by leveraging socially inspired mechanism for cooperation, coordination and reputation propagation. The feedback cycle created by these developments are illustrated in Figure 2.

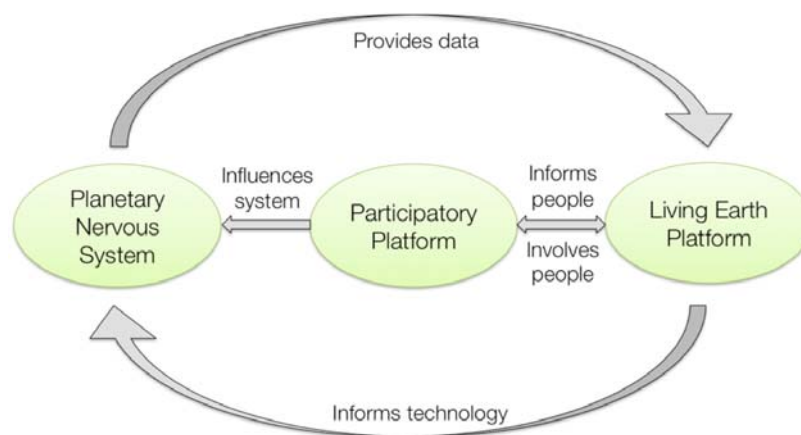


Figure 2: Visualisation of the feedback processes involved between models of our social system, and the ICT which informs and is informed by these models.

IMPACT

The FuturICT project will be the first large-scale research project worldwide to foster the scientific and ICT breakthroughs needed to address the challenges of humanity in the 21st century, from financial, economic and social instability to crime and conflict. Creating realistic global-scale simulations requires accurate techno-socio-economic models and, hence, fundamental breakthroughs in the social sciences and economics will follow as a natural outcome of the FuturICT Flagship.

Substantial progress and major innovation in science and technology: The FuturICT Flagship project has successfully gathered a core of the scientific communities needed for this ambitious endeavour of previous unseen scope, including leading ICT experts (particularly experts in reality mining, semantic technologies and visual analytics, national supercomputer and data centres in Jülich, Zurich, Stuttgart and Barcelona, the pervasive adaption community, and experts in distributed ICT systems), the social simulation community, and the Complexity Science community. In addition, a number of related institutions and organisations have also shown a strong interest in engaging with the project, such as the Institute of New Economic Thinking and groups from areas such as sustainability science, interdisciplinary physics and traffic experts (see the list of providers of letters of support in Appendix 3 or the actual letters on the FuturICT website).

The FuturICT Flagship project is supported by hundreds of scientists all over Europe and beyond, who believe in the necessity and feasibility of this project.

The FuturICT Flagship will be committed to the integration of the above activities in order to foster substantial progress and major innovations in science and technology. Below we comment on the potential effects on Europe's competitiveness.

Effects on Europe's competitiveness

Industry: ICT services, mobile systems, networking and embedded systems are all at the core of Europe's industrial strength. In all these areas, managing complexity, reliability and trustworthiness of interactive networked ICT systems is a key issue. This includes the car and aerospace industries where more effort is invested in the reliability of ICT than in any other area. Thus, the FuturICT increase resilience and usability of large scale ICT systems through socially inspired system engineering and a better understanding of the ICT-society co-evolutionary dynamics will significantly contribute to the competitiveness of European industry.

Society: FuturICT will bring clear and unprecedented benefits for society. For example, one practical application of socially adaptive ICT could be an 'intercultural adapter', which would allow people with different values and backgrounds to understand each other and find mutual agreements. It would be an answer to Europe's integration problems. Even more importantly, FuturICT will provide tools allow humanity cope better with the major challenges of today and tomorrow. The ability to detect upcoming crises will open up a possibility of avoiding or mitigating them.

Governance: FuturICT will enable the development of a set of radical, paradigm-changing results that will provide novel methods of modelling and prediction. Initially the goal is to create centres in Europe's main capital cities that are linked with data and results passed seamless from one to another. This will enhance our ability to govern in an open manner. Decision Arenas will be used to empower policy makers and allow for efficient and speedy crisis management but they may also be used to widen citizen engagement. However ultimately the project aims to create new ICT interfaces that would make this modelling power available to people outside a closed circle of mathematical and theoretical practitioners.

Sustainability: We argue that understanding the challenges of ICT systems largely resemble the challenges of organizing a well-functioning society, including issues like coordination, cooperation, adaptability, resilience, trust, crime, and conflict. Addressing these problems requires us to gain a fundamental understanding of the

way socially interactive systems work in a sustainable way. Assisted by the Climate KIC based at Imperial College and ETH Zurich, as well as through collaborators within the PEER project, the FuturICT Flagship will seek to find new pathways towards sustainability and better ways of improving the understanding of any scientific remedies.

The FuturICT Flagship project will produce significant outcomes for technology, science and society as represented in Figure 3.

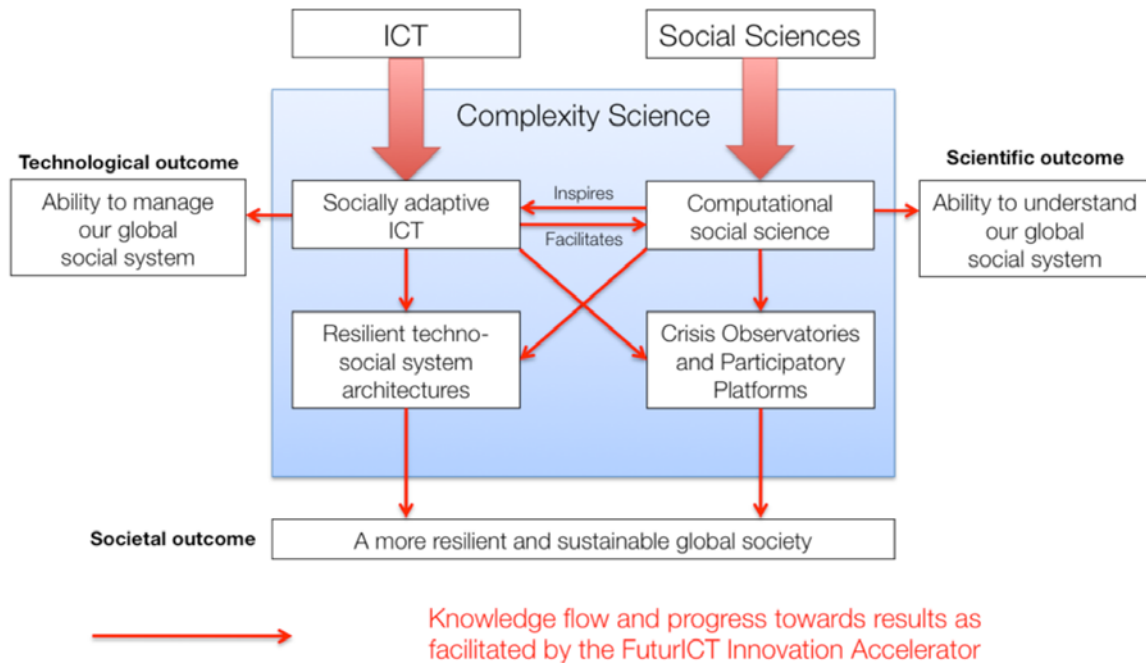


Figure 3: Scientific, technological and society outcomes of the FuturICT Flagship

INTEGRATION

The FuturICT Flagship project will promote the integration of a wide range of academic disciplines at an unprecedented scale. It will foster the integration of research programs of leading universities and the collaboration of scientists from Europe and beyond. Links have also been established with existing European Commission projects and initiatives (particularly ICT projects). The Flagship proposal will engage with other communities working on ICT, complexity science and social systems. FuturICT additionally aims to promote integration between academia, business, governance, and the public. There has also been a clear statement that the Flagship will be open to others beyond the Coordination Action phase.

The proposed Flagship framework will **bring relevant disciplines, stakeholders and resources together at European or larger scale** includes funding allocation and incentive schemes; a fund-raising mechanism; a contingency plan; a legal framework; strategies to ensure integration across disciplines, research institutions and governing bodies; strategies for technology transfer; plans for creating regional hubs; education, training and dissemination. The Innovation Accelerator of the FuturICT Flagship supports this framework by aiming to help businesses, politicians and scientists find the best experts for a project and by supporting the communication and flexible coordination in large-scale projects.

Incentives for institutions to participate in FuturICT will be established to promote scientific excellence, produce economies of scale and avoid unnecessary duplication of research. Instruments for funding will be generated by patenting new scientific knowledge, processes and results. A meritocratic process will allocate financial, human and structural resources according to a priority and evaluation scheme. The creation of a solid legal infrastructure is a priority to guarantee transparency and fairness, particularly from the standpoint of potential external investors. Protection instruments for Intellectual Property and insurance instruments to avoid financial crisis for the investors will be the necessary values added to the scientific excellence of the Flagship.

The main hubs for the FuturICT project will be formed in the Greater London Area (around UCL, involving Imperial College, London School of Economics, and Oxford University) and in the Zurich area (around ETH Zurich), with further regional research, innovation and technological hubs, connecting clusters of scientific and technological excellence under a common strategic and visionary goal. By providing a pool of funds for collaborative research, FuturICT will encourage researchers, business and government to work together in the specified scientific and technological areas.

COORDINATION ACTION OBJECTIVES

The main objective of the proposed Coordination Action is to design, consolidate and fully describe our plans for the FuturICT Flagship. During the Coordination Action period we aim to achieve this by

- Elaboration and assessment of vision and integrated research agenda
- Integration of research community and development of a shared identity
- Securing stakeholder commitment
- Resource identification and development of an operational framework

Work Packages will require insight from researchers in ICT, the social sciences, and complex systems theory. Thus ICT, social science and complexity theory run through every Work Package and are not split into separate Work Packages. Proposed coordination activities will serve to bring these communities together. Across all Work Packages, the majority of meetings will take place in London or Zurich, which both have good accessibility.

WP1: CO-EVOLUTION OF ICT AND SOCIETY: lead organiser **Paul Lucowicz**

This Work Package will be concerned with developing the detailed concept of the ICT vision behind the FuturICT Flagship proposal. As described in the proposal overview, the FuturICT project aims to achieve a paradigm shift towards social awareness, participatory, globally self-organised systems that co-evolve with human society. This new generation of systems will turn the ubiquitous, globally networked system that is already a reality today into a ‘virtual nervous system of human society’, blending ICT with social structures and processes in a symbiotic relationship. This will provide the basis for the novel data driven computational social science (WP2) and facilitate planetary-scale real-time observation and modelling of social processes (via the *Living Earth Simulation, Visualisation, and Participation Platform*; in short, the *Living Earth Platform*), empower novel ways of individual participation in political and economic life, and enable ICT systems to autonomously mediate social interaction and help mitigate global crises.

WP2: INTERCONNECTED OBSERVATORIES OF SOCIETY FOR A RESILIENT AND SUSTAINABLE FUTURE: lead organiser **Rosaria Conte**

This Work Package will detail a vision for the design of crisis observatories, decision arenas and participatory platforms. We envisage that these facilities would be applied across a range of demonstrator areas. The most suitable demonstrator areas will be selected within this Work Package. This Work Package will also consider creating a big library for agent-based and other simulation approaches (referred to as the ‘World of Modelling’) which may be utilised by researchers in all demonstrator areas. The different parts of the scientific roadmap will be elaborated by specific small teams (task forces) of specialist researchers that will consult a large variety of experts on the fields related to their tasks. The task forces will dedicate part of their effort to exploring transversal aspects, making a direct link with the vision developed in WP1. The task forces will also determine financial needs and resources corresponding to their areas of investigation. National Integration Meetings will be arranged and ‘Hilbert’ workshops held to define challenges.

WP3: DESIGNING AN INNOVATION ACCELERATOR: lead organiser **Dirk Helbing**

This Work Package will build on the review of the state of the art carried out by the EU VISIONEER project, alongside the VISIONEER proposed plan for the creation of an Innovation Accelerator. Furthermore, meetings will be organised to bring together members of the ICT, social science and complexity science communities in order to identify the fundamental scientific as well as the practical key challenges in creating the above described Innovation Accelerator, in particular the ones related to managing very large collaborative research projects of the special multi-disciplinary kind and the hub-and-spoke structure proposed here. Furthermore, it will specify the needed methods, tools and institutional designs in order to address these challenges and more generally provide novel, more appropriate approaches for the management, reporting, publication, and evaluation of scientific progress than those used today and over the past decades.

WP4: MANAGEMENT: lead organiser **Steven Bishop**

This Work Package will focus on managing the people, the finances and other resources related to FuturICT. A large part of the coordination responsibilities will include compilation of the final proposal for Flagship funding leading to the continuance of the research paths. A Management Committee will be formed to provide effective coordination, administration and financial management of the FuturICT Coordination Action and a Steering Committee set up to scientifically direct the tasks.

While the Work Packages bring about a formal structure, the partners also recognise that it is important to capitalise on the wealth and breadth of loose, informal discussions that add to the complexity of this project. The management ethos is to embrace these apparently minor inputs, without losing sight of the common goal by allowing the Work Package leaders some flexibility in managing their funds to facilitate these important interactions. This said, to maintain focus, most meetings during the Coordination Action period should take place at the hubs in London and Zurich.

A **Science Board** will be arranged to provide detailed scientific inputs from active collaborators and researchers in specialised fields. A **Scientific Advisory Board** will be set up consisting of senior figures from academia and beyond to advise on broad issues related to the Flagship concepts.

Open Call Funds

The distribution of resources is a key mechanism to guarantee the openness of the FuturICT preparatory action. A share of the overall budget will be placed in the commonly governed Open Call Fund. The fund will open to Partners and non-partners. A simple 'Open Call for Ideas' will be arranged to cover activities unanticipated at the proposal stage or responding to special opportunities.

WP5: FLAGSHIP INFRASTRUCTURE: lead organiser **Felix Reed-Tsochas**

This Work Package will focus on coordinating the development of the framework required for the effective implementation of the FuturICT Flagship. Consultation meetings will be held to define the Flagship framework, to identify required resources, and to determine feasibility and logistics for accessing such resources. Activities will be organised to collect best practice from other larger organisational structures, such as the EIT ICT Labs KIC and the Climate-KIC, but also from large-scale science projects such as the ATLAS experiment at CERN and the European Molecular Biology Laboratory (EMBL). These meetings will vary from face-to-face consultations, group activities and collaborations with these various institutes.

The first two FuturICT hubs will be created in London and Zurich. In London, UCL, Imperial and LSE will join forces to form a London Technology Innovation Centre.

WP6: DISSEMINATION AND STAKEHOLDER LIAISON: lead organiser **JB McCarthy**

This Work Package will ensure that the Coordination Action and the underlying Flagship vision and concept attain high visibility with all relevant stakeholders, and aims at securing their commitment and support to the ten year Flagship project. FuturICT has already attracted the interest of the media in different forms and many different languages. The interest for this project will surely increase, and this Work Package will support this growth by establishing a strong media presence. The project has already used an SME (The Motion Box) to create an animated logo, and further work will be planned to highlight the Flagship concept as well as the specific FuturICT project.

An Action Plan will be created for dissemination to FuturICT collaborators and beyond. This Action Plan will consist of key information, pivotal activities, and actions for the coming months, all in a simple and easy to read document. This Action Plan will be produced at months 3, 6 and 9, ensuring total public engagements with the project.