FuturICT – A Knowledge Accelerator to Explore and Manage Our Future in a Strongly Connected World

We have built particle accelerators to understand the forces that make up our physical world. But we still don’t understand the principles underlying our strongly connected, techno-socio-economic systems. To fill the knowledge gaps and keep up with the fast pace at which our world is changing, a Knowledge Accelerator must be urgently created. This 21st century challenge will be addressed by the FuturICT Flagship project. We envision that, after the age of physical, biological and technological innovations, Europe can lead the next era – a wave of social and socio-inspired innovations.

Globalization and technological change have made the world a different place. This has created or intensified a number of serious problems, such as international conflict and world-wide terrorism, global financial and economic crises, political instabilities and revolutions, the quick spreading of diseases, global environmental change, disruptions of international supply chains, organized crime and increased cyber risks. At the same time, the 21st century has the potential to create unprecedented benefits for our economy and society, based on a whole range of new methods and innovations.

Although creating more interconnected systems has contributed to the above problems, future information and communication technologies (ICTs) can also be part of the solution. This requires us to establish a new science of multi-level complex systems, bringing the best knowledge of experts on information and communication systems, complex systems and the social sciences together. The FuturICT flagship project will develop the capacity to explore and manage our future, based on a fundamental understanding of the principles that make connected systems work well.

The methods and data for such a scientific endeavor are now becoming available: it is time to make a federated and open Big Science effort akin the Human Genome Project. Open, because we need to prevent private monopolies of socio-economic data; federated, because joint efforts are the only way to tackle humanity’s global challenges and ensure leadership in socio-inspired ICT innovations. Investments into FuturICT’s techno-socio-economic Knowledge Accelerator can benefit the public and its individuals multiple times, by mitigating global problems and systemic risks, and by creating new opportunities to participate in social, economic and political affairs.

The Need for New Knowledge in a Fundamentally Changed World

Today, neither past knowledge nor established policies seem sufficient to manage the future. This is because technological, social and economic systems are becoming more and more complex and mutually interdependent. Such strongly connected systems behave fundamentally different from the
loosely connected systems of the past, a situation, which raises new scientific and ethical challenges (see Box 1):

- The dynamics of strongly connected systems with positive feedbacks is faster.
- Extreme events occur more often and can impact the whole system.
- Self-organization and strong correlations dominate the dynamics of the system.
- The system behavior is often counter-intuitive, and unwanted feedback or side effects are typical.
- The system behavior is hard to predict, and planning for the future may not be possible.
- Opportunities for external control are very limited.
- Even the most powerful computers cannot perform an optimization of the system behavior in real time, as the number of interacting system elements is too large.
- The competition for limited resources implies reduced backups in the system and a larger vulnerability to random failures or external shocks.
- The loss of predictability and control lead to an erosion of trust in private and public institutions, which in turn can lead to social, political, or economic destabilization.

Such strongly coupled systems cannot be managed well in a top-down fashion. Rather than controlling the single system elements individually, it becomes crucial to stimulate a favorable kind of self-organization in the whole system by establishing suitable interaction rules (the ‘rules of the game’). Bottom-up elements allow for greater flexibility, efficiency, and resilience of the system (see Box 2).

**BOX 1: Ethical Issues**

FuturICT has a strong ethical mission and motivation. The methods and tools the project plans to create are intended to benefit humanity, not just a few stakeholders. FuturICT wants to provide an open data, simulation, exploration and participatory platform for everyone. This platform is thought to establish a new public good on which services of all kinds can be built, i.e. it will support both commercial and non-profit activities. To prevent misuse of the platform and enable reliable high-quality services, the platform will be built on principles of transparency, accountability, reputation, and self-regulation.

FuturICT is not interested in tracking individual behavior or gathering data on individual actions. Its aim is to understand the macroscopic and statistical interdependencies within the highly complex systems on which we all depend.

The FuturICT project will have a strong research focus on ethical issues, and is committed to informing the public about the use of socio-economic data. For example, FuturICT will promote the development of a *Web of Trust* and of privacy-respecting data mining technologies that give users control over their data. It will take the strongest possible measures to prevent and counter-act the misuse of data and the Internet. More broadly, the project will seek public involvement to build and sustain confidence in its research objectives (see also Box 5).
Future Information and Communication Systems as Artificial Social Systems

The above mentioned factors have not only created serious problems in financial, economic, social, and political systems. Also ICT systems (i.e. Information and Communication Technologies) are increasingly suffering from similar problems that worry societies: the lack of coordination, instability, an inefficient use of resources, conflicts of interest. The recent explosion of cybercrime and the new notion of cyberwar leave the impression that conventionally operated ICT networks are eventually getting out of control.

This is happening because ICT systems are complex systems, which are made up of billions of non-linearly interacting components (computers, smartphones, software agents, ...). More and more often, these components take autonomous decisions based on an internal representation (“subjective” interpretation) of the surrounding world and expectations regarding future conditions. This effectively makes them artificial social systems. For example, computer-based automatic trading strategies now perform the majority of transactions in our world’s financial system.

Currently, most information and communication systems are not designed and tested for the collective behavior that result from the interaction of their components. (The same is also true for the socio-economic systems.) Therefore, as we go on connecting these systems more and more densely, this will cause a lack of robustness (failure tolerance) and a lack of resilience (i.e. a vulnerability to attacks and external shocks). Given the ubiquitous use
of ICT systems and the complete dependence of technological, social, and economic activities on the reliability of these systems, proper design principles for such socially interactive systems must be urgently identified.

The Urgent Need of a Federated Big Science Approach

The foreseeable problems in ICT systems and the techno-socio-economic challenges of humanity in the 21st century require our society to make large-scale federated investments to fill the serious knowledge gaps. The Flagship call by the European Commission provides a unique opportunity for this at a time when progress is pressing (see Box 3). We urgently need to learn how to manage our future in a complex, connected world. In fact, the current lack of powerful scientific concepts and a sufficiently large expert pool focused on assessing systemic risks and developing methods for integrated risk management is alarming. The increased interconnectivity and the lack of knowledge regarding its implications is the root cause of the pressing problems our societies are facing.

BOX 3: The European Flagship Program and its Call for Big Science

The FuturICT project is a response to the European Commission’s FET Flagship call in the area of Future and Emerging Technology. The objective is to support Big Science in Europe with a “Man on the Moon” scale vision. In the first round, 21 flagship candidates were narrowed down to six flagship pilots. Of these, FuturICT is the only one directly addressing techno-socio-economic and environmental challenges of the future.

Each pilot will submit detailed proposals by April 2012. At least two flagship projects will be supported by up to 1 billion EUR each over a time period of 10 years – a tenth (or less) of what is invested into other Big Science projects: the CERN elementary particle accelerator, the ITER fusion reactor, or the Galileo satellite program, the Human Genome project, nanotechnology, etc. About half of the money, i.e. 50 million EUR per year, must be mobilized by the project partners from national budgets and funding agencies, from business and industry, or from donations. We expect that a considerable fraction of the flagship budget will be distributed through open calls, which will allow a wide scientific community to contribute.

The challenges of the 21st century require the development of a new kind of science: the science of multi-level complex systems. This new science should allow us to understand not only the impact of one system component on another and the resulting links between micro-level interactions and macro behaviors. But we also need to understand the complex interdependencies between the different institutions, infrastructures and networks on which our society is built. This requires social scientists to ask the right questions. It requires complexity scientists to gain theoretical insights. And it requires computer scientists and information and communication experts to create the methods, data and platforms that will allow us to understand and manage our world better (see Figure 1).
Figure 1. The interdisciplinary concept of FuturICT

Need for a New Data and Multi-Level Complex Systems Science

This calls for a new data science (i.e. a “social information theory”), which focuses not just on bits and bytes, but also on the meaning and impact of information. And it requires a considerably extended complexity science, which studies not only the patterns and dynamics resulting from the non-linear interaction of simple elements. It also needs to understand the result of interactions between individuals with a cognitive complexity and system elements with a complex response to the surrounding world. Such systems with various levels of complexity are unlikely to be analytically tractable, but require the use of future supercomputers instead.

Despite the urgent need for such a multi-level complex systems science, it is still in a nascent state. But all the elements are there already. The FuturICT project will, for the first time, put them together by integrating the best of all available knowledge from the engineering, natural and social sciences (see Figure 1).

This new science will be boosted by the availability of vast amounts of data from a wide variety of techno-socio-economic systems. In fact, future sensor networks will produce more live stream data than can be stored or moved around. To make sense of them, they must be aggregated “on the fly” - and achieve this in a privacy-respecting way (see Box 1 and Dirk Helbing, Stefano Balietti: “From Social Data Mining to Forecasting Socio-Economic Crisis”, http://arxiv.org/abs/1012.0178). But these data will also make it possible to create something like a “Planetary Nervous System” and to create collective awareness of the impact that our decisions and actions are likely to have on our techno-socio-economic-environmental system.

**BOX 4: Expected Impact of FuturICT**

As the numbers below demonstrate, if the impact of the societal problems listed below would be reduced by 1% only, this would already create a benefit many times higher than the investments into the FuturICT flagship project. Based on previous success stories regarding a better management of complex systems, we expect that an improved understanding of the fundamental underlying issues will facilitate improvements between 10% and 30%, given the new insights are properly applied. For comparison:
In turn, the new ability to quantify the social impact of our actions will help us to avoid decisions that exploit or destroy the socio-economic fabric on which our society is built, such as social capital, solidarity and trust. It will eventually promote a more responsible behavior, just as the measurement of our environmental footprint has done. Developing the ability to quantify the social footprint seems a particularly promising way to successfully establish sustainable systems.

**What FuturICT Will Do**

*A Way Forward, Aided By Information*

The complexity of modern technology lies far beyond the capacity of the human brain to comprehend or analyze in detail. Information technology can considerably expand this capacity. For example, scientists and engineers rely on massive computer power and data processing on a hitherto unimagined scale to design and test everything from cars and electronic devices to medical drugs. We face even greater complexity in our socio-economic systems, especially in interaction with the rapidly expanding technological infrastructures such as the Internet and the Earth's vast, multi-component environment. Only recently, however, have we begun to exploit the power of information technology to build a better understanding of the Earth-human system, and to improve our capacity to manage this system on the basis of well-founded knowledge.

**BOX 5: FuturICT’s Goals**

FuturICT wants to promote human well-being, increase the self-awareness of society, reduce vulnerability and risk, increase resilience (the ability to absorb societal, economic, or environmental shocks), reduce damages by large-scale loss of control related to unexpected systemic shifts, develop contingency plans, explore options for future opportunities and challenges, increase sustainability, facilitate flexible adaptation, promote fairness, protect and increase social capital, support social, economic and political participation, find a good balance between central and decentralised (global and local) control, protect privacy and other human rights, pluralism and socio-bio-diversity, and support collaborative forms of competition (“co-opetition”).

The FuturICT project (part of the European Commission’s FET Flagship Program, Box 3) aims to develop a visionary system, founded on this modern information technology and integrated with the rest of science. This system will be able to act as a “flight simulator” for the development and testing of sound policies in the face of a complex and uncertain world. Such a system would gather and process data on a massive scale, giving politicians and other decision-makers, but also citizens, a much better knowledge on which to base decisions. It would enable us to explore the possible or likely consequences of even barely imaginable scenarios, effectively helping humanity to see just a little around the corner and into the likely future.

The potential benefits are huge: reducing the impact of sporadic economic crises by only 1 percent would save the European Union billions of Euros
every year (see Box 4). Thus, similar to weather forecasts, FuturICT can create value that is many times higher than the required investments.

How it Can Happen

To achieve its aims (see Box 5), the FuturICT project will develop a new information and communication technology (ICT) to collect massive data sets and mine them for useful or meaningful information. It will also have the capacity to self-organize and to adapt to the collective needs of users. These ICT systems will be the basis of a ‘Living Earth Platform’, consisting of three inter-connected new instruments to gain insights into our world: these are the ‘Living Earth Simulator’, the ‘Planetary Nervous System’ and the ‘Global Participatory Platform’.

Figure 2. Interdependencies of FuturICT’s main ICT components

The Living Earth Simulator will enable the exploration of future scenarios at different degrees of detail, employing a variety of perspectives and methods (such as sophisticated agent-based simulations and multi-level models). Exploration will be supported via an envisioned “World of Modeling” – an open software platform, comparable to an app-store, to which scientists and developers can upload theoretically informed and empirically validated modeling components that map parts of our real world. The Living Earth Simulator will require the development of interactive, decentralized, scalable computing infrastructures, coupled with an access to huge amounts of data, which will become available by integrating various data sources coming from online surveys, web and lab experiments, and from large-scale data mining.

This is where the Planetary Nervous System comes in – and the need for a new data science or “social information theory” allowing us to understand
under what conditions, and how, new knowledge is created from existing pieces of information. The Planetary Nervous System can be imagined as a global sensor network, where “sensors” include anything able to provide data in real-time about socio-economic, environmental or technological systems (including the Internet). Such an infrastructure will enable real-time data mining (“reality mining”) and the calibration and validation of coupled models of socio-economic, technological and environmental systems with their complex interactions. It will even be possible to extract suitable models in a data-driven way, guided by theoretical knowledge.

The **Global Participatory Platform** will promote communication, coordination, cooperation and the social, economic and political participation of citizens beyond what is possible through the eGovernance platforms of today. In this way, FuturICT will create opportunities to reduce the gap between users and providers, customers and producers etc., facilitating a participation in industrial and social value generation chains. Building on the success principles of Wikipedia and the Web2.0, societies will be able to harness the knowledge and creativity of multiple minds much better than we can do today. The Global Participatory Platform will also support the creation of interactive virtual worlds. Using techniques such as serious multi-player online games, we will be able to explore possible futures – not only for different designs of shopping malls, airports, or city centers, but also for different financial architectures or voting systems.

In addition to the interconnected systems forming the Living Earth Platform, FuturICT will also create an **Innovation Accelerator** that will identify innovations early on, discover valuable bits of knowledge in the flood of information, help to find the best experts for projects, and support the distributed generation of new knowledge. In particular, it will support communication and flexible coordination in large-scale projects, co-creation, and quality assessment. Hence, the Innovation Accelerator will also form the basis of the innovative management of the FuturICT flagship.

**Practical Steps to a Better Future: The Time is Now**

To succeed with its ambitious endeavor, the FuturICT project team is building communities in most European countries, America and Asia, bridging between ICT, social and complexity sciences. It will build the Living Earth Simulator by integrating various interactive Observatories, which will explore certain areas of our global systems through the combination of large-scale data mining, computational modeling, supercomputing and participatory approaches.
Organizational Principles

The strategy of the FuturICT partners is to identify a visionary goal, to formulate an Apollo-project-level mission (as expected by the FET flagship program), to identify the related grand scientific challenges, to develop a research strategy and roadmap, to form an integrated multi-disciplinary community, and to develop a platform for global collaboration. In order to support rapid scientific advances, research activities will be grouped around excellence clusters, i.e. a critical mass of experts in one institution closely connected with the best international experts in other European locations.

Openness is an important organizational principle of the FuturICT. We envisage that the composition of the consortium of experts will continuously change over time to take new rising stars of science on board. Through open calls, FuturICT will allocate substantial research budgets to innovative research in order to reward excellent findings and support innovative future research activities.

Openness will also be achieved by creating interfaces for the collaboration with other related projects, with business partners and policy makers. In particular, the research infrastructures created by FuturICT (such as the Exploratories of Society, Economics, Technology, and Nature) will be open to researchers outside the FuturICT consortium. The multi-level structure of FuturICT is also suited for a steady expansion.

In fact, scalability is an important organizational principle of the project, as it is anticipated that there will be an increasing demand for research in the area represented by FuturICT, i.e. the research platform must be suited to support continuous growth and participation.

Each research core of FuturICT (see Figure 4) will be jointly led by three (or more) researchers stemming from different European regions and complementary knowledge areas.

Figure 3. The fundamental scheme of FuturICT organization

www.futurict.fr

www.futurict.it

Figure 4. FuturICT as a network of national hubs
FuturICT will build interconnected Observatories of Financial and Economic Instabilities, of Conflicts and Wars, of Social Well-Being, of Health Risks, of Transportation and Logistics etc. These Observatories will be closely connected with each other to build interactive Exploratories of Society, Economy, Technology, and Environment (see Figure 3). The four Exploratories will eventually be integrated to build the Living Earth Platform and overcome “disciplinary silo thinking”. This will facilitate a systemic picture of risks and opportunities and an integrated risk management. They will pursue a pluralistic approach, allowing one to study many different perspectives concurrently. This will give us a more differentiated picture of the interactions on our planet and allow us to better manage our way in a rapidly changing world. To sum up, FuturICT will create new methods to gain insights about our world, analogous to the invention of microscopes and telescopes in the past. (In some sense, they could be called “socioscopeces”).

**BOX 7: Examples of Past and Possible Future Cascade Failures**

On November 4, 2006, an electricity line was temporarily turned off in Ems in Germany to facilitate the transfer of a Norwegian ship. This caused a chain-reaction leaving major parts of Europe without electricity. The foregoing scenario analysis had not checked for the coincidence with a possible spontaneous failure of another power line.

Heavy solar storms, as expected for the future, could simultaneously bring down major parts of the worldwide ICT system, since most ICT systems are not sufficiently shielded against the related atmospheric currents of electrically charged particles. As a consequence, cash machines, sales and customer supplies, computer and communication systems could fail critically at the same time in large areas.

On December 22, 2010, Skype pushed a faulty auto-update of its Internet telephony software. This lead to a crash and reboot of most Skype supernodes, a crucial part of their distributed systems. To make things worse, the reboot of the supernodes launched a distributed denial of service attack on the central Skype servers, thus incapacitating worldwide traffic.

The current economic crises started locally, due to a bursting real estate bubble in the US. The mortgage crises eventually hit building companies and caused the bankruptcy of more than 400 US banks. In the meantime, it endangers the stability of the European currency and even of the European Union. Several countries (including Greece, Ireland, Portugal, Spain, Italy and the US) are at the verge of bankruptcy. If the crises cannot be stopped, it will cause social unrest, political extremism and increasing crime and violence, which have the potential to endanger the cultural foundations of our society and peace.

The 2011 Tōhoku earthquake in Japan caused a tsunami that triggered an atomic chain reaction and disaster in several nuclear reactors at Fukushima. Soon afterwards, several countries, including Germany and Switzerland, decided to exit nuclear energy generation over the next decade(s). However, alternative energy scenarios turn out to be politically vulnerable. Two of three major regions providing Europe with gas do not seem to be entirely reliable. Moreover, Europe’s DESERTEC project, which planned to invest 1000 billion EUR into infrastructure to supply solar energy for Europe, has now an uncertain future due to another political unexpected event, the Arab Spring. This was triggered in particular by high food prices, which were no longer affordable to many people. These resulted in part from biofuel production, which intended to improve the global CO₂ balance, but instead competed with food production. The increasing food prices were further amplified by financial speculation.

The spreading of flu outbreaks is very much promoted by worldwide travel and sometimes food supply chains as well. In the case of the resulting pandemics, economic and social life can be enormously affected.
FuturICT’s research program will also be crucial for the effective design of future ICT systems, as they are indeed socially interactive systems (see Section on Artificial Social Systems). As our society has become largely dependent on information and communication technologies, their stability and reliability has become absolutely crucial – but at least for current designs, this stability is not guaranteed. Systemic breakdowns, cyber-crime and cyber-war are problems that have recently become virulent and show the vulnerability of the systems (see Box 7). At the same time, several social features such as self-organization, adaptiveness, emergent cooperation, social norms, cultures and community formation are new attractive characteristics for ICT systems. Trust is just one example of a hardly understood, but crucial property of our social and ICT systems. The creation of a Web of Trust, based on principles of social, reputation-based self-control in order to keep cyber-crime down is probably the most important example of a future socio-inspired ICT system.

Building on the involvement of nearly 300 teams of scientists in Europe and all over the world, FuturICT has a strong potential to promote not only the beneficial co-evolution of ICT and society, but also to encourage a new synthesis of the social sciences – supported by a plethora of computational methods for modeling, theory building and analysis. A new information science will emerge from the availability of Big Data, and its massive application in theory-building and validating tools. Beyond this, FuturICT will help overcome the current “data tragedy of the commons”, which may be compared with a language in which everybody owns different words. Creating an open platform, a “data commons” is expected to trigger off a new era of information and communication technologies, services, and products.

In summary, the FuturICT Knowledge Accelerator will bring about a quantum leap in our capacity to more effectively cope with the speed at which our world is changing, and so make a vital contribution to societal resilience and a sustainable future. It will do so by combining the best established scientific methods with multi-scale computer modeling, social supercomputing, large-scale data mining and participatory platforms (including web experiments and populated virtual worlds). Innovations needed to drive FuturICT forward to reach these ambitious goals will be promoted through a series of ‘Hilbert Workshops’, i.e. think tanks to identify the fundamental problems and how they can be solved.
**BOX 8: History**

A strong historical backdrop is provided by the Digital Earth endeavour that demonstrates the feasibility of the FuturICT project, which is thus standing "on the shoulders of giants".

*DigitalEarth*

http://www.digitalearth-isde.org/


The following quotes are from the above Wikipedia page, accessed on July 24, 2011:

"In a speech prepared for the California Science Center in Los Angeles on January 31, 1998, [the former US vice president Al] Gore described a digital future where schoolchildren - indeed all the world's citizens - could interact with a computer-generated three-dimensional spinning virtual globe and access vast amounts of scientific and cultural information to help them understand the Earth and its human activities...

Digital Earth has come to stand for the large and growing set of web-based geographic computing systems worldwide. These are both useful and promising, but do not yet constitute the envisioned ‘global commons’.

Below follow two excerpts from the Beijing Declaration on Digital Earth

[http://159.226.224.4/isde6en/hykx11.html]:

"Digital Earth is an integral part of other advanced technologies including: earth observation, geo-information systems, global positioning systems, communication networks, sensor webs, electromagnetic identifiers, virtual reality, grid computation, etc. It is seen as a global strategic contributor to scientific and technological developments, and will be a catalyst in finding solutions to international scientific and societal issues."

"Digital Earth should play a strategic and sustainable role in addressing such challenges to human society as natural resource depletion, food and water insecurity, energy shortages, environmental degradation, natural disasters response, population explosion, and, in particular, global climate change."

Considering this, FuturICT may be seen as a logical continuation of the Digital Earth Agenda with a focus on

1. exploring and managing socially interactive systems,
2. real-time mining of techno-socio-economic data to promote collective awareness and
3. creating participatory platforms including populated virtual worlds.

**BOX 9: Reference Cases**

Selected reference cases further illustrating FuturICT’s feasibility include:

- *IBM SmarterPlanet* (http://www.ibm.com/smarterplanet),
- *Microsoft Modeling the World* (http://www.modelingtheworld.com/)
- *Planetary Skin institute* (http://www.planetaryskin.org/)
- *Second Life* (http://secondlife.com/)
- *Google.org* (http://www.google.org/)
- *Gapminder* (http://www.gapminder.org/)
- *Observatorium* (http://www.observatorium.eu)
- *Disney Research* (http://www.disneyresearch.com/)
What FuturICT Will NOT Do

Most importantly, the FuturICT project will NOT attempt to collect “all the data in the world”, or to represent each individual on the globe by an identical copy in some giant multi-agent simulation, considering private features and preferences of all individuals. Science is the art of abstraction and approximation. Just as maps do not show all the features of our environment, a scientific model is specified such that a particular question can be addressed in the simplest possible way. That is, models are to be problem-specific, and the parameters and variables not expected to be relevant for the answer should be neglected. In many cases, one is interested in global interdependencies on the aggregate level, i.e. a macroscopic description is sufficient. Most computer simulations are based on a multi-level approach and not on the micro-simulation of the individual system elements.

BOX 10: What Distinguishes FuturICT from Other Candidate Flagships

FuturICT will develop a new science of big data, allowing one to understand how an ocean of information bits can be turned into useful knowledge, wisdom, and business opportunities.

FuturICT will build a Planetary Nervous System by harvesting the data streams from smart sensors that are now becoming commercially available and spreading all over the world.

FuturICT aims at building up non-embodied artificial intelligence and connecting the creativity and intelligence of many brains in the world.

FuturICT is promoting global health by building a related Observatory and identifying social ways of spreading healthy behavior.

As humans prefer to be helped by others, FuturICT also seeks ways to promote the mutual understanding and solidarity in increasingly multi-cultural and fragmented societies.

Thus, as a matter of principle, it would obviously not be possible or desirable to simulate each individual in detail, including the complexity of its cognitive dynamics. However, the interaction of many system elements typically reduces the dimensionality of the relevant system dynamics (i.e. there is a small fraction of variables that matter, while many variables do not change over the relevant time scale or change so quickly that they may be treated as random variables). In other words, the largest amount of complexity is on the level of the individual, while the more interesting or relevant collective behavior tends to be simpler, due to many factors such as herding effects, social conventions, norms, and laws (otherwise we would not have cultural trends, fashions etc.).

FuturICT is also NOT trying to build a simulator of all human activities on Earth from scratch. The strategy is rather to establish different Observatories in particular competence areas around an international team of excellent scientists, who have demonstrated their competence in the past to collect, analyze and visualize large data sets already. Over the time period of the
project, these Observatories will be then integrated to create a few Exploratories and eventually the Living Earth Platform.

BOX 11: Paradigm Shifts Expected from FuturICT

Humans are a unique species, as their behavior is largely driven by information. By the creation of virtual worlds and in many other ways, future ICT systems will partly overcome the limitations of our physical and biological world. In fact, they will create an almost unlimited number of new goods and services, and thereby many new economic opportunities, but also social and political ones.

Europe’s vision of creating an Innovation Union is a logical response to these opportunities. With its Innovation Accelerator approach, FuturICT will significantly contribute to laying the foundations of this Innovation Union. Through new ICT technologies, innovation scouts and knowledge transfer supply chains, the distance between academic inventions and innovations in the technological, social and political realm will be significantly reduced. In this way, transforming new ideas into new products will be much more efficient than today (currently this requires of the order of 30 years in many areas).

Fundamentally new ICT systems are key to exploring, understanding, and managing our future in a resilient and sustainable way. The FuturICT flagship will promote the required paradigm shifts:

- by integrating the best knowledge from the engineering, natural and social sciences, and bringing together big data, explanatory theories, massive computer simulations, and large-scale experiments in virtual and real-world settings.
- through the availability of big data on socio-economic behavior and large-scale simulation models, future ICT systems will open the door to a new era of the social sciences, which will reveal principles underlying the functioning of socially interactive systems.
- by revolutionizing the social sciences and future ICT systems, asking the right questions to understand the principles that make strongly connected, socially interactive systems work well.

This will trigger a wave of socio-inspired technologies, beyond social networking, the wisdom of crowds, and prediction markets. Future ICT systems will have the capability of social sensing, social thinking, social adaptiveness, social self-organization, etc. They will feature ICT-based cultures, collective awareness, reputation- and trust-based applications (such as “social money”) etc. And they will feature mixed reality systems, where it won’t be possible to tell apart the virtual and real world. The goal will be a beneficial human-information symbiosis.

The creation of such an information ecosystem will require a new kind of complexity science, which is capable of realistically understanding multi-level complex techno-socio-economic systems. This new complexity science will, in turn, facilitate the reduction of systemic risks by employing suitable decoupling strategies and the creation of resilient and sustainable socio-economic and ICT systems. However, a well-functioning information ecology also needs to overcome the lack of transparency, accountability, quality standards and trustworthiness of most current data services provided on the web for free. Currently, many companies collect huge data sets, but they are often fragmented and potentially sensitive.

As the World Economic Forum points out, users must be given control over their personal data [http://www3.weforum.org/docs/WEF_ITTC_PersonalDataNewAsset_Report_2011.pdf]. Moreover, it is important to develop methods of privacy-respecting data mining, which can satisfy individual, commercial and public interests at the same time [see Dirk Helbing, Stefano Balietti: “From Social Data Mining to Forecasting Socio-Economic Crisis”, http://arxiv.org/abs/1012.0178, for a proposal how to do this]. Such an approach will require a scalable bottom-up approach, transparency, user control, encryption of sensitive data and digital rights management, plus a manipulation-proof reputation system that supports a healthy “immune response” to malicious data and activities. In this way, it will be possible to create a self-controlled, trusted, and responsible future Internet (a “Web of Trust”). Two important use cases are the creation of an integrated multi-disciplinary self-organized reputation-based science platform and the invention of a reputation system that helps to avoid tragedies of the commons in a globalizing world.
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**BOX 12: Further Reading**

http://www.futurict.eu, see also http://www.futurict.ethz.ch/Media

http://www.futurict.ethz.ch/FurtherInformation, for example, “Pluralistic Modeling of Complex Systems”

http://springerlink.metapress.com/content/1951-6355/195/1/

http://www.futurict.ethz.ch/RelatedPublications