Work Programme 2014-15
Part I - Excellent Science

draft - 23 May 2013

1. Future and Emerging Technologies

Future and Emerging Technologies (FET) aims at radically new technologies by exploring novel and high-risk ideas building on scientific foundations. It promotes research beyond what is known, accepted or widely adopted and fosters novel and visionary thinking to open promising paths towards powerful new technologies, some of which could develop into leading technological and intellectual paradigms for the decades ahead. This approach is be driven by excellence and extends to exploring pre-competitive ideas for shaping the future of technology, enabling society to benefit from multi-disciplinary research collaboration that needs to be engaged at European level by making the link between research driven by science and research driven by societal challenges or by industrial competitiveness.

FET will be realised through three lines of activities:

- **FET Open** supports embryonic science and technology research exploring new foundations for radically new future technologies by challenging current paradigms and venturing into unknown areas. A bottom-up selection process widely open to any research ideas shall build up a diverse portfolio of targeted projects. Early detection of promising new areas, developments and trends, along with attracting new and high-potential research and innovation players, will be key.
- **FET Proactive** will nurture emerging themes and communities by addressing a number of promising exploratory research themes with the potential to generate a critical mass of inter-related projects that, together, make up a broad and multifaceted exploration of the themes and build a European pool of knowledge.
- **FET Flagships** supports ambitious large-scale, science-driven research aimed at grand interdisciplinary S&T challenges. Such activities will benefit from the alignment of European and national agendas, and provide a strong and broad basis for future technological innovation and economic application in a variety of areas, as well as novel benefits for society.

Across FET the following principles will be used to guide the scope of all FET activities:

- **Long-term vision**: the research proposed must address a new, original or radical long-term vision of technological possibilities that are far beyond the state of the art and that are currently not anticipated by existing technology roadmaps or their expected uses in society.
- **S&T targeted**: the research proposed targets concrete breakthroughs in science and technology that are arguably crucial steps towards achieving the long-term vision and that are plausibly attainable within the life-time of the proposed project.
- **Foundational**: the breakthroughs that are envisaged are foundational in the sense that they can establish a basis for a new kind of technology not currently anticipated.
- **High-risk**: the technological directions proposed are complex in the sense that their potential depends on a range of factors that cannot be apprehended from a single disciplinary viewpoint. Thus, this high-risk is countered by novel concepts and ideas, and by a strongly interdisciplinary research approach, where needed expanding beyond the strictly technological realm
- **Novelty**: the research proposed finds its plausibility in new ideas and concepts, rather than in the application or incremental refinement of existing ones.
- **Interdisciplinary**: the proposed collaborations are interdisciplinary in the sense that they go beyond current mainstream collaboration configurations in advanced science and technology research, and that they aim to advance different disciplines together and in synergy towards the S&T breakthrough.

Within this interdisciplinary setting, the proposed research will have a crucial **Information and communication** science and technology research component

A. CALLS

Call FET-Open - fostering novel ideas

Specific Challenge

Supporting a large set of early stage, high risk visionary science and technology collaborative research projects is necessary for the successful exploration of new foundations for radically new future technologies. By being explicitly non–topical and non-prescriptive, this challenge allows for new ideas to be explored, whenever they arise and wherever they come from, within the broadest spectrum of themes and disciplines. Nurturing such fragile ideas requires an agile, risk-friendly and highly interdisciplinary research approach, going well beyond the strictly technological realms. Attracting and stimulating the participation of new high-potential actors in research and innovation, such as young researchers and high-tech SMEs is also important for nurturing the scientific and industrial leaders of the future.

Scope

Proposals are sought for collaborative research projects with all of the following characteristics:

- Long-term vision: the research proposed must address a new, original or radical long-term vision of technological possibilities that are far beyond the state of the art and that are currently not anticipated by existing technology roadmaps or their expected uses in society.
- S&T targeted: the research proposed targets concrete breakthroughs in science and technology that are arguably crucial steps towards achieving the long-term vision and that are plausibly attainable within the life-time of the proposed project.
- Foundational: the breakthroughs that are envisaged are foundational in the sense that they can establish a basis for a new kind of technology not currently anticipated.
- High-risk: the technological directions proposed are complex in the sense that their potential depends on a range of factors that cannot be apprehended from a single disciplinary viewpoint. Thus, this high-risk is countered by novel concepts and ideas, and by a strongly interdisciplinary research approach, where needed expanding beyond the strictly technological realm
- Novelty: the research proposed finds its plausibility in new ideas and concepts, rather than in the application or incremental refinement of existing ones.
- Interdisciplinary: the proposed collaborations are radically interdisciplinary in the sense that they go beyond current mainstream collaboration configurations in advanced science and technology research, and that they aim to advance their different lines of science and technology work together and in synergy to achieve the targeted breakthrough.

Within this interdisciplinary setting, the proposed research will have a crucial Information and communication science and technology research component.

Expected Impact:

Projects will aim at one of the following two impacts:

- Establish early Proof-of-Principle of a new technological possibility, together with its scientific basis, as foundational contribution for a radically new line of science and technology research, or
- Establish a solid baseline of feasibility and potential for a new technological direction, ready for early take-up within an early-stage emerging innovation eco-system of high-potential actors .

In addition, projects will aim at the involvement of new and high-potential research and innovation players.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Call FET-Proactive - nurturing emerging themes and communities

Novel areas and themes need to be matured, by working towards structuring emerging communities and supporting the design and development of transformative research themes. The main benefits of this structuring yet explorative approach are emerging novel areas that are not yet ready for inclusion in industry research roadmaps, and building up and structuring of new interdisciplinary research communities around them. It makes the step from collaborations between a small number of researchers, to a cluster of projects that each address aspects of a novel research theme and exchange ideas, concepts, research results and first proofs of concept to jointly explore possibilities for future technologies.

FET Proactive initiatives have the following dual strategic objectives:

- An exploratory objective by stimulating the exploration of a variety of directions by building up critical mass of researchers and groups around promising emerging themes. Encouragement of new inter-disciplinary collaborative explorations of a new area.
- A pathfinding objective by aiming at translating science into concrete technological directions by projects that build on proofs-of-concept and, while still high-risk, want to take them to a next level of development and consolidate a technological directions that are mature enough for hand-over (to LEIT, societal challenges, FET Flagships, industry,...)

Nine candidate topics have been identified for funding under this work programme:

1. Time for Time
2. Constructive Symbiosis
3. Adaptive bottom-up construction
4. New possibilities at the nano-bio-chem interface
5. Knowing, doing and being
6. Ecological technology
7. Exploiting light-matter interaction
8. Quantum technologies
9. Global Systems Science

Topic 1: Time for Time

Specific Challenge

In most of the modern sciences and technologies, time is mainly considered as the background with respect to which processes are measured. In contrast, the primary goal of this initiative is to focus on time itself and to explore the implications for future and emerging technologies. A deep understanding of time in physics has been fundamental for modern technologies. For example, the current global navigation technologies reach unprecedented precision only thanks to our understanding that the rate of the passage of time at the satellites' altitudes is different from the rate of passage of time on the Earth surface. But apart from physics, there are several more disciplines that are concerned with time –philosophy, psychology, history, geology, computer science, biology and neuroscience – not to mention arts like literature, cinema or music. This points at many different motivations and methods to study and use time – often at vastly different scales and levels of abstraction. What can be learned from this in terms of future technologies to, for instance, understand, measure, model, program, manipulate, stop, create, invert, multiply, perceive or differently experience and use time in its multiple manifestations? This initiative seeks to explore new technological possibilities deriving from these multiple notions of time.

Scope

Projects should focus on some of the following topics:

- Study temporal information processing and our cognitive functioning with respect to the perception and experience of time. Develop models and technology to measure and manipulate the perception and experience of time. Investigate and demonstrate implications from time perception and some degree of control thereof in technological systems like in robotics, virtual and augmented reality or cyber physical systems.
- Investigate different subjective notions of time and their relationships as they occur across different time scales, or how they vary according to cultural, contextual and personal differences, as emphasized by anthropology or the study of time related pathologies. Develop techniques for encoding such different notions of time in computing, modelling and simulation languages that can deal with different time spans (e.g., from real-time reactivity, over biological or bio-dynamical rhythms, to diurnal or longer cycles of use and repetition).
- Understanding and exploiting the properties of time at shorter time scales, beyond the currently accessible. Search for the manifestation of quantum effects at very short time (and space) scales. Investigate the impact on quantum information theories.
- Revisit the fundamentals of time, for example from the concept of time as an emergent entity, considering time as a thermodynamics process and studying the relation between time and entropic processes.
- Study of the role of time at vastly different time scales, from quantum world processes to the age of the Universe, and investigate the relation to the different biological processes and its impact on the human being (e.g. at the biological or psychological level).

This initiative will not support research on novel devices to measure time, neither will it fund work on new materials, technologies or processes to optimise the use of time in industrial settings.

Expected impact

By advancing knowledge on different aspects of time, projects will demonstrate technological impacts such as, but not limited to, the following:

- Technology that takes into account the variability of human time perception and its impact on various human activities, for instance in terms of memory and decision making.
- Technologies for treatment of time-related pathologies, or for exploiting insight on the variability and/or controllability of time perception in multiple contexts, e.g. work, study, entertainment, rest.
- Better understanding and raised awareness on how biological processes (like neurological and neuropsychiatric diseases, ageing, and others) influence our perception of time and, thus, our cognition capabilities. Such results may open opportunities for new technologies to mitigate the negative impacts from time on such processes.
- Mechanistic predictive modelling of disease development based on multi-scale understanding of physiological processes, may lead to medical devices that evolve to engineer chronobiomimetic therapeutic solutions.
- Understanding the properties of time at ever smaller time (and space) scales will have a profound impact on the fundamental understanding of nature (e.g., from quantum information theory) and on the development of small scale technologies, where both gravitational and quantum effects should be taken into account.
- Raised awareness of important insights on the concept of time with a broader audience, thus not only through scientific and technological work but also through various media or artistic intervention.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 2: Constructive symbiosis

Specific Challenge

Nature and biology provide many examples of systems with outstanding and attractive properties, for example with respect to long-term viability, efficiency, adaptability or resilience. Bio-inspired technologies have made tremendous progress in uncovering and copying some of the underlying key principles. This objective goes beyond inspiration from nature and bio-mimicry and seeks to explore hybrid artificial-natural systems in which the nature and complexity of interactions can be considered to be a kind of mutualisticly advantageous symbiosis as it is found in nature.

Scope

Proposals are expected to combine concepts and knowledge from different disciplines towards creating a self-sustaining and constructive ('win-win') symbiosis between the artificial and the natural, by addressing one or more of the following topics:

- Development of modelling techniques and architectural principles related to symbiotic systems.
- Deeper understanding of essential properties of symbiosis in nature such as energy and resource sharing and self-regulation, waste conversion, the intertwining of metabolic processes, mutual-adaptation, co-evolution and growth regulation.
- Design of symbiotic interactions between humans and technology at molecular, cell, tissue, organism or community level.
- Design of symbiotic interaction of artificial and other (non-human) natural systems such as bacteria, for artificial photosynthesis, for synthetic biology, for new forms of computation or for new concepts in environmental and urban development.

Expected impact

- New hybrid systems and system functionalities that far outperform existing devices
- Build-up of core competence in the relevant highly interdisciplinary areas closing the gap between biological sciences and technology for building hybrid systems
- Preparation for the creation of entirely new habitats, for instance in extreme conditions.
- Impacts for future symbiotic technologies, hereby also considering the influences of the new technologies on humans and nature, and methods to promote positive co-evolution and co-adaptation of symbiotic systems.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 3: Adaptive Bottom-up Construction

Specific Challenge

This initiative aims to explore techniques and methodologies for bottom-up design, manufacturing, and construction of materials and physical artefacts at various size scales, ranging from the nano-scale (e.g. atomic, molecular, cellular) up to macro-scale. The long term goal is to achieve growth or self-assembly of such artefacts, possibly in a scale-invariant way. Inspiration can be found from biological processes like morphogenesis or epigenetics, or in the study of self-organisation, adaptation or evolution in order to design and assemble complex functional materials, artefacts or larger complex structures in cost-effective, reliable and adaptive ways, under relatively affordable conditions (cost and others).

Scope

Proposals are expected to address a combination of the following topics:

- Understand the theoretical aspects of interaction and dynamics among various physical entities and across different physical scales, and their role for achieving certain capabilities, functionalities and properties at aggregate level, such as safety, robustness and the ability to continuously adapt and learn.
- Explore and experiment self-assembly of under-actuated/un-actuated entities that can aggregate or reconfigure in a non-random purposeful manner, integrating strategies of growth, development or evolution to continuously adapt to changing conditions or requirements. This includes new composite, adaptive and reactive materials, bio-materials, and artefacts from nano to macro scales.
- Develop multi-scale models and simulation strategies and experiment methods for bottom-up building of macroscopic structures with complex architectures and characteristic features from nano to macro levels starting from the controlled assembly of selected building blocks to create new functionalities and truly adaptive materials and systems able to respond to their environments.

Expected impact

- Advanced multi-functional self-composing and self-healing materials with excellent structural / mechanical and durability properties that could be used in innovative construction in the future.
- New modular and self-reconfigurable artificial systems of various scales, that can develop, adapt and learn from their environment
- New self-assembled and/or adaptive bio and nano-electronics systems for new forms of computing, biomedical applications (drug delivery, hyperthermia therapy), nanosensors (air security), and others.
- Create artificial biological entities and machines such as molecular assemblers able to sense and manipulate individual molecules and atoms by assembling living things from the bottom up.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 4: New possibilities at the nano-bio-chemistry interface

Specific Challenge

This explores new possibilities at the intersection of nanotechnology, (cell-)biology, (bio-)physics, chemistry, information science and mathematical modelling. This is aimed at new tools and techniques for advancing research (e.g., in neuroscience or biology), at the conception of novel systems, materials (e.g., synthetic or hybrid ones) or at applications such as new implants, drug delivery and medicine. Where relevant, long-term biocompatibility will be taken into account. Strong synergies between the different disciplines are expected for jointly exploring such new technological possibilities.

Scope

Proposals are expected to address a combination of the following topics:

- Complex biomimetic and biocompatible materials and artefacts with active interfaces to their host, for instance for regeneration of tissue, prosthetic devices or long-lasting implants.
- New techniques for information sharing between devices operating on and within biological substrates
- New technologies and methodologies for interfacing with biological systems in physical, chemical, electrical ways at the level of cells or below and in-vivo, for probing, imaging and/or control.
- Platforms for imaging of, and controlled interaction with biochemical processes far beyond current capabilities of complexity and automation, for instance for artificial cells
- New forms of computation or information storage, implemented directly within nano-bio-chemical substrates.
- Novel approaches to molecular motors or self-propelled molecular objects, artificial cells or micro-organisms.

Expected impact

Projects will contribute in concrete terms to achieving one of the following impacts:

- New therapies, drug screening and drug delivery techniques, diagnosis, prosthetics and implants.
- Multi-functional bio-materials, e.g., for energy generation, storage or harvesting.
- New practices and methodologies from in-vivo imaging and experimentation/research techniques.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 5: Knowing, doing and being

Specific Challenge

This initiative addresses the interdisciplinary fundamentals of knowing, thinking, doing and being, in close synergy with foundational research on future artificial cognitive systems and robots. It aims at renewing ties between the different disciplines studying knowledge (especially beyond the 'declarative' and action oriented kind of knowledge), cognition (e.g., perception, understanding, learning, action) and related issues (e.g., embodiment, thinking, development, insight, knowledge as a social construct, identity, responsibility, culture...) from various perspectives (e.g., neural, behavioural, social, epistemological), enriching the basis for research that takes artificial cognitive systems beyond the level of dull task execution.

Scope

Proposals are expected to address at least one of the following topics:

- New concepts and new generic paradigms in cognitive systems such as new approaches to embodiment, learning, reasoning, autonomy, new theories of agency, knowledge and mind, not limited to prior anthropocentric or bio-mimetic models. Projects will demonstrate these paradigms in robust control of future robotic systems in challenging environments, possibly co-habited with human or other cognitive artefacts. Work will also cover new morphological designs such as nano- and micro-robots, swarms or unconventional robot shapes.
- Integrative studies of knowing, thinking, doing and being that bridge between low-level/physiological (e.g., neuronal) and high-level/philosophical (e.g., belief, intention, identity) descriptions. These multidisciplinary studies are expected to go well beyond addressing the perception-action loop, and to tackle issues of development, experience, understanding, the notion of self, empathy, social belonging and culture. They will develop in close synergy with technological experiments, for instance in robotics, cyber physical settings or large scale simulations that reflect, test and refine insights gained.
- Approaches for understanding the long-term development of individual and social knowledge and identities, especially in highly heterogeneous and dynamic settings (reflecting aspects of e.g., diversity, urban change, migration, social divides, inter-disciplinarity, etc). Projects are expected to take into account the role of technologies and infrastructures in this, as well as how technology can facilitate societal changes.

Expected impact

- New foundations for future robotics and other artificial cognitive systems with clear progress beyond current capabilities and design concepts.
- A deeper understanding of social robotics, robot development and interaction in mixed human-robotic settings.
- Understanding the origins and development of synergies and divides in socio/technical contexts and ways to influence them.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 6: Ecological technologies

Specific Challenge

The aim is to explore new ways of avoiding overall environmental impact of technologies, by seeking new holistic paradigms for future mass-technologies. This should go well beyond incrementally reducing impacts along a single dimension (like energy consumption or use of materials).

Scope

Projects will address at least one of the following topics:

- new conceptual frameworks, design and life-cycle approaches that take ecological and sustainability concerns to the limit, including aspects of fitness for purpose (for instance pro-simplicity and slow technologies), use and reuse (includes a socio/economical dimension like from eco-incentives), flexibility of functionality, noise, change over time, reliance on what is available from other devices or from the environment ('functionality scavaging'), serviceability, gentle degradation, toxicity, etc.
- demonstration of zero negative impact devices along multiple dimensions like energy, material footprint (common instead of rare), locality of resources, social impact from use, end-of-life, quality of use, stresses, etc.
- techniques to measure, model and predict the negative impacts of mass deployment of ubiquitous technologies at various market and time scales, and to quantify their 'eco-scalability' properties and trade-offs

Expected impact

- New approaches to various ubiquitous technologies (e.g. ICT, nanotechnologies, novel materials, energy technologies) and infrastructures to reduce their potential long-term negative impacts.
- proof-of-concept of functional near to zero negative impact devices that are meant for large scale consumption or deployment
- Increasing awareness of eco-scalability issues and alternative design approaches in industry and society.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

The second scope bullet can be partially implemented using the prize instrument (will require a separate topic in the WP).

Topic 7: Nanoscale Opto-mechanical devices

Specific Challenge

The various interactions between electromagnetic and mechanical degrees of freedom in nano-scale systems are beginning to be understood, for instance from research in cavity optodynamics, and have been delivering a lot of basic science results, both in the classical and in the quantum regime (e.g. for realising a quantum ground state through optomechanical cooling). This initiatives seeks to explore the technological implications, towards new components and systems that outperform current technologies and that can be envisaged for practical usage.

Scope

Proposals are expected to address a combination of the following topics by an appropriate mix of theory development, simulation and modelling, and proof-of-concept development:

- Achieve practical generation, manipulation, control, and readout of nanomechanical motion in a broad range of frequencies including high frequencies, using electromagnetic radiation rather than electrical signals;
- Build integrated devices containing multiple nanoscale mechanical and optical elements, allowing to play with light and sound in independent as well as in coupled ways.
- Establish new possibilities, for instance to exploit integrated nano-optomechanical devices as optical nonlinearities for silicon photonics, for novel electro-optic interfaces to link nano-electronics with nano-optics, for efficient single-photon IR detection, for small-scale mechanical to electrical/optical energy conversion, the use of optical levitation or of transformational techniques in both the optical and acoustic domains,

Expected impact

Project will contribute in concrete terms to achieving at least one of the following impacts:

- New devices and device functionalities (e.g., metrology, storage, switching) in unexplored frequency domains that outperform existing devices in terms of key performance characteristics.
- Practical feasibility at room temperature from using light instead of electrical signals for manipulating mechanical degrees of freedom
- New basis for future photonics technology and opto-electro integration at the nano-scale.

Projects will also contribute to build-up of core competence in the new material science and processing techniques needed, which is a crucial asset for European leadership in this area.

Instruments, funding level, budget: budget XX M€

CP, funding level: 100%, budget xxM€

Topic 8: Quantum technologies

Specific Challenge

Devices that exploit quantum phenomena such as superposition and entanglement have the potential to enable radically new technologies. Several promising directions are now well known, for instance in computation, communication, security, metrology, sensing, simulation and material science. However, bridging from the scientific results to concrete engineering technologies has proved difficult. This objective challenges the research community to develop solutions using quantum technology to address real world problems.

Scope

Proposals are expected to address one or more of the following topics:

- Development of a quantum simulator for solving a specified problem in an application domain e.g. in the life sciences or material science;
- Development of quantum networking beyond point-to-point, i.e., towards an addressable multi-hop and scalable quantum communication network.
- Development of devices exploiting quantum phenomena that enable substantially improved performance in technological applications.

Expected impacts

- New technologies and devices with far better performance than existing devices.
- New tools based on quantum technologies for solving problems in applied science
- Build-up of core competences for the wider exploitation of quantum technologies in mainstream engineering.

Instruments, funding level, budget

CP, funding level: 100%, budget xxM€

Topic 9 Global Systems Science (GSS)

Specific Challenge

The challenge is to improve the way scientific knowledge can stimulate, guide, and help evaluate policy and societal responses to global challenges like climate change, financial crisis, pandemics, and global growth of cities. Policy challenges shall be addressed by radically novel tools for producing and delivering scientific knowledge to the policy processes.

GSS will put to full use the abundant data on social, economic, financial, technological, and ecological systems available today. GSS-emphasises system thinking and the need to link with all pertinent actors in the policy process – citizens, policy makers, NGOs... GSS will build on results from, among others, Complex Systems Science, Science of Networks, Mathematics of Big Data, digital social science, etc.

Scope

All projects should address the below points:

- Theoretical foundations of GSS among others understanding systemic risk, crisis, decision making under uncertainty, mathematics of Big Data, algorithmic game theory for use in policy, understanding cascading effects in networks....
- Contributions to solve real world problems in one of the selected policy areas: systemic risk in finance/economics, global problem of cities, global pandemics, global energy systems, climate change impact.
- Policy informatics, i.e. development of ICT tools to generate and better absorb the scientific evidence-base in the policy process and societal dialogue: computing platforms to simulate highly interconnected systems, data platforms and (mathematical) tools for analysis of (often unstructured) data and novel data visualization tools.
- Societal informatics, i.e. development of society/human-centred ICT tools to allow citizens to actively participate in the policy process, to collectively gather data and analyse evidence, and novel methods to better judge and use scientific evidence: e.g. games, gamification, and narratives to convey model results and present data.

Expected impact

Impact will be judged by

- Level to which research proposed is rooted in policy needs and will lead to results that are well beyond the state-of-the-art
- Level of use/uptake of GSS tools and methods in the selected policy areas by societal stakeholder and by policy makers, in particular by EC policy directorates
- Capacity of GSS to help integrate societal responses across policy domains by development of a system-wide integrated evidence base of data and models.

Instruments, funding level, budget: budget XX M€

Topic 10 Coordination and Support Activities

[TO BE REFINED STILL]

Specific Challenge

This objective groups all coordination and support activities under FET

Scope

- stimulate dialogue on emerging science and technology
- structuring emerging themes and communities at the European level
- enhance visibility of the results towards impact and innovation
- analysis for pathfinding future technological directions

Expected impact

- Establishing FET as a credible actor in the S&T landscape
- Impact on long-term innovation potential in Europe

Instruments, funding level, budget: budget XX M€

CSA, funding level: 100%, budget xxM€

Call FET-Flagships - tackling grand interdisciplinary science and technology challenges

FET Flagships are science-driven, large-scale, multidisciplinary research initiatives oriented towards a unifying goal, aiming at transformational impacts on science and technology and substantial benefits for European competitiveness and society. The goals of such initiatives are visionary and highly ambitious in terms of scientific challenges, resources required and coordinated efforts. They require cooperation among a range of disciplines, communities and programmes, extending over a long period (in the order of 10 years duration). FET Flagships are based on partnerships that enable effective coordination of efforts.

A call in 2013 (FP7-ICT-2013-FET-F) selected two FET flagships, Graphene and the Human Brain Project, which led to a ramp-up phase starting October 2013. The following objectives aim at supporting the continuation of the two initiatives after this ramp-up phase.

Topic 1: Graphene

Specific Challenge

Proposals should address the grand scientific challenge of the Graphene flagship, continuing the work of the ramp-up phase along the Common Research Roadmap. Proposals should be justified in terms of expected scientific advance, potential technological breakthroughs and socio-economic impact.

a) One project with a duration of 48 months ("Core Project"). Proposals should describe core research tasks, based on the common research roadmap, as well as how they establish and maintain a contractual framework for collaboration with other projects and initiatives based on the work done during the ramp-up phase. This framework needs to ensure a proper coordination and integration of all the research projects and initiatives that contribute to the FET Flagship. The governance to be put into place needs to ensure effective management and appropriate representation of stakeholders. Specific topics to be covered in the Core Project should include:

a. Further development and exploration of material aspects of Graphene, including synthesis protocols and adding new functionalities, as well as exploration of other 2D materials

b. Investigating health and environmental issues of Graphene and other 2D materials, including interactions with cells, effects in specific tissues, possible hazards, biostability and biodegradation and tests for possible regulation.

c. Progressing fundamental science for Graphene and other 2D materials, e.g. investigating fundamental limits for functional graphene nanostructures in electronics beyond CMOS, and the use of exfoliated TMDC in electronics.

d. Enabling the production of Graphene or Graphene film, including developing the technology for bulk production, bringing in customer requirements, and providing Graphene to other parts of the core project and to complementary projects.

e. Providing (i) the coordination of the flagship fleet of complementary EU funded projects, (ii) the governance of the wider flagship programme covering other projects and initiatives, and (iii) the collaboration of the programme with other initiatives or programmes in Europe, international or in other continents.

f. Ensuring the coverage of all the flagship activities, in the core and complementary projects, with activities fostering innovation, dissemination, ethics and societal aspects.

b) Projects that complement the Core Project ("Complementary Projects"). Proposals should be aligned with the Common Research Roadmap of the FET Flagship and contribute to the goals formulated in this roadmap and to the unifying goal of the Flagship. Consortia should engage in the Graphene Flagship contractual framework in case the proposal is selected for funding. Proposals

should demonstrate how they draw on and contribute to the activities set in place by the Flagship initiative.

Proposals should focus on one or more of the following indicative topics:

a. Development of high-frequency electronics, capable of significantly outperforming state-of-the-art technologies. This includes optimizing process technologies, developing new concepts, design and realization of graphene-based integrated circuits, standardisation and benchmarking.

b. Investigation of photonics and optoelectronics, based on graphene or other 2D materials, including photodetectors, graphene-based lasers, optical routing, opto-electronic networks, polarizers, isolators, etc.

c. Exploring use of graphene for spintronics and progress towards novel types of functional graphene spintronic devices, including for example studying induced magnetism, spin transport and spin relaxation, spin sensors and spin gating, and fabrication of devices.

d. Development of sensing devices based on graphene membranes

e. Investigating the use of graphene and other 2D materials in technologies aimed at flexible electronic devices and systems, including materials and fabrication process, flexible energy solutions, flexible RF electronics and wireless connectivity solutions, flexible sensors, flexible passive electronics and system-level platforms for flexible electronics.

f. Investigating energy applications of Graphene and other 2D materials in the context of different energy conversion and storage devices. This includes photovoltaics, energy storage, fuel cells, and H_2 storage.

g. Investigation and production of nanocomposites: transferring properties of graphene and other 2D materials to the meso-macroscopic level, and studying behaviour of graphene composites at the macro/micro/nanoscale.

h. Delivering innovation that enables the industrial exploitation of results of the Graphene flagship.

Scope

Proposals should describe how they will continue the existing work with the relevant disciplines and stakeholders, how resources brought together in the ramp-up phase will be used and/or strengthened, and how the new core project will provide efficient coordination under strong scientific leadership, in collaboration with related ERANET project(s) and other projects and initiatives at European, national and regional level.

Expected impact

- transformational impact on science and technology and substantial benefits for the European economy and society in the area of Graphene and other 2D materials
- European leadership in the area of Graphene and other 2D materials

- strengthening of the interfaces between ICT, material science and other disciplines
- realisation of the fully operational phase of the FET Flagship Graphene

Instruments, funding level, budget: budget XX M€

a): CP (one project only)

b): CP (around 4-6 projects)

Funding level: xx%, budget xxM€

Topic 2: Human Brain Project

Specific Challenge

Proposals should address the grand scientific challenge of the Human Bran Project flagship, continuing the work of the ramp-up phase along the Common Research Roadmap. Proposals should be justified in terms of expected scientific advance, potential technological breakthroughs and socio-economic impact.

a) One project with a duration of 48 months ("Core Project"). Proposals should describe core research tasks, based on the common research roadmap, as well as how they will establish and maintain a contractual framework for collaboration with other projects and initiatives based on the work done during the ramp-up phase. This framework needs to ensure a proper coordination and integration of all the research activities that contribute to the FET Flagship. The governance to be put into place needs to ensure effective management and appropriate representation of stakeholders. Specific topics to be covered in the Core Project should include:

a. Further development of the models, simulators and building tools for the brain simulation platform, regarding collaborative brain reconstruction and simulation, and enhancing them to cover the mouse brain.

b. Further development of the HPC platform, regarding middleware for remote visually guided interactive supercomputing; enhancement of the processing and memory capacity to support dynamic multi-scale brain model reconstruction and simulation.

c. Maintenance and availability of the 4 other HBP platforms' environment and architecture, in coordination with their further elaboration in complementary integrated projects.

d. Providing (i) the coordination of the flagship fleet of complementary IP projects, (ii) the governance of the wider flagship programme covering other projects and initiatives, and (iii) the collaboration of the programme with other initiatives or programmes in Europe, international or in other continents.

e. Ensuring the coverage of all the flagship activities, in the core and complementary EU funded projects, with activities fostering innovation, dissemination, ethics and societal aspects.

b) Projects that complement the Core Project ("Complementary Projects"). Proposals should be aligned with the Common Research Roadmap of the FET Flagship and contribute to the goals formulated in this roadmap and to the unifying goal of the Flagship. Consortia should engage in the Human Brain Project Flagship contractual framework in case the proposal is selected for funding. Proposals should demonstrate how they draw on and contribute to the activities set in place by the Flagship initiative.

Proposals should focus on one or more of the following indicative topics:

f. Data collection regarding the multi-level organisation of the mouse and human brains and further development of the neuroscience platform: pursue the high throughput screening of

the mouse brain and of the human brain; elaborate an internet accessible 3D mouse brain atlas and encyclopaedia; federate data and knowledge on the human brain.

g. Data collection regarding brain function and cognitive architectures: pursue the development of cognitive architectures from data obtained in new targeted experiments, to complement the human brain atlas on the neuroscience platform.

h. Mathematical and theoretical foundations of brain research: further develop theory for bridging scales and understanding regarding learning and memory; further elaborate large-scale models and principles of brain computation.

i. Medical Informatics Platform: further develop tools to derive unique signatures of brain diseases; federate clinical researchers, hospitals and industries regarding data sources and provide related tools including for search and analysis.

j. Neuromorphic Computing Platform: enhance the previously developed mouse brain-scale neuromorphic computing systems and experiment with the neuro-robotics platform; develop next neuromorphic computing systems at human brain-scale and for super real-time.

k. Neuro-robotics Platform: complement this collaborative platform with virtual prototypes of cognitive devices in relation to models derived from brain simulation / HPC / NMC platforms; develop capabilities at the level of the simulated mouse cognition and behaviour.

l. Future neuroscience applications: deliver convincing demonstrations of the brain models (simplified versions running on the neuro-robotics platform) regarding perception and action; experiment mechanisms and principles of cognition in the domain of spatial navigation and goal-oriented behaviour.

m. Future medicine applications: deliver convincing demonstrations on the brain simulation platform, regarding causation of neurological and psychiatric diseases, based on hypotheses from the signatures obtained on the medical informatics platform.

n. Future computing applications: deliver convincing demonstrations of the potential of brain-inspired approaches regarding development of future HPC (cores, communication, information), software, NM computers and devices, and robots.

o. Delivering innovation that enables the industrial exploitation of results of the HBP flagship.

i. flagship.

Scope

Proposals should describe how they will continue the existing work with the relevant disciplines and stakeholders, how resources brought together in the ramp-up phase will be used and/or strengthened, and how the new core project will provide efficient coordination under strong scientific leadership, in collaboration with related ERANET project(s) and other projects and initiatives at European, national and regional level.

Expected impact

- transformational impact on science and technology and substantial benefits for the European economy and society in the understanding of the human brain, including for example impacts on health and neuromorphic computing
- European leadership in the key focus areas of the Human Brain Project
- strengthening of the interfaces between ICT, neuroscience and other disciplines
- realisation of the fully operational phase of the FET Flagship Human Brain Project

Instruments, funding level, budget: budget XX M€

a): CP (one project only)

b): CP (around 4-6 projects)

Funding level: xx%, budget xxM€

Topic 3: Support to the FET Flagships

Specific Challenge

Proposals should support the FET Flagships and the FET Flagship concept through coordination with other on-going efforts, elaborating on the flagship concept and spotting additional opportunities for the two FET Flagships.

a) An ERA-NET between national and/or regional funding agencies aiming at supporting the FET Flagships Graphene and Human Brain Project. Proposals should build on the FET Flagship ERA-NET selected in 2013 (call FP7-ICT-2013-11) and should describe how they will coordinate national and/or regional efforts with the common research roadmap. Proposals should include a call for transnational projects to support the two flagship initiatives.

b) Coordination and Support Actions that explore the applicability of the Flagship concept to other grand scientific challenges in the context of national requirements and in view of their societal benefits, in particular through community events aimed at identifying such challenges and establishing how they bridge to innovation.

c) Coordination and Support Actions that complement the activities of the two flagships in areas such as outreach to a wider audience, including organising events for public debate, or activities related to innovation.

Scope

Proposals should describe how they will continue the existing work with the relevant disciplines and stakeholders, how resources brought together in the ramp-up phase will be used and/or strengthened, and how the new core project will provide efficient coordination under strong scientific leadership, in collaboration with related ERANET project(s) and other projects and initiatives at European, national and regional level.

Expected impact

a)

- enhanced complementarities and synergies of regional, national and European research programmes and initiatives
- networking between national funding agencies and creation of a discussion forum for matters of interest related to the two FET Flagships
- strengthening of the two flagship initiatives through transnational projects that complement the core and complementary projects in the areas of Graphene and Human Brain Project
- reduction of the fragmentation of the European Research Area (ERA)

b)

- Insights into potential applicability of Flagship concept in specific scientific areas, as well as possible bridging to technology, innovation and societal benefits.

c)

- Increased effectives of FET Flagships in areas such as outreach, stakeholder debate and exploitation.

Instruments, funding level, budget: budget XX M€

a): ERA-NET

b), c): CSA

Funding level: xx%, budget xxM€

Call High Performance Computing PPP – HPC towards exascale

The HPC strategy Communication "High Performance Computing: Europe's place in a Global Race"[1] highlights the strategic nature of HPC as a crucial asset for the EU's innovation capacity and outlines a strategy to ensure European leadership in the supply and use of HPC systems and services by 2020. The implementation of this HPC strategy combines three elements: (a) developing the next generation of HPC towards exascale; (b) providing access to the best supercomputing facilities and services; and (c) achieving excellence in HPC applications.

This call aims at the first element of the HPC strategy (i.e. the development of the next generation of HPC towards exascale computing technologies), leveraging the existing European strengths for building the next generation of extreme performance computing by 2020 and taking advantage of the new opportunities created from the transition from peta to exascale computing.

Scope

The goal is to achieve world-class extreme scale computing capabilities in platforms, technologies and applications, while ensuring that a broad spectrum of mid-range and entry-level HPC systems can be built using the targeted technologies in order to maximize the exploitation potential and develop a sustainable European HPC Ecosystem. The long-term impact will be the development of autonomous European capability for the definition and implementation of world-class Exascale systems.

Topic 1: Computing Platforms

Specific Challenge

The work aims at developing Exascale-capable architectures which are balanced at all levels (including e.g. CPU capabilities, memory bandwidth, interconnect performance) and functions (compute, I/O, failure recovery, etc), validated with the appropriate application drivers. Proposals should target the following architecture elements and their integration into HPC systems: CPU, memory, interconnects, heterogeneous architectures and packaging design.

Scope

Solutions developed should address the following issues:

- Energy efficiency: to be addressed at every level of the system stack design (including I/O). Gains in energy efficiency achieved by closer integration of the system components should be investigated.
- Scalability and locality: to be addressed as a multi-domain optimization problem, including issues such as for example low latency interconnects, latency hiding mechanisms, new communication concepts such as active messages and the integration of high-throughput memory with high performance compute logic.

[1] COM(2012)45 of 15.2.2012

- Resiliency: Solutions should demonstrate key contributions to maintaining and enhancing reliability, availability and serviceability of the total system as seen by the system operators and by end users. Issues to be addressed include amongst others energy-aware checkpoint/restart schemes leveraging new non-volatile memory technologies, error reporting scaling up to 1M threads, fault-prediction algorithms and tools enabling system operators to predict failure situations and conduct preventive maintenance, and flexible system configuration and re-configuration.

Topic 2: I/O Platforms

Specific Challenge

This sub-objective covers all elements of the I/O stack, from middleware to storage devices and aims at ensuring a good balance of performance between the capabilities of the compute elements of a system and the data storage system. Proposals should address the issues such as end to end performance utilisation and optimisation, energy efficiency, scalability, resilience and availability of I/O systems.

Scope

Special attention is given to:

- I/O system resiliency: addressing issues such as research on error propagation paths, impact of new memory/storage devices, improving application resiliency through concurrent and incremental checkpointing, etc.
- Improved storage hierarchy performance by integrating solid state devices (current and future block and byte addressable devices) into the caching and data consolidation layers, I/O servers and compute nodes including I/O middleware optimization.
- I/O system simulation and measurement: modelling and simulation of massive scale storage subsystems to predict the end-to-end-performance up to Exascale and enabling the rightsizing of any storage infrastructure.
- I/O in Networks: Research on high throughput low latency networking suitable for extreme scale, addressing issues such as distributed caching and pre-fetching in networks and leveraging high-level information on I/O patterns.

Topic 3: Interfaces and APIs for Future Extreme Scale Systems

Specific Challenge

New interfaces and APIs recognized by the HPC community are required to successfully face the important challenges of Exascale computing while ensuring interoperability and development of independent technologies. Communication and dissemination activities towards relevant standards bodies and research programmes and frameworks are fundamental components of the work. International cooperation aspects should be addressed if necessary in order to maximise the impact of the results.

Scope

Proposals should focus on interfaces or APIs in (at least) one of the following areas:

- I/O interfaces: For example, transparent application I/O patterns to optimise low-level I/O layers; controls to enable QoS provisioning of I/O; performance measurement APIs for I/O subsystems.
- Power / performance management APIs: APIs to monitor power consumption at high resolution and enable of auto-tuning of the system based on defined policies; interfaces to enable application level power/performance monitoring and improvement.
- Thermal management APIs: APIs to monitor thermal information at all the levels from the electronic components to the complete infrastructure.
- Resilience: APIs to exchange information between the different levels of the system (application, system management, node management) to manage the resiliency of the application.
- Hardware abstraction: For example, APIs to improve hardware abstraction in compilers, compiler features and debugging and performance tools; efficient APIs for run-time; APIs to support inter- and intra-node communication, thread management and explicit management of the memory and storage hierarchy, and APIs and driver level support for high performance debugging and application level performance optimization.

Topic 4: Programming Environment and Tools

Specific Challenge

This sub-objective addresses the HPC technology software stack lying between the applications software layer and the systems software and hardware layers.

Scope

Focus is on the following areas:

- Programming methodologies, environments and tools: development of new programming models, domain-specific languages and programming paradigms to facilitate the effective exploitation of advanced computing systems from large scale industrial systems to extreme scale systems. The measures of effectiveness include programming productivity, feasibility for incremental application migration, establishment of software standards, and performance in all aspects (computational, memory-use, I/O, energy requirements, etc). The programming tools work should address all aspects of effective exploitation by applications in particular at extreme-scale, and include (but not limited to) support for new programming models and annotations for legacy code, compilers and run-time systems; debugging and correctness tools, performance analysis and prediction, tuning and auto-tuning tools.
- Co-design: capture of requirements through application benchmarking and the development of mini-applications; support mechanisms to address resiliency, energy efficiency and energy management and I/O optimisation.

Topic 5: Coordination for the HPC strategy:

Specific Challenge

The aim is to support the implementation of a common European HPC strategy through coordination of the activities of stakeholders such as the European Technology Platform for HPC (HTP4HPC), PRACE, application owners and users, the European exascale computing research community etc. The work will include activities for promoting a joint community structuring and other non-research activities such as the development of Strategic Research Agenda for High Performance Computing (including the roadmap for exascale in Europe), the mapping and analysis of related national and international R&I programmes/activities/research agendas in HPC towards exascale, coordination with and participation in relevant international activities, etc.

Expected impact

Topics 1, 2, 3 and 4:

- Strengthened European industry and research in the supply, operation and use of HPC systems;
- Development of autonomous European technology for building the next generation of extreme performance computing and its exploitation in Europe
- Improved European competitiveness in applications that are most important for Europe.
- European research at the forefront of the development of extreme-performance system software and tools

Topic 1

- Platforms with clear and highly ambitious scalability targets (e.g. approaching 500 petaflop/s in 2016 - potential for exascale by 2020)
- Increased return on investments made in PRACE Tier-0 supercomputers and in on-going EC-supported efforts in exascale platforms

Topic 3

- Impact on standards bodies and other EU and international research programmes and frameworks

Topic 5

- Structuring the efforts of stakeholders for implementing the European HPC strategy
- Reinforced cooperation in international endeavours on HPC software and systems towards exascale

Instruments, funding level, budget: budget XX M€

a): CP, Funding level: 70%, Budget: xx million

b): CP, Funding level: 70%, Budget: xx million

c): CP, Funding level: 70%, Budget: xx million

d): CP, Funding level: 70%, Budget: xx million

e): CSA, funding level: 100%, Budget: xx million

Timing

The above topics to be called in 2014

Topic 6: System Management Software

Specific Challenge

In the coming years systems management software will become a critical component that controls and supervises the productivity, power consumption and resilience of supercomputers of growing scale and complexity, up to Exascale and beyond.

Scope

Proposals should focus in the following areas:

- Interconnect management: For example, adaptive and dynamic routing algorithms to create optimal traffic patterns, OS bypass to optimize and scale application requests, congestion and trouble-shooting diagnostics, power management of interconnect fabrics and NICs as well as scalable interconnect management tools.
- Cluster management: For example, innovative cluster management framework to scale to millions of components; on-the-fly monitoring models sharing data with programming tools and enabling a graphical supervision of Exascale dimensions; new event collecting and filtering techniques supporting fast growing scales; data mining, data analysis- on-the-fly and post mortem; flexible system-image configuration and management tools to compose, integrate and store system images.
- Resource management: For example, new approaches to resource management and job scheduling to cope with growing, complex and heterogeneous environments; new distributed management architectures and scheduling algorithms facilitating internal resource and job parallelization; integration of I/O criteria and workflow into the job scheduling, real-time data analysis and reduction integrated into HPC workflows and management/scheduling; multi-objective, adaptive scheduling and application interaction to deal with the highly dynamic and application dependent workload environment.

Topic 7: New HPC Usage Modes

Specific Challenge

The aim is to understand new trends in HPC usage models and applications driving them. This work will help shape research agendas in the full HPC stack such as tools, programming models, algorithms, user interfaces and H/W, since different usage and delivery models target different users, with widely different backgrounds and competencies.

Scope

Research should focus in the following areas:

- HPC for Big Data workloads, addressing Big Data workload characterizations and their impact in processor designs, run-time, OS and programming languages and tools; new methods in data migration and storage; highly dynamic, uncertain and streaming of data of unprecedented sizes and the impact in algorithms and systems; data standards enabling cross-disciplinary data processing and interoperability based on innovative data services (e.g. storage access, indexing, metadata, etc.)
- "HPC as an instrument" to achieve special goals that requires dedicated and specialized resources, e.g. catastrophe response, real time and interactive HPC data-driven use, etc.
- "Industrial Usage of HPC as a commodity" addressing the deployment and consumption of HPC solutions and results at an industrial scale and mode with a different usage charge model (i.e. as a standard commodity product like electricity).

Expected impact (topics 6 and 7)

- Strengthened European industry and research in the supply, operation and use of HPC systems;
- Development of autonomous European technology for building the next generation of extreme performance computing and its exploitation in Europe
- Improved European competitiveness in applications that are most important for Europe

Instruments, funding level, budget: budget XX M€

a): CP, Funding level: 70%, Budget: xx million

b): CP, Funding level: 70%, Budget: xx million

Timing

The above two topics to be called in 2015

B. OTHER ACTIONS (not subject to calls for proposals)

The International Human Frontier Science Programme Organisation

An annual subscription to the International Human Frontier Science Programme Organisation (HFSPO)[2] will be made. This will allow the EU (representing the EU27 – EU-G4) Member States to fully benefit from the Human Frontier Science Programme (HFSP) and provide increased visibility for European research. According to the conclusions of the Intergovernmental Conference held on 11 June 2013 the Community subscriptions for 2014 and 2015 will be EUR 4,847,281 and EUR 4,944,165, respectively.

C. PERSPECTIVES FOR 2016

(to be done)

[2] The European Community is a Management Support Party (member) of the HFSP Organisation (HFSPO) and has funded HFSP under previous Framework Programmes

2 Research Infrastructures

A. CALLS

Call: Development, deployment and operation of ICT-based e-infrastructures

e-Infrastructure is expected to support all other areas of Horizon 2020, including Societal Challenges, LEIT, FET and ESFRI, both in the general sense of providing the infrastructure needed for research and innovation in these areas, as well in the specific sense of production-level e-infrastructures servicing the computing and data needs of any project in the framework programme. Acquisition of ICT systems should be therefore avoided in H2020 projects to the extent that they can be adequately serviced by e-infrastructures.

This workprogramme is motivated by the following priorities:

- Integrating e-infrastructure resources and services across all layers (networking, computing, data, software, user interfaces), in order to provide seamless services tailored to user needs. Integration will be facilitated by agreeing and deploying common or interoperable core services and service building blocks, which is the main aim of Objective 4, by avoiding rigid boundaries between computing and data (e.g. in Objectives x, y, w and z), and by user-driven integration through VREs (Objective x) and through a user forum as requested in Objective x.
- Implementing the e-infrastructure to ride the wave of "big data", on the basis of the policy orientations provided by the High-Level Group on Scientific Data [ref] and the "framework for action" published on xxxxxx in xxxxx 2013. This is implemented through Objectives x, y, z...
- Providing support to the e-infrastructure for Open Access as defined in the Communication on Scientific Information, and for federating researcher electronic identities as defined in the ERA Communication. This refers to Objective 1.
- Implementing the e-infrastructure part of the EU strategy on High Performance Computing (HPC), in particular the provision of Tier-0 services (PRACE), the infrastructure for computing applications (Centres of Excellence) and a network of HPC Competence Centres for SMEs. This is reflected in Objectives x, y and z. A Public-Private Partnership (PPP) in HPC is expected to encompass in a coherent framework these two elements together with the development of HPC technologies towards exa-scale computing (supported in the FET part of the Excellent Science pillar).
- Implementing the recommendations of the GÉANT Expert Group aiming at developing GÉANT as the European communications commons and as a global hub for research, innovation and education, as described in Objective X.
- Addressing the 12 Strategic Programming priorities.

In addition, *innovation* is mainstreamed in all objectives that are relevant. This has several facets, e.g. opening the use of e-infrastructure to industry and SMEs as in Objective X; driving innovation by the very advanced needs of e-infrastructure as in the open research activity under GÉANT (Objective X); building partnerships between industry suppliers and e-infrastructure providers as in the case of data and compute clouds (Objective 2) or the PPP on HPC; encouraging the use of pre-commercial procurement (PCP) and public procurement for innovation (PPI); and systematising technology transfer from e-infrastructures to the market by launching a dedicated support action (see Objective X).

This work programme gives strong emphasis to the *development of human capital* especially in areas that suffer from shortages in supply or where new skills and professions need to emerge, e.g. in computational sciences, e-infrastructure operation or "data science". In addition to Objective X that is dedicated to education, training and skills, Objectives 5 (Data Services), 6 (Centres of Excellence), 9 (computing for SMEs) and 10 (VREs) are expected to develop strong activities in human capital, including through the use of Marie Curie fellowships where appropriate.

Software cuts across almost all Objectives with some sub-objectives being exclusively devoted to software, e.g. 6(a) on computing application codes or 2(6) on database software for extremely large datasets. All software to be developed under the programme needs to be open source with a "cc by" type of license, unless it can be well justified that it should be otherwise. Finding ways to mix commercial software from ISVs within service offerings is encouraged.

International cooperation is necessary to ensure that EU e-infrastructures are interoperable with those of 3rd countries and reach out to resources, facilities and human talent wherever these are located. International cooperation is therefore encouraged "bottom up", i.e. in any project proposal where proposers think that international partners should be involved. Furthermore, coordination and support actions are invited under Objective X and support to the Research Data Alliance is envisaged in Objective 3.

Governance and business models for e-infrastructures should aim at ensuring that a minimum level of service is available throughout the EU in order to avoid a *digital divide* between developed and less developed regions. The continuing use of structural funds from ERDF to build capacities and e-infrastructure at national level is greatly encouraged.

Clear business plans for *financial sustainability* are expected by all proposals. Business models may greatly vary depending on the service in question, from "government pays" to subscription-based, to "user-pays" or per-use payments. Income by national or European projects that want to buy services, or income by industry, is relevant in many cases and should be enabled. Sustainability of long term data preservation is a major challenge and difficult to contemplate without committed institutional funding. Partnering with the private sector is welcomed where appropriate.

All proposals are requested to suggest *clear metrics* (key performance indicators) for monitoring their results and impact.

Topic 1: e-Infrastructure for Open Access

Specific Challenge

The objective is to deliver a robust e-infrastructure supporting Open Access policies, including for Horizon 2020, based on already existing e-infrastructures (institutional and thematic repositories, aggregators, etc.). The infrastructure should support reliable and permanent access to digital scientific records. A key element will be capacity building to link literature and data in order to enable a more transparent evaluation of research and reproducibility of results.

Scope

Proposals should address all the following actions:

(1) Service-driven data e-infrastructures responding to general and specific requirements of researchers and research organisations for open access to and deposit of scientific information (including journal articles, books, monographs, conference proceedings, thesis, grey literature, software and data, as well as services linking literature, data and software). These e-infrastructures will further develop the research capacity through a coordinated and participatory architecture linking institutional and thematic repositories across Europe with scientific information to be used by humans and machines. An essential part of this service-driven approach will be researcher helpdesks designed to support the producers and users of scientific information, as well as human networks to support data sharing and implementation of Open Access policies in Europe. The e-infrastructure should be incorporated as a legal entity within the first year of the project.

(2) Developing proof of concept and prototyping new services in support of open science (e.g. new forms of publishing, innovative services based on data mining and new forms of peer review), assisting researchers and educators in everyday tasks. Proposals should consider barriers (including legal) to data sharing in the context of these new services.

(3) Supporting the global interoperability of open access data e-infrastructures and linking with similar platforms across the globe in order to complement the physical access to research facilities with data access and to ensure that Europe plays a leading role in international collaborations.

It is expected that one proposal will be selected spanning over 3 to 4 years.

Expected impact

The intellectual capital of Europe is available to researchers, business and citizens to generate economic and scientific advances now, and that capital is safely preserved for further exploitation by future generations. Open Access publications resulting from Horizon 2020 funded research are available and easily findable online. Accurate science metrics for Horizon 2020 can be produced with

almost no effort. Most of the European institutional repositories (at least 80%) as well as the principal thematic repositories are part of the same interoperable repository network.

Instruments, funding level, budget: budget XX M€

CP, CSA; funding level: 100%, Budget: 15 million

Timing

Call 2014

Topic 2: Managing, preserving and computing with big research data

Specific Challenge

The objective is to develop and deploy integrated, secure, permanent, on-demand service-driven and sustainable e-infrastructures. These e-infrastructures should incorporate advanced computing resources and software to increase the available capacity to manage, store and analyse extremely large, heterogeneous and complex datasets.

The e-infrastructures will provide services cutting across a wide-range of scientific communities in tiered or mesh architectures. Expected challenges are coping with different computational requirements, system and service architectures, formats, types, vocabularies and legacy practices of scientific communities that generate and use the data. Proposals are encouraged to leverage on prior work on open prototype services and to use discoverable service catalogues, common APIs, service-level agreements (SLAs) and transparent billing.

Scope

The proposals should address at least one of the first five (5) actions, or actions 6 or 7 individually:

(1) Establishing a federated pan-European data e-infrastructure to provide cost-effective and interoperable solutions for data management and long term preservation. The needs for data access, replication, annotation, search, compute, analysis and reuse of information across disciplines should be accommodated in different research and education contexts. All these functions should expose standard interfaces for interoperation with other data sources to aggregate them or to be aggregated. Sustainability is of paramount importance. Robust business models should be proposed to encourage investment from all stakeholders. Foreseen challenges are technical, legal and organisational;

(2) Services to ensure the quality and reliability of the data e-infrastructure, including certification mechanisms for repositories and certification services to test and benchmark capabilities in terms of resilience and service continuity of e-infrastructures;

(3) Federating institutional and, if possible, private data management and curation tools and services used across or at some point of the full data lifecycle. Addressing identification of open data sources and data collected with sensitive or restricted access features is foreseen as a challenge. Services and tools should be federated on the basis of an open architecture and should coordinatedly support Data Management Plans;

(4) Large scale virtualisation of data/compute centre resources to achieve on-demand compute capacities, improve flexibility for data analysis and avoid unnecessary costly large data transfers.

(5) Development and adoption of an open seamless stack that can be deployed on different hardware and e-infrastructures (such as clouds providing infrastructure-as-a-service (IaaS), HPC, grid infrastructures...) that abstracts application development from available remote computing systems.

This open stack should deliver PaaS adapted to the scientific community with a short learning curve. Adequate coordination and interoperability of existing e-infrastructures (including GÉANT, EGI, PRACE and others) is recommended

(6) Support to the evolution of EGI (European Grid Infrastructure) towards a flexible compute/data infrastructure capable of federating and enabling the sharing of resources of any kind (public or private, grid or cloud, etc.) in order to offer computing and storage services to the whole European scientific community. The proposal will address supply of cloud services (IaaS, PaaS, SaaS) at European level, service coordination, basic operations services (accounting, helpdesk, security etc.), engagement of new communities and dissemination activities.

(7) Proof of concept and prototypes of data infrastructure-enabling software (e.g. for databases and data mining) for extremely large or highly heterogeneous data sets scaling to zetabytes and trillion of objects. Clean slate approaches to data management targeting 2020+ "data factory" requirements of research communities and large scale facilities (e.g. ESFRI projects) are encouraged.

Expected impact

- Increased availability of scientific data for scientific communities independently of they having already embraced or not e-science.

- Better optimisation of the use of IT equipment for research.

- Avoiding lock-in to particular hardware or software platforms in the development of science.

- Long-tail scientific communities find more interesting the use of information technologies for storage and computing of results as the learning curve for embracing IT's state-of-art becomes smaller.

Instruments, funding level, budget: budget XX M€

CP, CSA, ERA-NET, PCP; Funding level: 100%, Budget: 45 million out of which max 10M€ for (6)

Timing

Call 2014

Topic 3: Towards global data e-infrastructures

Specific Challenge

The objective is to support the European contribution to the development and operation of global data infrastructures by strengthening and consolidating Europe's contribution to the Research Data Alliance (RDA) and ensuring that RDA serves its main aim, namely to foster research data interoperability at global level. RDA is an open international forum to create consensus on solutions and best practices to specific problems hampering data exchange and interoperability.

Scope

Actions will support all of following points:

(1) the definition, operation and monitoring of the governance structures of the Research Data Alliance (RDA); secondment and exchange of staff where appropriate;

(2) the active participation of European stakeholders (organisations and individual experts) in RDA and leadership initiatives in strategic working group activities; EU industry involvement and innovation will be promoted in particular;

(3) engaging scientific communities having underdeveloped data infrastructures in defining the best practices for data exchange and interoperability; and

(4) establishing the coordination mechanisms at European level (national research funders, European education and research associations) and with international organisations dealing with standardisation, research data and education issues (IETF, W3C, CODATA, OECD, UNESCO, ...).

Expected impact

Europe will be in a leading position lowering access to world's store of research data and supporting multi-disciplinary, data intensive global scientific collaborations. These collaborations are essential to tackle big societal challenges related with public health, energy, environment, education etc. It will help the development and adoption of relevant international open standards based on the best practices of a very large spectrum of research communities. It will engage research communities at early stages of standards development and address common data requirements for new services bringing together users and technology providers. It will promote sustainable models for research data sharing and install trust in the adopted solutions and promote usability of underlying data infrastructure technologies avoiding the divide between information-rich and information-poor communities

Instruments, funding level, budget: budget XX M€

CSA; funding level: 100%, Budget: 5 million

Timing

Call 2014

Topic 4: Integration of Core and Basic Operations Services for e-Infrastructures

Specific Challenge

The overall objectives are to:

(a) harmonise a set of core infrastructure services (data discovery, provenance, access, transfer, replication and searching and federated identity provisioning) for use by both production e-infrastructures and e-infrastructures under development to ensure that services are interworking and/or interoperable and therefore facilitate collaboration between scientists and provide seamless access to resources;

(b) make boundaries between data and compute services transparent to the user by integrating operations services such as accounting, monitoring, service registry, user support, incident management etc.

Provenance services for research data should supply digital identifiers (DIs) to enable persistent citation of digital objects, connect contents to authors and authors to their institutions, research projects and potentially any other relevant entity in the production value chain of scholarly content. DIs will open new prospects for advanced services for science and education and for encouraging openness and building trust.

The Authorisation and Authentication services should allow a European-wide single sign-on service enabling researchers to collaborate within secure and trusted distributed virtual research environments where scientific resources and content can be accessed, used, stored and shared.

Accounting services should include the implementation of standards (and their development if they do not exist) for enabling interoperability and aggregation in recording the usage of research resources securely and reliably.

Scope

The proposals will address one of the three following actions (only one proposal per action will be funded):

(1) Development and promotion of the uptake of a Digital Identifier e-infrastructure for digital objects (articles, datasets, collections, nomenclature, etc), contributors and authors which cuts across geographical, temporal, disciplinary, cultural, organizational and technological boundaries, without relying on a centralized system but rather federating locally operated systems to ensure interoperability. The requirements of all relevant stakeholder groups (researchers, libraries, data centres, publishers, etc.) will be addressed;

(2) Deployment and promotion of a pan-European identity federation for research communities including researchers, educators and students, in compliance with existing identity inter-federation efforts. This includes support for a large pilot involving (research and education) institutions in all EU

Member States that are ready to set up federations of identities through best-practice and expertise sharing in legal, technical, commercial and organisational issues. In order to increase trust in information resources, the supported infrastructure should include accounting functionality. Collaboration among e-Infrastructure providers and identity federation providers – including public sector - to overcome technical, organisational and legal obstacles for the implementation of an integrated and interoperable authentication and authorisation infrastructure is necessary. Prototypes using alternative methods of identification (e.g. social media identities) are encouraged.

(3) Coordination and support of a set of core infrastructure and operations services (other than those mentioned in the two previous actions) for use by both production e-infrastructures and e-infrastructures under development in order to ensure that services are interworking and/or interoperable. Providers of current authentication system should be targeted and support to users should be coordinated.

Expected impact

- Improved use of IT resources in e-infrastructures for e-science

- Common look and feel of e-infrastructures for science.

- Avoid duplication of efforts for services common to many e-infrastructures

Instruments, funding level, budget: budget XX M€

CP, CSA; Funding level: 100%, Budget: EUR 10 million; the intention is to fund one proposal in each of the above three actions where possible

Timing

Call 2014

Topic 5: Community data services

Specific Challenge

The objective is to deploy future-proof community-driven research data e-infrastructures (community "data networks") addressing societal challenges, e.g. Our Planet/Climate, Our Environment, Our Species, Our Oceans, Our Universe, Our Health, Our Education, Our Information. The e-infrastructure should provide reliable on-demand services (i.e. access, storage, preservation, discovery, analytics, compute, mash-up of interdisciplinary data) adapted to the specific requirements of broad research communities, where relevant in cooperation with other e-infrastructures. This requires adapting the service architectures to address requirements in terms of data volume, distribution, heterogeneity, discoverability processability, etc.; common open data and compute services with new ways of handling metadata - the descriptive information about the scientific attributes being studied – as well as the way to translate them; fostering cross-disciplinary data interoperability; and functions allowing data citation and promoting data sharing and trust.

Scope

Each project is expected to:

(1) Define the semantics, ontologies, the "what" metadata, as well as defining the best computing models and levels of abstraction (e.g. by means of open web services) to process the rich semantics at machine level (the so called "how" metadata). Support community efforts towards using and evolving open Web standards such as those related with Linked Open Data for data provisioning.

(2) Support proof of concept, prototyping and deployment of advanced data services and research and education environments. These environments should provide the "researcher, educator, student, librarian" a toolset and desktop with easy to use functionalities and access to top-of-the-range connectivity and computing.

(3) Engaging scientific and user communities to collaborate in building the common data e-infrastructures, as well as in education on data management, quality-control, sharing and reuse.

Expected impact

Researchers can today access on-line sources only in a small fraction of all research data produced. In the future the breadth and depth of data available will grow dramatically. Complexity and heterogeneity of data will also increase. Researcher's efficiency and productivity will rise by accessing data by means of reliable services and infrastructures for discoverability, access, use and reuse of data. A well designed data infrastructure will allow research communities to make economies of scale by adopting common approaches to data management lifecycle (data and metadata curation). It will promote trust in the data that is made accessible by embedding quality control practices avoiding data corruption.

Instruments, funding level, budget: budget XX M€

CP, CSA, ERA-NET; Funding level: 100%, Budget: 70 million

Timing

Call 2015

Topic 6: Centres of Excellence for computing applications

Specific Challenge

The overall objective is to establish a limited number of Centres of Excellence (CoE) for the application of HPC in scientific and industrial domains, focusing on scientific, industrial or societal challenges. These Centres will develop a culture of excellence, both scientific and industrial, placing computational science at the centre of scientific discovery and industrial competitiveness. CoEs may be "thematic", addressing specific application domains such as medicine, life science or energy; "transversal" on computational science (e.g. algorithms, analytics, numerical methods etc.); or "challenge-driven", addressing societal or industrial challenges (e.g. ageing, climate change, clean transport etc.); or a combination of these types.

This Objective contributes to the implementation of the EU strategy on High Performance Computing (HPC) to be carried out by the expected Public-Private Partnership (PPP) in HPC, in particular to achieving excellence in HPC application delivery and use.

Scope

The CoE's are expected to be:

(1) integrated: encompassing not only HPC software but also relevant aspects of hardware, data storage, connectivity, security, etc.;

(2) multidisciplinary: with domain expertise co-located alongside HPC system, software and algorithm expertise; and

(3) user-driven, with the application users and owners playing a decisive role in governance;

(4) distributed with a possible central hub, federating capabilities around Europe, exploiting available competences, and ensuring synergies with national/local programmes;

Proposals for CoEs will address:

o Provision of services such as:: developing, optimising (including if needed re-design) and scaling towards peta and exascale computing; testing, validating and maintaining HPC application codes and managing the associated data; quality assurance; co-design of hardware, software and codes; consultancy to industry and SMEs; research in HPC applications; and addressing the skills gap in computational science.

o Working in synergy with the other components of the PPP in HPC, (a) by associating their work with one or more PRACE supercomputing centres, or other HPC centres that have capacities to meet the computational needs for the activities of the CoE, and (b) by identifying suitable applications for co-design activities relevant to the development of HPC technologies towards exa-scale

o Sustainability embracing a wide range of service models and obtain funding from a mixture of sources, including through sponsorship by industry. Clear business plans need to be presented in the proposal.

o Creating communities around specific codes that impact the target sectors, involving ISVs where appropriate, and exchange of best practices in particular for SMEs

o A governance structure driven by the needs of the users. Commercial management expertise will be needed along with technical expertise to manage industry clients and supply chains.

8-10 CoEs are expected to be funded in this Objective in order to test the concept. A follow up Call is expected in the future that will build on the results and lessons learnt from the present Call.

Expected impact

Improved access to computing applications and expertise that enables researchers and industry to be more productive, leading to scientific excellence;

Improved competitiveness for companies and SMEs through access to CoE expertise and services;

European leadership in applications that address societal challenges or are important for industrial applications through better code performance and better code maintenance and availability;

More scientists and engineers trained in the use of computational methods and optimisation of applications.

Instruments, funding level, budget: budget XX M€

CP, CSA; Funding level: 100%, Budget: 50 million

Timing

Call 2014

Topic 7: PRACE

Specific Challenge

The overall objective is to pool and rationalise HPC resources in Europe in order to create a world-class infrastructure, and to provide state-of-the-art services and access to this infrastructure to users, independently of location.

This Objective contributes to the implementation of the EU strategy on High Performance Computing (HPC) to be carried out by the expected Public-Private Partnership (PPP) in HPC, in particular to providing access to the best supercomputing facilities and services for both industry and academia.

Scope

PRACE should address the following:

(1) Provide a seamless and efficient Tier-0 service to users Europe-wide based on promoting research excellence and innovation; this includes peer-review procedures for the allocation of computing time; transparent billing; and specific services adapted to the needs of ESFRI projects, Horizon 2020 projects/programmes, large institutional users or industry. Tier-0 are those services provided at pan-European level with machines devoted to PRACE more than 50% and having a minimal performance to be periodically defined by the PRACE consortium;

(2) Carry out activities (training, service prototyping, software development etc.) that build on national HPC capabilities (Tier-1) and are necessary to support Tier-0 services or a functional European HPC ecosystem;

(3) Ensure openness to new user communities and new applications;, promote industrial take-up of HPC services in particular by SMEs;

(4) Implement inclusive and equitable governance and a flexible business model to ensure long term financial sustainability; the business model should allow financial or in-kind contributions by research projects/programmes, institutions, industry and regions or countries;

(5) Develop and maintain the strategy for the deployment of a rich HPC ecosystem with different machine architectures - evolving towards exascale - including the implementation roadmap at EU and national level and the specifications and technical requirements for a varied set of Tier 0 systems ensuring a broad coverage of user needs;

(6) Working in synergy with the other two components of the PPP:

- with the Centres of Excellence (see previous Objective – CoEs for computing applications), to which the associated PRACE supercomputing centres will provide computational support and expertise;

- with the development of HPC technologies towards exa-scale funded under FET; PRACE will provide the technical specifications to guide the research activities for future exascale prototypes and systems expected to be deployed in the PRACE ecosystem;

(7) Design and execute training and skills development programmes tailored to the needs of research in academia and industry in order to stay at the forefront of scientific breakthroughs, as well as introduction of scientific computing and HPC in academic curricula;

(8) Develop an international cooperation policy and associated activities;

PRACE should provide core and basic services in coordination with other e-infrastructure providers to promote interoperability and a seamless user experience, in accordance with Objective 4. Interworking with other computing infrastructures such as clouds and grids should be ensured

Expected impact

- Improved services and procedures to access the PRACE infrastructure and common services, and improved allocation schemes to ensure openness to new user communities and applications

- Increased amount of computing cycles available to researchers at European level through user-friendly and efficient procedures, helping Europe to stay at the forefront of scientific breakthroughs and innovation;

- Increased number of industrial organisations (in particular SMEs), EU projects and institutional users benefiting from access to PRACE and from training in HPC;

- Increased investment in HPC infrastructure in Europe (national, regional and EU);

- Long term financial sustainability through flexible business models and inclusive governance;

- Linking demand and supply in the European HPC ecosystem, with improved collaboration of the PRACE procurers with technology developers and suppliers to foster innovation;

Instruments, funding level, budget: budget XX M€

CP (named beneficiary: PRACE); Funding level: 100%, Budget: 30 million

Timing

Call 2015

Topic 8: Network of Competence Centres for SMEs

Specific Challenge

The objective is to support one network of HPC competence centres to promote services anywhere in Europe and the dissemination of best practice in HPC use for SMEs.

This objective contributes to the implementation of the European HPC strategy, in particular to foster the use of HPC by SMEs. HPC competence centres have been set up in Member States to facilitate access of industry and in particular SMEs to HPC services.

The network will address coordination, outreach, training and the exchange of best practice and software components between the participating national and regional competence centres, complementing their current activities and services with actions of a clear European added-value that cannot be performed at local level. Direct support to adoption of HPC by specific SMEs is not expected to be carried out by this network.

Scope

Proposals should address at least the following actions:

(1) networking of existing HPC competence centres providing HPC services to exchange best practices and pool technical, expertise or business resources;

(2) awareness raising and visibility activities of the benefits of HPC for SMEs;

(3) identification of the pool of SMEs and available expertise in the different business areas at European level, and mechanisms to match SME needs and the available expertise;(4) training (in synergy with the activities carried out by PRACE and other organisations providing specific training for SMEs in HPC);

Expected impact

- The Network of HPC Competence Centres will be a reference for best practices for supporting SME competitiveness through access to HPC;

- Increased number of SMEs that are aware of the potential and/or become users of HPC;

- Establishment of a focal point at European level for expertise in HPC use by SMEs;

- Increase in the size of he HPC market (services, ISVs, computers).

Instruments, funding level, budget: budget XX M€

CSA; funding level: 100%, Budget: 3 million

Timing

Topic 9: GEANT

Specific Challenge

The overall objective is to create a European communications commons that supports the acceleration of compute- and data-intensive collaborative research and education through innovative services, operational excellence and global reach.

Scope

GÉANT will:

(1) Provide cost-effective and reliable services for very high-speed connectivity, identity federation, resource virtualisation, mobility and trust in order to support knowledge communities, ensuring digital continuum of services to users anywhere in the EU.

(2) Enable talent anywhere in the world to cooperate with their peers in Europe through interoperable services, as well as extend beyond the traditional researcher base into wider public services where appropriate.

(3) Advance the state-of-the-art of the communication commons by constant development of both innovative multi-domain services and their use, and by translating this innovation into a competitive European ICT sector, for instance through specific open calls, pre-commercial procurement or public-private partnerships between industry, academia and user communities; and exploring with industry possibilities of service provisioning through market aggregation and brokerage, new business models, best practices or coordination.

(4) Means to cope with the changing environment by structuring the governance of the European communications commons for accountability, measurability, transparency and sustainability; focusing on flexible services geared towards users; stimulating development of GÉANT's human capital (including training and exchange schemes); and aligning the regulatory, standardisation and policy framework to enable full exploitation of the communications commons.

GÉANT should provide core and basic operation services in coordination with other e-infrastructure providers to promote interoperability and a seamless user experience.

Expected impact

By 2020 GÉANT is the European communications commons where talent anywhere is able to collaborate with their peers around the world and have instantaneous and unlimited access to any resource for knowledge creation, innovation and learning, unconstrained by the barriers of the pre-digital and the present digital world. Europe is the hub for research networking excellence world-wide. The GÉANT governance is able to cope with the changing environment and the GÉANT community collaborates intensively with European industry and academia, produces innovative solutions grounded on business needs and drives the internet evolution.

Instruments, funding level, budget: budget XX M€

CP (named beneficiary)

The beneficiaries of the grant will be the legal entities operating the National Research and Education Networks (NRENs) in [list of countries] and the legal entities created by NRENs to contribute to the deployment of connectivity and services on a European scale (DANTE, TERENA and NORDUnet) formed as a consortium coordinated by DANTE, City House, 126-130 Hills Rd, Cambridge, UK.

Funding level: 100% re-imbursement rate for all costs including research and innovation in services, except 50% for procurement & operations (this needs a special clause – if not possible: - maximum 100% re-imbursement rate for all costs (and they will claim only 50% for communication by necessity as the funding is too low to cover all costs)

Budget: 100 million

Timing

Call 2015

Topic 10: e-Infrastructures for virtual research environments (VRE)

Specific Challenge

The objective is capacity building in interdisciplinary research communities to empower researchers through development and deployment of service-driven digital research environments and tools tailored to their specific needs. These virtual research environments (VRE) should integrate resources across all layers of the e-infrastructure (networking, computing, data, software, user interfaces).

Each VRE should abstract from the underlying e-infrastructures using standardised building blocks and workflows, well documented interfaces, in particular regarding APIs, and interoperable components. Over time VREs will be composed of generic services delivered by e-infrastructures and domain specific services co-developed and co-operated by researchers, technology and e-infrastructure providers, and possibly commercial vendors. The VRE projects should clearly identify and build on requirements, e.g. for integration of heterogeneous data from multiple sources and value-added services for computing, simulation, and data exploration, mining and visualisation. They should re-use tools and services from existing infrastructures and projects at national and/or Community level as appropriate.

VREs may target any area of science and technology, especially interdisciplinary ones, including ICT, web science and social sciences and humanities.

Scope

The proposals will address one or more of the following actions:

(1) Researcher-driven (bottom-up) integration of heterogeneous data from multiple data sources and providers, with a view to enhance interdisciplinary co-operation and enable e-infrastructure consolidation in broad domains of societal challenges.

(2) Validation in real-world use cases designed to serve the needs of interdisciplinary VREs.

(3) Development of value-added services stemming from researcher needs and which are made possible by open data access and digital innovations.

(4) Promotion of collaboration between research establishments and industry on e-infrastructures and support VREs to adopt innovative ICT tools and services.

Expected impact

VREs are expected to result in more effective collaboration between researchers and higher efficiency and creativity in research; accelerated innovation in research via an integrated access to potentially unlimited digital research resources, tools and services across disciplines and user communities; and enabling researchers to process structured and qualitative data in virtual and/or ubiquitous workspaces.

Instruments, funding level, budget: budget XX M€

CP, CSA; Funding level: 100%, Budget: 25 million

Timing

Call 2014

Topic 11: Policy development and international cooperation

Specific Challenge

The overall objective is to support the coordination of national and/or regional policies and programmes for e-infrastructures, to develop complementarities and cooperation between e-infrastructures and activities implementing other Union policies (such as regional, cohesion, industrial, health, employment, or development policy), and to ensure coordination between different Union funding sources to optimise e-infrastructures investments in Europe. The aim is also to facilitate the cooperation of European e-infrastructures with their non-European counterparts, ensuring their global interoperability and reach and potential technology transfer from projects.

Scope

Proposals will support one or more of the following actions:

(1) The dissemination of information on the e-infrastructure programme and project results, including project concertation;

(2) Stakeholder initiatives, including a user forum to provide orientations for e-infrastructure service interoperability and integration;

(3) Policy coordination with the major national and European policy makers, including the collection of information needed for policy making e.g. through consultation actions and surveys;

(4) Support to monitoring results and impact of the Horizon 2020 e-infrastructure activities, including through metrics and indicators;

(5) Support to technology transfer from the e-infrastructures projects to the market;

(6) Support to international cooperation with developing countries and regions in terms of connectivity, services, use cases and applications.

Expected impact

A consistent and dynamic European policy for research infrastructures is developed and is coordinated EU-wide. Support actions provide solid ground for future choices and help in decision making and deployment of e-infrastructures. Impact and results analysis is available in real time and can inform policy choices. Novel technology and services with market potential is identified and span off to the market. Support measures for international cooperation address specific issues regarding reciprocal use, openness or co-financing of e-infrastructures, as well as ensure Europe's persistent presence and influence in the global e-infrastructure.

Instruments, funding level, budget: budget XX M€

CSA; Funding level: 100%, Budget: 5 million

Timing

Call 2014

Topic 12: Skills and new professions for e-infrastructures

Specific Challenge

The changing methods of (digital) science and research require that researchers, professors and students receive adequate support in computing and networking, as well as in handling, analysing and storing large amounts of data and content. This is the emerging profession of the so-called "research technologists" for which formal education hardly exists today. Professional recognition of this community and the development of appropriate curricula, training and skills are crucial to ensure effective services to institution staff and students.

Scope

Proposals should address one or more of the following actions (proposals addressing action 3 should preferably address also 4 and vice versa):

(1) Defining or updating university curricula and sharing best practices across Europe notably for research technologists and data scientists.

(2) Developing training programmes (including lifelong learning) for research technologists, e-science practitioners and data librarians working as part of a team of researchers or in supporting research teams; this should include the use of e-education and videoconferencing tools and sharing of educational contents for e-infrastructures.

(3) Support the communities of scientists specialised in e-infrastructures and ICT specialists operating e-infrastructures at campus, national and European level through: information sharing (e.g. authoring case studies and success stories), information on training programmes, specific events, incentives for innovation, and staff exchanges.

(4) Awareness raising activities on e-infrastructures and the role of Research Technologist for the wider researcher and student community in all scientific fields.

Expected impact

The number of high level education institutions offering degrees for research technologists and data scientists will double. Graduates and practitioners in these fields have access to degrees, programmes and information sharing tools to improve their skills. The majority of European researchers have access to training on e-infrastructures if they have the need to develop related skills.

Instruments, funding level, budget: budget XX M€

CP, CSA, ERA-NET; Funding level: 100%, Budget: 3 million

Timing

Call 2015

B. OTHER ACTIONS (not subject to calls for proposals)

C. PERSPECTIVES FOR 2016

(to be done)