

Future and Emerging Technologies



Information and Communication Technologies under FP7 Extract from Work Programme 2011-12 for ICT

Future and Emerging Technologies (FET) fosters exploratory research to open up new avenues across the full breadth of future information and communication technologies. It supports new and alternative ideas, concepts or paradigms of risky or non-conventional nature. FET aims to go beyond the conventional boundaries of ICT and ventures into uncharted areas, often inspired by and in close collaboration with other scientific disciplines.



Radical breakthroughs in ICT increasingly rely on deep synergies with other disciplines (for instance, biology, chemistry, nanoscience, neuro- and cognitive science, ethology, social science, economics) and with the arts and humanities. This requires new attitudes and novel collaborations between a broad diversity of actors in research. In this respect, FET is the home for transformative research that can lead not only to a range of exceptional and unprecedented outcomes in science and technology, but can also create new practices, paradigms and reshape disciplines.

The **FET Communication "Moving the frontiers of ICT – a strategy for research on future and emerging technologies in Europe"**¹ sets out new lines of action for FET. Accordingly, this Work Programme extends the scope and ambition of the two complementary FET schemes, FET Open and FET Proactive.

FET Open scheme: challenging current thinking and attracting future potential

FET-Open is a **light, topic-agnostic and deadline free** scheme specifically designed to be open and continuously responsive to novel and fragile ideas that challenge current thinking, whenever they arise and wherever they come from. It aims at foundational breakthroughs that can open radically new directions for information and communication technologies in the future.

FET Proactive scheme: tackling targeted transformative research and exploring new large-scale scientific challenges and cooperation models

FET Proactive provides **targeted support** to selected promising domains where **critical mass** needs to be built up, aligned with economic and social challenges and priorities that call for long-term foundational and transformative research. This work programme sets out a number of Proactive Initiatives in key areas, in some cases also embedding the drive for a global research agenda.

¹ Com(2009) 184 - http://ec.europa.eu/information_society/events/fet/2009/documents/fetcom.pdf

Although FET is open to broad participation, two new objectives specifically aim to give leadership to young researchers and high-tech research-intensive SMEs. As **young researchers** will be the future leaders in science, technology and innovation, FET aims to empower them to jointly explore radical directions that may not fit within current academic research agendas. Likewise, **high-tech, research-intensive SMEs** are instrumental for pushing forward alternative visions and for turning novel research results into a competitive advantage for creating new markets. FET aims to increase their role in cooperative research to further enhance their disruptive innovation potential and to unlock longer-term scientific and industrial leadership. This work programme devotes at least 20% of the FET Open scheme budget to support collaborative projects empowering young researchers and high-tech, research-intensive SMEs.

Because of its foundational nature, FET research is especially well placed for **global collaboration**. This work programme provides opportunities to extend on-going FET projects through new collaboration components involving the best researchers worldwide, so as to create global interest and raise the level of ambition around research avenues incepted within FET.

Special Initiatives

A special initiative on exascale software and systems with a significant international cooperation dimension, a long term perspective and the engagement of industry is foreseen under this Work Programme.

A Call² on 'Science of Global Systems' will aim at progressing research on global systems dynamics to better understand the interactions between ecological and socio-economic systems and to improve their ability to respond to global environmental changes.

Participation in the Open Access Pilot in FP7

Open Access, defined as free access over the internet, aims to improve and promote the dissemination of knowledge, thereby improving the efficiency of scientific discovery and maximising return on investment in R&D by public research funding bodies. Since August 2008, the European Commission has been conducting a pilot initiative on Open Access to peer reviewed research articles in its Seventh Framework Programme (FP7). This pilot covers seven FP7 areas. Beneficiaries funded partially or entirely through this Challenge will be required to deposit peer-reviewed articles resulting from projects into an institutional or subject-based repository, and to make their best efforts to ensure open access to these articles within six months³

² The perspective is to have a joint call with the Environment theme. This is under the condition that the Commission decision adopting the 2012 work programme presents the objective also under the Environment theme.

³ Further information: http://cordis.europa.eu/fp7/find-doc_en.html; http://ec.europa.eu/research/science-society/open_access; http://ec.europa.eu/research/science-society/scientific_information/

FET Open Scheme

Radically new ideas can come anytime, from anybody and from anywhere. They obviously do not necessarily fit within predefined topical calls, nor are they comfortable with strict submission deadlines. FET-Open is specifically designed to be open and responsive to such fresh courageous thinking. It aims to give promising but still fragile ideas the opportunity to mature into a credible and well-founded new direction of research.

What is common to all objectives under FET-Open is that they seek proposals on radically new concepts and visions of the nature and use of information and information technologies, grounded in scientifically plausible and often inter-disciplinary ideas on how to achieve them. In spite of the high risk of failure, FET-Open projects can be the first step on the way towards future European scientific and industrial leadership in areas that today simply do not exist yet.

The FET-Open scheme is unique in that it applies a two step submission process⁴ in which short proposals of maximum 5 pages can be submitted at anytime. Only proposers of the most promising ideas are then invited to submit a full proposal. This design makes the scheme highly responsive while the overhead for the proposing consortium in case of failure to pass the evaluation is minimized.

In this work programme, the FET-Open scheme features the following objectives:

- Objective ICT-2011.9.1: Challenging current Thinking
- Objective ICT-2011.9.2: High-Tech Research Intensive SMEs in FET research
- Objective ICT-2011.9.3: FET Young Explorers
- Objective ICT-2011.9.4: International cooperation on FET research

Together they aim at fostering and supporting the best ideas grounded in scientific and technological excellence, whenever, wherever and whoever they may come from.

All FET-Open objectives call for STREPs⁵. CSAs, which are accepted only under objective 2011.9.1, are submitted directly as full proposals and are evaluated in one step.

⁴ The two step submission process applies for STREPs only and it does not apply to the FET-Open objective ICT-2011.9.4 on International Cooperation in FET research.

⁵ With the exception of Objective ICT-2011.9.4 on International cooperation on FET research.

Objective ICT-2011.9.1: FET Open: Challenging Current Thinking

Target Outcome

This objective supports the exploration of new and alternative ideas that, because of their risky or non-conventional nature, would not be supported elsewhere in the ICT Work Programme. It seeks:

- foundational breakthroughs as crucial steps towards radically new forms and uses of information and information technologies within a clear long-term vision that is far beyond the state of the art;
- ambitious proof-of-concept and its supporting scientific foundation, where novelty comes from new, high-risk ideas rather than from the refinement of current ICT approaches;
- new inter-disciplinary collaborations, possibly with prominent and internationally recognized non-EU research teams where these can provide a significant added value.

This objective also supports Coordination and Support Actions for creating the best conditions within which FET research can flourish and achieve the transformative impacts that it aspires to. These activities may be, for example:

- actions, including networking and dissemination activities, aiming at the emergence of new research communities or collaborations involving a broad diversity of disciplines and actors into FET research;
- actions towards the increased active involvement of high-tech research intensive SMEs in exploratory research directions relevant to future ICT markets;
- actions that stimulate excellence and future leadership of pioneering teams of young researchers along new, exploratory research directions relevant to future ICT;
- actions aiming to strengthen the international dimension of FET.

Expected Impact

For STREP projects:

- Opening new avenues of research towards future ICT that may be radically different from present day ICT;
- Strengthening the future potential for high-risk / high-impact research and innovation;
- New research alliances in transformative research, exploiting synergies in the global science and technology scene for increased impact and excellence.

For CSA actions:

- Catalyse transformative effects on the communities and practices for high-risk and high-impact research and on the mechanisms to support the global nature of such research;
- New, engaged and risk-taking research communities prepared to develop new and non-conventional approaches for addressing future challenges in science and society.

Funding schemes

STREP, CSA

Indicative budget distribution⁶

EUR 75 million⁷, out of which a maximum of EUR 7.5 million for CSA.

Call

FP7-ICT-2011-C

Proposals are continuously receivable until 11 September 2012 (STREP) and 12 March 2013 (CSA). FET-Open applies a two-step submission scheme and FET-Open specific eligibility and evaluation criteria (see last pages of this document or Appendix 5 of the Work programme 2011-12).

⁶ The budget amounts for the 'FET Flagship Initiatives' and for part of the FET Open Call (EUR 46 million) are from the 2011 budget, under the condition that the draft budget for 2011 is adopted without modification by the budgetary authority. The remaining amount for Call 8, Call 9, and for the remaining part of FET-Open (EUR 47 million) is indicative and is expected to be added from the 2012 budget for which a new financing decision to cover the budget of that year will be requested at the appropriate time.

⁷ Indicative budget which is expected to be committed for successful proposals from the cut-off dates 06/07/2010 up to and including 10/04/2012 (batch 9 to batch 13 included)

Objective ICT-2011.9.2: FET Open: High-Tech Research Intensive SMEs in FET research

Target outcomes

This objective fosters the participation of high-tech, research intensive SMEs in a driving role in collaborative research projects targeting visionary, multi-disciplinary research. This will:

- link novel ideas, results or paradigms from science on the one hand, and marketable ideas on the other, that can lead to new, visionary and non-mainstream business opportunities and create future markets;
- generate a new scientific and technological asset base on which the SMEs can establish themselves firmly as future innovation players in areas with a high potential for future commercial or societal impact.

This objective does not seek short term commercial outcomes. It will therefore *not support*, for example, the incremental improvement of state-of-the-art technology, mainstream research aimed at short term product or service development, the incremental improvement of existing lines of business activity, research aimed to catch-up with the competition, foraging or market studies, or the mere development of new business models or business plans.

The consortium will contain at least one research intensive high-tech SME⁸ with an established and proven in-house research capacity and that will play a driving role in setting and executing the research agenda of the project. This objective is expected to be addressed by small STREPs proposals, each with a funding in the order of EUR 1 million, where the largest share of the resources is allocated to the participating SME(s).

Expected Impact

- Opening new avenues of research towards future ICT that may be radically different from present day ICT;
- In-house research capacity and research eco-system of the SMEs secured and broadened, thus leading to sustainable future innovation potential;
- High-tech, research-intensive SMEs recognised as first-class players in FET research;
- Increased visibility, exposure and impact of FET research.

Funding scheme

STREP

Indicative budget distribution⁶

EUR 9 million⁹

Call

FP7-ICT-2011-C

Proposals are continuously receivable until 11 September 2012. Two-step submission and evaluation process with specific eligibility and evaluation criteria (see pages 21-22 of this document or Appendix 5 of the Work programme 2011-12).

⁸ An SME is an enterprise which has fewer than 250 employees, has an annual turnover not exceeding 50 million EUR, and/or has an annual balance-sheet total not exceeding 43 million EUR. Possible relationships with other enterprises must be taken into account when calculating these data of the enterprise. Research centres, research institutes, contract research organisations or consultancy firms are not eligible SMEs for the purpose of the Co-operative and Collective schemes.

⁹ Indicative budget which is expected to be committed for successful proposals from the cut-off dates of 17/05/2011 up to and including 10/04/2012 (batch 11 to batch 13 included)

Objective ICT-2011.9.3: FET Open: FET Young Explorers

Target outcomes

This objective aims at capturing the creative potential of young researchers by fostering their leadership and participation in collaborative research projects targeting first-ever and exploratory, multi-disciplinary research.

This exploration should be grounded in scientifically plausible ideas that can provide a novel basis for the development of radically new concepts and visions that extend the conventional boundaries of ICT. New multi-disciplinary approaches and unconventional methodologies are encouraged.

This objective is expected to be addressed by small STREP proposals, each requesting a grant in the order of EUR 1 million. A project must be led by a young researcher, and the leadership by young researchers of all work packages is also required. No more than six years should have elapsed between the award of a Ph.D. (or equivalent) for each such young researcher and the date of submission of the short proposal.¹⁰

Expected Impact

- Opening new avenues of research towards future ICT that may be radically different from present day ICT;
- Empower the next generation of European science and technology leaders through their increased leadership of collaborative ICT research;
- Promote early independence of young high potential researchers.

Funding scheme

STREP

Indicative budget distribution⁶

EUR 6 million⁹

Call

FP7-ICT-2011-C

Proposals are continuously receivable until 11 September 2012. FET-Open applies a two-step submission scheme and FET-Open specific eligibility and evaluation criteria (see pages 21-22 of this document or Appendix 5 of the Work programme 2011-12).

¹⁰ Proof must be submitted at step 2 of the evaluation, together with the full proposal. Extensions of this period may be allowed only in case of eligible career breaks which must be properly documented: maternity (18 months per child born after the PhD award) & paternity leave (accumulation of actual time off for children born after the PhD award) and leave taken for long-term illness, national service.

Objective ICT-2011.9.4: FET Open: International cooperation on FET research

Target outcomes

This objective aims to increase and accelerate the impact of FET research projects by cooperating with non-EU partners of excellent global standing. It targets the extension of ongoing FET projects with complementary research activities in which collaboration with non-EU¹¹ research partners brings significant added value.

The research content is expected to focus on new activities that expand the research challenges and reinforce the impact of the ongoing project. The outcome of that research is expected to be made freely and openly available for the benefit of the research community.

Funding can be requested by the partners from the ongoing FET project and by the new non-EU research participants to cover the coordination and joint research activities necessary to complement the ongoing project. Proposals must be presented by the coordinator of the on-going project.

Expected Impact

- Enhanced outcomes, global reach and impact of ongoing FET research projects through research collaboration with non-EU participants with complementary expertise;
- Research cooperation between world-class EU and non-EU researcher teams reinforced, thus facilitating the emergence of global alliances.

Funding scheme

Additional funding to existing grant for on-going FET¹² IP and STREP projects ending at least 18 months after the submission date of the proposal.

Indicative budget distribution⁶

EUR 3 million⁹

Call

FP7-ICT-2011-C

Proposals are continuously receivable until 12 March 2013. One-step submission and evaluation process and specific eligibility and evaluation criteria (see pages 21-22 of this document or Appendix 5 of the Work programme 2011-12).

¹¹ The new participating organisations cannot be located in EU Member States or in Associated Countries

¹² Ongoing projects selected under any of the FET objectives of the FP7 ICT Work Programmes.

FET Proactive

FET Proactive spearheads transformative research, supports community building and enhances Europe's innovation potential around a number of fundamental long-term challenges in ICT.

- **Challenging Current Computing and Communicating:** Nature exhibits forms in which information can exist or be transferred that are qualitatively different from the principles used in ICT today. New paradigms based on inspiration from nature and physics will be investigated in *Quantum Information and Communication Technologies*, *Neuro-Bio Inspired Systems* and *Unconventional Computing*.
- **Complexity, Evolution and Adaptation:** Large systems are encountered in both nature and engineering: systems of a technical nature, of a techno-social, social or biological nature. The theory and fundamental insights needed to address the ICT challenges relating to such systems are explored in *Dynamics of Multi-Level Complex Systems* and *Fundamentals of Collective Adaptive Systems*.
- **Co-evolution of Society, Science and Technology:** When societal challenges such as energy consumption and efficiency, epidemics or policy impact assessment have an impact on science and technology, there is a need to seize the opportunity for finding radically different ICT technologies. Examples are *Minimising Energy Consumption of Computing to the Limit* and also *Dynamics of Multi-Level Complex Systems*.
- **Preparation for FET Flagships:** a call for Coordination and Support Actions will integrate fragmented research efforts around large-scale, visionary and goal-driven, multidisciplinary research initiatives.

Candidate topics for calls in Work Programme 2013 include new breakthroughs arising from the FET Proactive Initiatives launched in earlier calls of FP7, inter alia *Atomic Scale Technologies*, *Embodied Intelligence* and *Human Computer Confluence*.

FET Proactive Initiatives apply specific eligibility and evaluation criteria (see pages 21-22 of this document or Appendix 5 of the Work programme 2011-12).

Objective ICT-2011.9.5: FET Flagship Initiative Preparatory Actions

FET Flagship Initiatives are science-driven, large-scale, multidisciplinary research initiatives oriented towards a unifying goal and nucleated from ICT future and emerging technologies. The goals of such initiatives should be visionary and highly ambitious, requiring cooperation among a range of scientific disciplines and research topics going beyond the ICT programme. FET Flagship Initiatives are envisioned to be long term programmes on a scale much beyond current FET Proactive Initiatives. The overarching nature and magnitude implies that they can only be realised through a federated effort of key stakeholders, building on European excellence. Specific aspects to consider are:

- **Mission:** the unifying goal should be a clearly formulated and broadly accepted long term vision involving major challenges in science and technology, requiring a large federated effort, and justified via comparison with existing activities and state of the art
- **Impact:** a clear leverage effect, substantial progress and major innovation in science and technology; affecting competitiveness of European industry, society, governance and sustainability, considering potential ethical and legal implications
- **Integration:** an operational framework describing how relevant disciplines, stakeholders and resources will be brought together at European or larger scale, and how they can be efficiently coordinated under strong scientific leadership along a cohesive roadmap with reasonable milestones that mark valuable interim results

Target Outcome

- a. Complete design and description of a consolidated candidate FET Flagship Initiative, including assessment of feasibility in scientific, technical and financial terms, i.e. with a well-defined goal thoroughly justified in terms of scientific advance and impact, implementation plan, an operational framework, the identification of resources, maturity, capacity, clear evidence of commitment from key stakeholders (in particular scientific communities, Member States and Associated Countries, funding agencies and global partners) with adequate level of integration and identity of the supporting community, and the development of an integrative research agenda to enable the launch of a FET Flagship by 2013. The objective is to support in the order of 5-6 projects, with a maximum duration of 12 months, addressing this target outcome.
- b. Provide support to the setup of candidate FET Flagships by coordination of common issues, e.g. establishment of common platforms to tackle frequent tasks or shared interests, promoting networking and structuring of communities, organisation of joint events etc. The objective is to support 1 project, with a funding in the order of EUR 1 million, addressing this target outcome.

Expected Impact

- A goal-driven, federated effort towards a challenging scientific or technological vision to generate European scientific leadership, and a strong potential for longer term technological innovation and economic exploitation.
- Involvement and commitment from key stakeholders.
- Launch of FET Flagship Initiatives that deliver through their implementation key benefits for science, technology, economy and society, and which will significantly contribute to the coordination of EU and national research programmes and initiatives.

Funding Scheme

CSA: The objective is to support in the order of 5-6 projects, with a maximum duration of 12 months, under target outcome a) and 1 project, with a funding in the order of EUR 1 million, under target outcome b).

Indicative Budget Distribution⁶

EUR 10 million

Call

FP7-ICT-FET-F

Objective ICT-2011 9.6: FET Proactive: Unconventional Computation (UCOMP)

Nature (e.g. living cells), and our physical environment in general, show many unconventional ways of information processing, such as those based on (bio-)chemical, natural, wetware, DNA, molecular, amorphous, reversible, analogue computing, etc. These are generally very sophisticated, ingenious and highly effective for specific purposes, but sufficient knowledge (either from a theoretical or an engineering perspective) to properly exploit, mimic, or adapt these systems, is lacking.

The objective is to develop alternative approaches for situations or problems that are challenging or impossible to solve with conventional methods and models of computation (i.e. von Neumann, Turing). Typical examples include computing in vivo, and performing massively parallel computation.

The focus of this objective is beyond existing initiatives (e.g. *Quantum ICT*, *Neuro-IT* and *Brain-Inspired ICT*).

Target outcomes

Foundations for a radically new kind of information processing technology based on unconventional paradigms. The proposed concept should be developed within the framework of a broader, long-term vision on its potential implementation and impact.

Projects should:

- pursue information processing, respecting the link between computation and the physico-chemical properties of its embodiment.
- strengthen the theoretical foundations in the area, keeping a strong focus on their potential application in (future) systems and devices.
- demonstrate key steps towards physical information processing systems, including appropriate construction, organisation, adaptation and operation methodologies.
- develop an appropriate interface to conventional IT systems and devices, wherever relevant

Expected impact

- Foundations, approaches and proofs of concept for radically new kinds of computation.
- Possible contributions beyond the area of ICT (e.g. health, environment or security).
- Global international research cooperation in this area, in particular with participants from the USA, Canada, New Zealand and Japan.

Funding schemes

STREP

Indicative budget distribution⁶

EUR 15 million

Call

FP7-ICT-2011-8

Objective ICT-2011.9.7: FET Proactive: Dynamics of Multi-Level Complex Systems (DyM-CS)

Many artificial and natural systems are characterized by a high level of differentiation in structure and organization; they exist in areas as diverse as the Internet, energy management, climate, financial markets, infrastructures (including ICT), biology, transport, epidemics, meteorology, urban planning, social simulation and policy impact assessment. In order to describe and control these systems there is a need to observe and reconstruct their dynamics and make sense of large amounts of heterogeneous data gathered on various scales. Most of these areas would benefit from an international effort in collecting and sharing data, models and from looking for a general, common theoretical approach. The science of complex systems (CSS) offers a framework for this theoretical approach.

The objective of this Initiative is to make steps towards a general theory on complex systems through contributions in the area of dynamics of multi-level systems.

Target outcomes:

- a. New mathematical and computational formalisms on dynamics of multi-level systems developed and validated on real-world applications involving large and heterogeneous data sets. This could involve, for example, addressing emergence of and interactions between scales, combining the concepts of 'programmability' and 'self-organisation', or addressing 'out of equilibrium' considerations. Priority application areas should present clearly defined challenges to ICT and/or have a relevant user/social/economic component. Through these areas, CSS should be able to provide solutions for current ICT systems or lay the foundations for new ICT paradigms. For the validation, appropriate organizational structures should be chosen, e.g. large socio-technological systems, complex biological organisms or large organizations. The latter can be validation partners, testing the theory on themselves.
- b. World-class international research cooperation, global alliances in this research area, and links with similar actions outside Europe, in particular with participants from USA, Japan and China.

Expected impact

Target outcome a:

- Progress towards a general theory on complex systems
- New ICT-based methods and principles for the management of large scale systems, including ICT systems themselves.
- Better understanding of structural patterns (e.g. resilience, sensitivity to failure) of complex systems in socio-economic and technological areas.

Target outcome b:

- New EU and global collaborations between researchers in the disciplines involved in CSS.

Funding schemes

- a. IP, STREP
- b. CSA

Indicative budget distribution⁶

- IP/STREP: EUR 22 million
- CSA: EUR 1 million

Call

FP7-ICT-2011-8

Objective ICT-2011.9.8: FET Proactive: Minimising Energy Consumption of Computing to the Limit (MINECC)

The energy consumption of computing technologies becomes more and more an obstacle to realizing new functionalities in, for instance, mobile or distributed applications, and limits performance. It also has an increasing impact on energy supply and environment. Since energy efficiency of today's technologies is orders of magnitude above the theoretical limits, disruptive solutions and radically new approaches are needed to close this gap.

Target outcomes:

Proposals should lay the foundations for radically new technologies for computation that strive for the theoretical limits in energy consumption while maintaining or even enhancing functionality and performance. At least one of the following outcomes should be addressed:

- a. New elementary devices and inter-device-communication mechanisms operating at the limits of minimum energy consumption.
- b. Novel computing paradigms with radically improved energy efficiency. Examples include approaches inspired by biology, post-Boolean logics and computing under uncertainty, randomness and unreliability as a result of low-energy device properties.
- c. Software models and programming methodologies supporting the strive for the energetic limit (e. g. energy cost awareness or exploiting the trade-off between energy and performance/precision).

Proposals should aim for a proof of concept and investigate the viability of the approach. The expected energy gain should be indicated, and the proposal should foresee appropriate energy metrics or benchmarks for verification.

Expected impact

- Understanding of theoretical limits of energy efficiency in computation (e.g. energy dissipation, thermodynamic and quantum physics limits)
- Foundations of computing technologies with negligible energy consumption
- Reduction of the environmental impact caused by the energy consumption of ICT.

Funding schemes

STREP

Indicative budget distribution⁶

EUR 15 million

Call

FP7-ICT-2011-8

Objective ICT-2011 9.9: FET Proactive: Quantum ICT (QICT) including ERA-NET-Plus

The objective is to conceive theoretically and develop experimentally novel and powerful technological applications of quantum coherence and entanglement. In particular, projects should develop a conceptual platform for potentially disruptive technologies, advance their scope and breadth and speed up the process of bringing them from the lab to the real world.

Target outcomes

The results obtained should push forward the boundaries of our knowledge and ensure a constant progress in the quantum ICT area, in particular by

- a. Demonstration of quantum simulators capable to operate on quantum many-particle systems and to simulate technologically relevant systems (e.g., coupled systems in condensed matter, new materials and chemical compounds).
- b. Demonstration of hybrid systems linking different quantum bit realizations (e.g., by bridging atomic/molecular and optical systems with condensed matter systems). Possible devices include those that interconnect different qubit memories and quantum information carriers, and quantum repeaters.
- c. Novel quantum devices exploiting entanglement and quantum coherence as a resource, such as quantum sensing, imaging, measurement and communication.
- d. Enabling methods and technologies to support aforementioned outcomes (e.g., the control of coherent operations with many quantum bits in the experimental domain, or the search for new algorithms and protocols in the theoretical domain).
- e. A joint call for proposals on QICT, to be funded through an ERA-NET-Plus action between national and/or regional grant programmes.

STREPs should address at least one of the research foci a)-d), IPs should address two or more.

Expected impact

- Significant technological achievements with higher performance and superior energy efficiency such as entanglement assisted sensors and metrology
- Better understanding of the dynamics of complex systems and phenomena and design of novel artificial materials with tailored properties through quantum simulators and computers
- Extending the distance of secure quantum links through quantum repeaters
- Closer cooperation and greater alignment between the participating national/regional research programmes through an ERA-NET-Plus action

Funding schemes

a.)-d.): STREP, IP; e.): ERA-NET-Plus

Indicative budget distribution⁶

a.)-d.): EUR 15 million

e.): EUR 7 million (Any funds remaining following the selection of an ERA-NET-Plus action will be transferred to IP/STREP actions under this Objective)

Call

FP7-ICT-2011-9

Objective ICT-2011 9.10: FET Proactive: Fundamentals of Collective Adaptive Systems (FOCAS)

The socio-technical fabric of our society more and more depends on systems that are constructed as a collective of heterogeneous components and that are tightly entangled with humans and social structures. Their components increasingly need to be able to evolve, collaborate and function as a part of an artificial society.

A key feature of Collective Adaptive Systems (CASs) is that they comprise many units/nodes, which have their own individual properties, objectives and actions. Decision-making is distributed and possibly highly dispersed, and interaction between the units may lead to the emergence of unexpected phenomena. They are open, in that nodes may enter or leave the collective at any time, and boundaries between CASs are fluid. The units can be highly heterogeneous (computers, robots, agents, devices, biological entities, etc), each operating at different temporal and spatial scales, and having different (potentially conflicting) objectives and goals. The objective is to establish a foundational framework for CASs.

Target outcomes

- a. **Operating Principles:** principles by which CASs can operate. These should go beyond existing control and optimisation theories, taking into account the diversity of objectives within the system, conflicts resolution, long term stability, and the need to reason in the presence of partial, noisy, out-of-date and inaccurate information
- b. **Design Principles:** principles necessary to build and manage CASs, such as enabling the emergence of behaviour and facilitating prediction and control of those behaviours. These principles should exploit the inherent concurrency and include methods for system validation.
- c. **Evolutionary Properties:** properties concerning the evolutionary nature of CASs, e.g. open-ended (unbounded) evolutionary systems, the trade-off and interaction between learning and evolution, and the effect of evolution on operating and design principles.

IPs should address all three target outcomes. STREPs should have a main focus.

Expected impact

- New functionalities for adaptive ICT systems enabled through novel principles, methods and technologies for designing and operating collective adaptive systems.
- New insights into the general properties of large scale distributed systems.

Funding schemes

IP, STREP

Indicative budget distribution⁶

EUR 23 million

Call

FP7-ICT-2011-9

Objective ICT-2011 9.11: FET Proactive: Neuro-Bio-Inspired Systems (NBIS)

Brains are remarkable computing systems which clearly outperform conventional architectures in many real-world tasks. Computational neuroscience has made tremendous progress in uncovering the key principles by which neural systems process information, and ICT has advanced to a point where it is possible to integrate a comparable number of transistors in a VLSI system as neurons in a mammalian brain. Yet we are still unable to build artificial systems with basic "thinking" abilities comparable with even simple insect brains.

In particular, this objective addresses the need to:

- learn more about the relationship between structure, dynamics and function in neuronal circuits and assemblies, and how information is represented or "coded" in a brain.
- develop deeper and more comprehensive theories of neural processing, possibly building on results obtained in the domains of dynamic and complex systems.
- close the gap between neuroscience and engineering by motivating interdisciplinary work that ties data with theories, novel computing paradigms, models and implementations.

Target outcome

- a. Developing and applying radically new neural recording, imaging or interfacing concepts and designs for a deeper understanding of neural information processing.
- b. New multi-scale dynamical theories of neural representation for the development of neuro-bio-ICT systems that can perform high-level tasks (e.g. robust object recognition, or classification), going beyond purely sensory-driven information processing.
- c. Development and prototyping of modular brain-like computing architectures that combine neural processing primitives to give a better understanding of brain function and facilitate the design of more complex processing systems for real-time and optimized performance.
- d. World-class global research cooperation and alliances in this area, and links with similar actions outside Europe, in particular with participants from USA and Japan.

IP/STREP proposals should address at least 2 of a), b) or c). CSA proposal should address d).

Expected impact

Target outcome a.)-c.):

- New computing paradigms leading to advanced bio-inspired sensing and processing systems, which are naturally able to learn and adapt
- New concepts leading to new brain-computer interface technologies
- Target outcome d.):
- New EU and global collaborations between researchers in multiple disciplines spanning engineering, physical and life science domains.

Funding schemes

a.-c.): IP, STREP

d.): CSA

Indicative budget distribution⁶

- IP/STREP: EUR 22 million
- CSA: EUR 1 million

Call

FP7-ICT-2011-9

Objective ICT-2011.9.12:

Coordinating Communities, Identifying new research topics for FET Proactive initiatives and Fostering Networking of National and Regional Research Programmes

Target Outcome

- a. Actions supporting the coordination and cooperation of the targeted research communities, assessing the impact and proposing measures to increase the visibility of the initiative to the scientific community, to targeted industries and to the public at large. These actions should also foster the consolidation of research agendas.
- b. Actions supporting and promoting cooperation with non-EU¹³ research teams in foundational research on FET topics, with a balanced participation from partners in the EU and from target countries.
- c. Short duration actions (typically 6-12 Months) to organise consultations of multi-disciplinary communities to formulate novel FET research topics, focussing on new emerging research areas. The main objective should be to identify and motivate one or more new research avenues from a global perspective, the associated fundamental challenges, and to analyse the expected impact on science, technology and society.
- d. Actions to organise conferences and workshops which should foster dialogue between science, policy and society on the role and challenges of interdisciplinary ICT related long-term research, increasing Europe's creativity and innovation base and bridging diverse European research communities and disciplines.
- e. ERA-NET actions fostering the networking of future and emerging research activities conducted at national or regional level, facilitating the mutual opening of national and regional research programmes where appropriate. These actions should involve national and/or regional research programme owners.

Proposals should focus exclusively on one of the target outcomes.

Expected impact

- Reinforced coordination of research projects in FET Proactive Initiatives in current or previous calls, strengthening research excellence and co-operation with partners from outside Europe.
- Early identification and increased awareness of new trends emerging on a global scale in support of future proactive initiatives
- Novel widely supported and well motivated research topics to be considered as inputs for future ICT work programmes.
- Increased visibility of the FET community and links between European research communities
- Structuring and integrating effects through ERA-NET actions

Funding Scheme

CSA

Indicative Budget Distribution⁶

EUR 3 million in FP7-ICT-2011-7 of which 2.5 million will be reserved for CSA under focus e)

EUR 3 million in FP7-ICT-2011-8

EUR 2.5 million in FP7-ICT-2011-9

Calls

FP7-ICT-2011-7 (foci c, d and e)

FP7-ICT-2011-8 (foci a, b, c and d)

FP7-ICT-2011-9 (foci a, b, c and d)

¹³ The targeted organisations cannot be located in EU Member States or in Associated Countries

Special Initiatives

This initiative is coordinated as part of the "Géant and e-Infrastructures" activity.

Objective ICT-2011.9.13

Exa-scale computing, software and simulation

Target outcomes

a. Exascale computing

The target is to develop a small number of advanced computing platforms with potential for extreme performance (100 petaflop/s in 2014 with potential for exascale by 2020), as well as optimised application codes driven by the computational needs of science and engineering and of today's grand challenges such as climate change, energy, industrial design and manufacturing, systems biology. These platforms should rely on vendors' proprietary hardware or on COTS.

Proposals should address major challenges of extreme parallelism with millions of cores in the areas of programming models, compilers, runtime support, performance analysis, operating systems, algorithms, memory access, interconnects, power consumption and system resilience). All software should be developed as open source.

Each project should bring together (a) one or more supercomputing centres with a leading role in system software development; (b) technology and system suppliers, whether these are academic centres or private companies, including system vendor(s) in case of targeting particular vendors' machines; and (c) industrial or academic centres to co-develop a small number of exa-scaled application codes. Each project should split the effort roughly 40/60 in applications and simulation vs. systems development.

Proposals should demonstrate synergies with efforts under the Capacities programme on the deployment of leadership-class HPC (High Performance Computing) systems. Proposals may include international cooperation components that are complementary to European expertise and essential to address the exa-scale grand challenge.

Two to three projects are expected to be selected. This selection will attempt a balance between application domains and exascale computing approaches.

b. Coordination of international cooperation

Supporting a common European strategy and a driving role for European stakeholders in international efforts on the development of future extreme-scale HPC systems.

Expected impact

- Europe in the frontline of international efforts for the development of HPC system software and tools;
- Strengthened European industry supplying and operating HPC systems; preparing European industry and research organisations to achieve world-leadership in this area.
- European excellence in exascale level simulation codes for the benefit of society, industrial competitiveness and policy making; emergence of EU top-class simulation centres for exa-scale systems.
- Reinforced cooperation in international endeavours on exascale software and systems.

Funding schemes

a) IP, b) CSA

Indicative budget distribution⁶

- IP: EUR 24 million
- CSA: EUR 1 million

Call

FP7-ICT-2011-7

This objective applies the general evaluation criteria of the ICT theme programme that can be found in the ANNEX 2 of the Work Programme 2011-12.

The perspective is to have this initiative implemented via a joint call with the Environment theme.

Objective ICT-2011.9.14: Science of Global Systems²

Progress in global systems dynamics is required to better understand the interactions between ecological and socio-economic systems and to better respond to global environmental change. Global coordination requires new developments in science based on global system models that span the whole range from local regional to global multi-national decision making. A science of global systems must pay special attention to the interface with policy and society to better ground the scientific tools. IT will support the massive needs in computing and data handling and help establishing new links between science, policy and society.

Target outcomes

- Improve use of data and knowledge from the past to choose between options for the future: Tools to represent uncertainty and to construct chains of causality (narratives) from models and data to outcomes for use in socio-political decision processes.
- ICT tools for better use- and user centred modelling techniques, data collection and user-model interaction. Methods to address use of system models in a policy decision context.
- Understanding of distributed multilevel policy decision processes. Identify system patterns relevant for properties like resilience, vulnerability, and regime shift tendencies.
- Use and develop formal languages, constructive type theory and domain specific languages to make policy interfaces of models more adaptable to changing contexts.

Expected impact

- Better links between modellers and stakeholders facilitated by new policy-relevant concepts in modelling of global systems;
- Overcome fragmentation in research in various policy-relevant models resulting in a better uptake of modelling results for global coordination of policies;
- Policy uptake in targeted areas: socio-ecological system and climate change impacts, innovation as a global system, dynamics of the financial system and new models for economy.

Funding scheme

STREP

Indicative budget distribution⁶

EUR 3.5 million (ICT contribution)

Call

FP7-ICT-2011-8

Indicative Timetable

Objective	Submission Scheme	Indicative launch of the Call & Submission deadline
FP7-ICT-2011.9.1: FET Open Challenging Current Thinking	STREP: two step CSA: one step	Continuously receivable from 4 th of August 2010 until 31 December 2012 (with cut-off dates for batches).
FP7-ICT-2011.9.2: FET Open High-Tech Research Intensive SMEs in FET research	STREP: two step	Continuously receivable from 4 th of August 2010 until 31 December 2012 (with cut-off dates for batches).
FP7-ICT-2011.9.3: FET Open FET Young Explorers	STREP: two step	Continuously receivable from 4 th of August 2010 until 31 December 2012 (with cut-off dates for batches).
FP7-ICT-2011.9.4: International cooperation on FET research FET Open and FET Proactive	IP/STREP: one step	Continuously receivable from 4 th of August 2010 until 31 December 2012 (with cut-off dates for batches - First cut-off date 17 May 2011).
FP7-ICT-2011.9.5 Fet Flagship Initiative Preparatory Actions	CSA: one step	Call open: 20 July 2010 Deadline: 2 December 2010
FP7-ICT-2011.9.6 FET Proactive Unconventional Computation (UCOMP)	STREP: one step	CALL 8 Call open: July 2011 Deadline: January 2012
FP7-ICT-2011.9.7. FET Proactive Dynamics of Multi-Level Complex Systems (DyM-CS)	IP/STREP/CSA: one step	CALL 8 Call open: July 2011 Deadline: January 2012
FP7-ICT-2011.9.8. FET Proactive Minimising Energy Consumption of Computing to the Limit (DyM-CS)	STREP: one step	CALL 8 Call open: July 2011 Deadline: January 2012
FP7-ICT-2011.9.9. FET Proactive Quantum ICT (QICT) including ERA-NET-Plus (MINECC)	IP/STREP/ ERA-NET: one step	CALL 9 Call open: January 2012 Deadline: April 2012
FP7-ICT-2011.9.10. FET Proactive Fundamentals of Collective Adaptive Systems (FOCAS)	IP/STREP: one step	CALL 9 Call open: January 2012 Deadline: April 2012
FP7-ICT-2011.9.11. FET Proactive Neuro-Bio-Inspired Systems (NBIS)	IP/STREP/CSA one step	CALL 9 Call open: January 2012 Deadline: April 2012

Objective	Submission Scheme	Indicative launch of the Call & Submission deadline
FP7-ICT-2011.9.12. Coordinating Communities, Identifying new research topics for FET Proactive initiatives and Fostering Networking of National and Regional Research Programmes	CSA: one step	Call 7 : 7 (foci c, d and e) Open : 28 September 2010 Deadline: 18 January 2011 Call 8 : (foci a, b, c and d) Open : July 2011 Deadline: January 2012 Call 9: (foci a, b, c and d) Open : January 2012 Deadline: April 2012
FP7-ICT-2011.9.13. Exa-scale computing, software and simulation	IP/CSA: one step	Call 7 Open : 28 September 2010 Deadline: 18 January 2011
FP7-ICT-2011.9.14. Science of Global Systems	STREP: one step	CALL 8 Call open: July 2011 Deadline: January 2012

Funding schemes
CSA Coordination and Support Action
IP Large-scale Integrating Project
STREP Small or medium scale focused research action

FET Open and FET Proactive apply specific eligibility and evaluation criteria. Proposers are asked to familiarise themselves with the provisions of Appendix 5 of the Work Programme 2011–2012 before submitting proposals to these schemes.(see following pages of this document).

Appendix 5: FET eligibility and evaluation criteria

FET Evaluation criteria

Eligible proposals under any of the FET objectives will be evaluated according to three criteria - Scientific/Technological Quality, Implementation and Impact. A score will be awarded for each of these criteria, based on the considerations listed below. For FET-Open short proposals only Scientific/technological Quality applies.

	1. S/T quality	2. Implementation	3. Impact
short STREP (FET Open) Objective 9.1, 9.2 and 9.3	<ul style="list-style-type: none"> Clarity of targeted breakthrough and its relevance towards a long-term vision. Novelty and foundational character. Plausibility of the S/T approach. 	<i>(not applicable to short STREP)</i>	<i>(not applicable to short STREP)</i>
	Threshold: 4/5		
Collaborative Projects (FET Open and FET Proactive, STREPs and IPs)	<ul style="list-style-type: none"> Clarity of targeted breakthrough and its relevance towards a long-term vision. Novelty and foundational character. Specific contribution to progress in science and technology. Quality and effectiveness of the S/T methodology. 	<ul style="list-style-type: none"> Quality of workplan and management. Quality and relevant experience of the individual participants. Quality of the consortium as a whole (including complementarity, balance). Appropriate allocation and justification of the resources to be committed (person-months, equipment, budget). 	<ul style="list-style-type: none"> Transformational impact of the results on science, technology and/or society. Impact towards the targeted objective in the workprogramme. Appropriateness of measures envisaged for the dissemination and/or use of project results.
	Threshold: 4/5	Threshold: 3/5	Threshold: STREP 3.5/5 IP 4/5
	Weight: 50%	Weight: 20%	Weight: 30%
Coordination and Support Actions (FET Open and FET Proactive)	<ul style="list-style-type: none"> Clarity of objectives. Contribution to the co-ordination and/or support of high-risk and high-impact research, for new or emerging areas or horizontally. Quality and effectiveness of the coordination and/or support activities. 	<ul style="list-style-type: none"> Quality of workplan and management. Quality and relevant experience of the individual participants. Quality of the consortium. Appropriate management of the resources to be committed (person-months equipment, budget). 	<ul style="list-style-type: none"> Transformational impact on the communities and/or practices for high-risk and high-impact research. Appropriateness of measures for spreading excellence, use of results, and dissemination of knowledge, including engagement with stakeholders.
	Threshold: 3/5	Threshold: 3/5	Threshold: 3/5
	Weight: 40%	Weight: 20%	Weight: 40%

Thresholds are set for each criterion, as indicated in the tables above. A proposal failing to achieve any of these threshold scores will be rejected.

Additional eligibility criteria applicable to FET-Open

In addition to the eligibility criteria set out in Annex 2 to the work programme 2011-12, all FET-Open **short proposals** are subject to the following eligibility criteria:

1. The length of Part B should not exceed 5 A4 pages, excluding a title page.
2. Part B should be fully anonymous, meaning that none of the participants or contact points should be explicitly mentioned, or any of the authors be otherwise identifiable. Background references and a list of publications are also excluded.

Proposals (short and full) submitted to FET-Open Objective ICT-2011.9.2: High-Tech Research Intensive SMEs in FET research are subject to the following additional eligibility criteria:

3. The consortium must contain at least one SME.¹⁴

Proposals (short and full) submitted to FET-Open Objective ICT-2011.9.3: FET Young Explorers are subject to the following additional eligibility criteria:

4. A project must be led by a young researcher, and the leadership by young researchers of all work packages is also required. No more than six years should have elapsed between the award of a Ph.D. (or equivalent) for each such young researcher and the date of submission of the short proposal.¹⁵

Proposals submitted to FET-Open Objective ICT-2011.9.4: International cooperation on FET research are subject to the following additional eligibility criteria:

5. Proposals must be presented by the coordinator of an on-going FET¹⁶ IP or STREP project ending at least 18 months after the submission date of the proposal.

For short proposals and where applicable, eligibility criteria 3 and 4 require a declaration on the cover page of the proposal (see proposal template in Guide for Applicants).

Priority order for proposals with the same score

As part of the evaluation by independent experts, a panel review will recommend one or more ranked lists for the proposals under evaluation, following the scoring systems indicated above. A ranked list will be drawn up for every indicative budget shown in the call fiche.

If necessary, the panel will determine a priority order for proposals which have been awarded the same score within a ranked list. Whether or not such a prioritisation is carried out will depend on the available budget or other conditions set out in the call fiche. The following approach will be applied successively for every group of *ex aequo* proposals requiring prioritisation, starting with the highest scored group, and continuing in descending order:

Proposals will be prioritised according to the scores they have been awarded for the criterion *scientific and/or technological excellence*. When these scores are equal, priority will be based on scores for the criterion *impact*. If necessary, any further prioritisation will be based on other appropriate characteristics, to be decided by the panel, related to the contribution of the proposal to the European Research Area and/or general objectives mentioned in the work programme.

¹⁴ An SME is an enterprise which has fewer than 250 employees, has an annual turnover not exceeding 50 million EUR, and/or has an annual balance-sheet total not exceeding 43 million EUR. Possible relationships with other enterprises must be taken into account when calculating these data of the enterprise. Research centres, research institutes, contract research organisations or consultancy firms are not eligible SMEs for the purpose of the Co-operative and Collective schemes.

¹⁵ Extensions of this period may be allowed only in case of eligible career breaks which must be properly documented: maternity (18 months per child born after the PhD award) & paternity leave (accumulation of actual time off for children born after the PhD award) and leave taken for long-term illness, national service.

¹⁶ Ongoing projects selected under any of the FET objectives of the FP7 ICT Work Programmes.

Future and Emerging Technologies

Information and Communication Technologies under FP7

Extract from Work Programme 2011-2012 for ICT



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