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COUNCIL DECISION ESTABLISHING THE SPECIFIC PROGRAMME IMPLEMENTING HORIZON 2020 - THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION (2014-2020)

WORK PROGRAMME 2014 – 2015

2. Future and Emerging Technologies

V2.9 of 17/09/2013

INFORMAL DRAFT DISCUSSION DOCUMENT

Important notice:
The present document is meant to facilitate the discussions towards the preparation of the work programme 2014 – 2015. It does not at this stage cover all relevant aspects and it does not prejudge the outcome of the on-going interinstitutional negotiations on Horizon 2020 or internal work on cross-cutting aspects. Hence, it remains subject to change. Information, such as indicative budgets per call/area, will be provided at later stage.

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Introduction to Future and Emerging Technologies

The mission of Future and Emerging Technologies (FET) is to turn Europe's excellent science base into a competitive advantage by uncovering radically new technological possibilities through unexplored collaborations between advanced science and cutting-edge engineering. It will help Europe to grasp leadership early on in those future technology areas that promise to renew the basis for future European competitiveness and growth and that will make a difference for society in the decades to come. FET actions will help to create in Europe a fertile ground for responsible and dynamic multi-disciplinary collaborations on future and emerging technologies and for kick-starting new European research and innovation eco-systems around them. They will be the seeds for future industrial leadership and for tackling society's grand challenges.

In order to succeed in this mission FET promotes research beyond what is known, accepted or widely adopted and supports novel and visionary thinking to open promising paths towards powerful new technologies. The supported research will be interdisciplinary and positioned between research driven by science and research driven by societal challenges or by industrial competitiveness, bringing closer science and engineering. It will contribute to accelerating the transition from upstream research to technology development.

FET has three main lines of activity that contribute, each in their own way, to a variety of societal challenges and areas of future industrial leadership.

- **FET Open** supports early-stage joint science and technology research around new ideas for radically new future technologies. It will build up a diverse portfolio of targeted projects to explore a wide range of new technological possibilities, inspired by cutting-edge science, unconventional collaborations or new research and innovation practices. Early detection of promising new areas, developments and trends, along with attracting new bold-visioned and high-potential research and innovation players will be key. FET-Open will represent 40% of the overall FET budget in Horizon 2020.
- **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. Through this line of activity FET engages in the coordinated exploration of a new theme, as well as in the consolidation of promising future technologies to be taken up by industry and society. Under its proactive calls the present workprogramme supports two themes (***H2020-FETPROACT)*** selected from a bottom-up consultation (see 'FET Observatory'[1]) and a third one (***H2020-FETHPC***) implementing part of the HPC strategy elaborated in the context of the HPC Public-Private Partnership by ETP4HPC[2].
    - **Global Systems Science** (GSS) aims to radically improve the way in which 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. This is a highly interdisciplinary theme with strong policy impacts.
    - **'Knowing, doing and being: cognition beyond problem solving'** aims at renewing ties between the different disciplines studying knowledge, cognition

[1] http://cordis.europa.eu/fp7/ict/fet-proactive/fetconsult2012-topics_en.html

[2] http://www.etp4hpc.eu

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), to artificial cognitive systems beyond the level of dull task execution or problem solving. This topic has been selected for its potential to boost future innovation potential in robotics, materials and cyber-physical systems.

    - **'Towards exascale high-performance computing'** is the science and technology building block of Europe's trailblazing initiative to achieve world-class extreme scale computing capabilities in terms of platforms, technologies and applications.

- **FET Flagships** support ambitious large-scale, science-driven research aimed at grand interdisciplinary S&T challenges. Such activities require and 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. The present workprogramme continues to support and to further develop two FET flagships (call ***H2020-FETFLAG***):

    - The **Graphene** flagship pushes the science and technologies for a new class of material beyond the era of silicon, bringing graphene and related 2D-materials, from academic labs to industry, manufacturing and society.

    - **Human Brain Project** (HBP) aims to simulate and better understand the Human Brain in order to develop new diagnostic tools and treatments for brain diseases, as well as new classes of low-energy technologies with brain-like intelligence, such as neuromorphic computing.

FET aims at shaping the future technology landscape and European thought-leadership on new and emerging technologies. The combination of a bottom-up spirit and a broadly based participatory agenda-setting assures that FET explores radically new avenues while remaining sensitive to future needs from industry and society. By promoting interdisciplinary collaboration that go well beyond the strictly technological and 'hard' scientific disciplines, FET promotes dialogue and cooperation between science, industry, citizens and policy makers on how to turn new technological possibilities into an opportunity for industry and a benefit for society. This will boost long-term innovation potential in Europe both from the abundance of novel ideas and the actors ready to take them forward.

The silo-breaking research collaborations in FET will also improve readiness across Europe to take up new research and innovation practices for making leading-edge science and technology research more open, creative and closer to society, especially through 'digital science', promoting for instance open scientific data, advanced simulation, and the use of tools for open collaboration or for better involvement of the general public in research. These are essential tools for building operational links between science, technology, innovation and society, as well as across disciplines, so that even the most advanced results can find their way to stimulate industrial leadership and for addressing societal challenges.

FET research is well placed for global collaborations that can raise the level of excellence and accelerate the impact from global alliances. Thus, participation of excellent non EU partners in FET activities, whenever necessary and essential, is welcome.

Projects funded under the Future and Emerging Technologies Work Programme 2014-15 will participate in the Pilot on Open Research Data in Horizon 2020. In particular, unless it goes against their legitimate commercial interests, beneficiaries will be required to deposit certain types of research data and metadata into a data repository of their choice, and to take measures to make it possible for third parties to access, mine, exploit, reproduce and

disseminate the deposited data and metadata free of charge. Further information on the Open Research Data Pilot can be found here: *[link to the future Guidelines on Open Access in Horizon 2020]*.

A. Calls

Call FET-Open –novel ideas

H2020-FETOPEN-2014/2015

This call aims to support early-stage joint science and technology research for radically new future technological possibilities. The call is entirely non-prescriptive with regards to the nature or purpose of the technologies that are envisaged and thus targets mainly the unexpected. A bottom-up selection process will build up a diverse portfolio of projects. In order to identify and seize opportunities of long-term benefit for citizens, the economy and society, the early detection of promising new areas, developments and trends, wherever they come from, will be essential. The call also seeks for coordination and support activities to turn Europe into the best place in the world for responsible collaborative research on future and emerging technologies that will make a difference for society in the decades to come.

FETOPEN 1: FET-Open research projects

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. Nurturing fragile ideas requires an agile, risk-friendly and highly interdisciplinary research approach. Recognising and stimulating the driving role 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 technology-enabled possibilities that are far beyond the state of the art and currently not anticipated by technology roadmaps.
- **Breakthrough S&T target**: research targets scientifically ambitious and technologically concrete breakthroughs 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 line of technology not currently anticipated.
- **High-risk**: the potential of a new technological direction depends on a whole range of factors that cannot be apprehended from a single disciplinary viewpoint. Thus, this high-risk has to be countered by novel concepts and ideas, and by a strongly interdisciplinary research approach, where needed expanding well 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 joint science- and technology research, and that they aim to advance different scientific and technological disciplines together and in synergy towards a breakthrough.

This call is open to early-stage research on any new technological possibility. Topics resulting from the recent broad bottom-up search for new ideas (see 'FET Observatory') can also inspire new interdisciplinary partnerships and proposal submissions[3].

Expected impact: Projects will aim at one of the following two impacts:

- Initiating a radically new line of technology by establishing Proof-of-Principle of a new technological possibility, together with its scientific basis, or
- Kick-starting an emerging innovation eco-system of high-potential actors around a solid baseline of feasibility and potential for a new technological option, ready for early take-up.

The active involvement of new and high-potential research and innovation players, which may become the European scientific and technological leaders of the future, is encouraged. Impact is also sought in terms of take up of new research and innovation practices (especially those driven by advanced developments in information and communication technology - digital science) and, more generally, from making leading-edge science and technology research more open, collaborative, creative and closer to society.

Type of action: Research and Innovation Action (100% funding)

FETOPEN 2: Coordination and Support Activities

Specific challenge: The challenge is to make Europe the best place in the world for collaborative research on future and emerging technologies that will renew the basis for future European competitiveness and growth, and that will make a difference for society in the decades to come.

Scope: Activities should address at least one of the following topics:

- stimulating exchange on interdisciplinary research for future technologies by involving and bringing together through dedicated events or otherwise a broad range of actors in research and innovation, including young researchers, citizens, educators, entrepreneurs and high-tech SMEs;
- facilitating broad dialogue on emerging sciences and technologies, and their relevance for, and potential impacts on, citizens and society;
- structuring emerging themes and the relevant interdisciplinary communities, expanding well beyond the purely technical realms, at the European level, and establishing links with related international initiatives;
- identifying and pathfinding promising future directions for science and technology research;
- supporting take-up of new research methods and practices, for instance to improve interdisciplinary synergies (including with the social sciences and humanities) or for citizen participation;
- enhancing visibility and stimulating appropriation and take-up of FET research towards impact and innovation, especially in ways not anticipated by the projects, for instance

[3] Time for Time, Constructive symbiosis, Bottom-up intelligent construction, Ecological technology, New possibilities at the nano-bio-chem interface, Nano-optomechanical technologies, Quantum technologies (see http://cordis.europa.eu/fp7/ict/fet-proactive/fetconsult2012-topics_en.html)

using new media and artistic channels or targeting new audiences (e.g. for development);
- assessment of direct and indirect impacts of FET research on the science and technology landscape and the perception of these by individuals and society;

Expected impact:

- European thought-leadership on new and emerging technologies with a strong engagement of scientists, citizens, innovators and policy makers.
- Improved long-term innovation potential in Europe both from the abundance of novel ideas and the actors ready to take them forward.
- Improved readiness across Europe to engage in silo-breaking research collaboration and to take up new research and innovation practices.
- Improved understanding of impact mechanisms for long-term science and technology research.

Type of action: Coordination and Support Action (100% funding)

Call FET Proactive –emerging themes and communities

H2020-FETPROACT-2014/2015

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 to jointly explore possibilities for, and long-term implications of future technologies that matter.

FET Proactive initiatives have one of the following strategic objectives:

- An **exploratory** initiative explores a variety of directions and builds up a pool of knowledge and new research alliances around promising emerging themes. This will encourage new inter-disciplinary collaborations around a new area or theme, sifting through a wide range of options in order to get a better understanding of which ones may be the more promising directions towards future technologies.
- A **delivery** initiative aims at translating science into concrete technological directions by projects that build on proofs-of-concept and that want to take them to a next level of development. This will consolidate a technological direction within an emerging ecosystem of science and innovation actors

Three proactive initiatives will be funded under this Call:

A. Global Systems Science (GSS)
B. Knowing, doing, being: cognition beyond problem solving
C. Towards exascale high performance computing

The third initiative implements, through a separate call (***H2020-FETHPC***), part of the HPC strategy elaborated in the context of the HPC Public-Private Partnership by ETP4HPC.

FETPROACT 1 - 2014: 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, social science and humanities, 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.

Type of action: Research and Innovation Action (100% funding)

FETPROACT 2 - 2014: Knowing, doing, being: cognition beyond problem solving

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 or problem solving.

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, multi-robot systems or unconventional robot shapes.
- Integrative studies of knowing, thinking, doing and being that bridge between low-level (e.g., neuronal, physiological) and high-level (e.g., belief, intention, identity) descriptions. These multidisciplinary studies are expected to go well beyond addressing the perception-action loop, and to tackle issues such as 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 non-performative aspects of social robotics, development and interaction in mixed human/technological settings.
- Improved understanding of the impacts of the technologically enhanced environments on the human behaviour, at the individual and collective levels
- Understanding the origins and development of synergies and divides in socio/technical contexts and ways to influence them.

Type of action: Research and Innovation Action (100% funding)

Call FET-Proactive - towards exascale high performance computing

H2020-FETHPC-2014

High Performance Computing (HPC) is a crucial asset for Europe's innovation capacity and is of strategic importance to its scientific and industrial capabilities, as well as to its citizens. The European strategy in HPC aims at ensuring European leadership in the supply and use of HPC systems and services by 2020. The implementation of this HPC strategy in Horizon 2020 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. A Public Private Partnership (PPP) with the European Technology Platform in HPC (ETP4HPC) (establishment expected by the end of 2013) will provide, throughout Horizon 2020, the framework for the implementation of elements (a) and (c) of the evolving HPC strategy, based on the Strategy Research Agenda (SRA) of the ETP4HPC[4].

The focus of this proactive call is on element (a) of the HPC strategy and the research and development for advanced applications and co-design of element (c). The support for elements (b) and the infrastructure aspects of HPC applications in element (c) of the strategy will be provided by the e-Infrastructure part of the Excellent Science pillar.

This calls aims at 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.

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.

This activity will be coordinated with complementary work in LEIT/Advanced Computing, LEIT/Photonics, and ECSEL (Electronic Components and Systems for European) that will develop basic system technology that is relevant to the needs of exascale computing (e.g. microprocessors, photonics components, interconnects or system software, programming environments for critical/real time systems, etc.).

FETHPC 1 - 2014: HPC Core Technologies, Programming Environments and Algorithms for Extreme Parallelism and Extreme Data Applications

Specific challenge: The challenge is to achieve, by 2020, the full range of technological capabilities needed for delivering a broad spectrum of HPC systems, from extreme-scale HPC systems, to extremely efficient, innovative and competitive mid-range and entry-level systems for the broader HPC market (which includes, for instance, highly demanding embedded and distributed systems). The designs of these systems will need to respond to critical demands of energy efficiency, new delivery models, as well as to the requirements of new types of applications, including extreme-data applications. New methodologies, environments and tools for extremely-parallel and data-intensive programming are needed to achieve code quality and portability, reduce software development and maintenance costs while maximally

[4] See http://www.etp4hpc.eu/strategy/strategic-research-agenda/

exploiting underlying system capabilities (e.g., exploiting millions of cores in an energy-aware way). New mathematics and new algorithms will be needed for ultra-scalable algorithms with predictable performance for existing or visionary applications, including data-intensive and extreme data applications.

Scope: Proposals should target at least one of the following topics:

a) **HPC core technologies and architectures,** addressing one or more of the HPC core technologies (processors, memory, interconnect and storage) and their optimal integration into HPC systems, platforms and prototypes. Projects should have a co-design approach driven by ambitious applications and aiming at radical overall system performance improvement while at the same time addressing issues such as: a holistic understanding of energy efficiency across the full HPC system architecture; I/O, storage and data-throughput capabilities especially for big-data applications; radical scalability, concurrency, locality and resilience in the presence of millions of cores.

b) **Programming methodologies, environments and tools**: development of new programming models, domain-specific languages and programming paradigms to facilitate the effective exploitation of the full system capabilities (including energy management) of the emerging large- and extreme scale systems, in particular for extreme parallelism and extreme data applications.

c) **APIs for Future Extreme Scale Systems and exascale stack**: New APIs and the corresponding efficient, flexible and scalable exascale system software for managing extreme scale systems, taking into account extreme parallelism, extreme data, energy consumption and resilience. Projects are expected to include communication and dissemination activities towards relevant standards bodies and research programmes. It is expected that proposals on this point have the critical mass, if necessary beyond Europe, to strategically coordinate the API work in the exascale stack.

d) **New mathematical and algorithmic approaches** for existing or emerging applications on extreme scale systems. Work should include energy-aware algorithms and maximally exploit the projected characteristics of exascale-class systems. Specific issues are quantification of uncertainty and noise, multiscale and extreme data. Software engineering for extreme parallelism should be addressed. Open source development is privileged.

Expected impact:

- Contribution to the realisation of the ETP4HPC Strategic Research Agenda, thus strengthened European research and industrial leadership in the full range of HPC technologies.
- Covering wide segments of the future HPC market, from extreme-scale HPC systems, to extremely efficient, innovative and competitive mid-range and entry-level systems for the broader HPC market.
- Impact on standards bodies and other relevant international research programmes and frameworks.
- European excellence in mathematics and algorithms for extreme parallelism and extreme data applications.

Type of action: Research and Innovation Action (100% funding). A minimum of 60% of the available budget will be allocated to research under part a) of the scope.

FETHPC 2 - 2014: HPC Ecosystem Development

Specific challenge: to develop a sustainable European HPC Ecosystem

Scope:

a) **Coordination of the HPC strategy**: 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 (ETP4HPC), PRACE, application owners and users (including emerging HPC applications), the European exascale computing research community, the open source HPC community, etc. The work will include activities for promoting a joint community structuring and synchronisation as well as other non-research activities such as the development of Strategic Research Agenda for High Performance Computing (including the roadmap for exascale in Europe), the link to the H2020 Societal Challenges, 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. Specific actions for attracting young talent into HPC should be included.

b) **Excellence in High Performance Computer Architecture**: The aim is to prepare the establishment of a virtual distributed European Research Centre in High Performance Computer Architecture. Excellence of participating teams is of crucial importance. Specific long-term research topics should be put forward as well as ways of performing research in these topics and harmonising computer architecture curricula. Activities to strengthen links to venture capital and promoting entrepreneurship should be included.

Expected impact:

- Strengthened European research and industrial leadership in the supply, operation and use of HPC systems;
- Contribution to the realisation of the ETP4HPC Strategic Research Agenda
- Development of competitive European technology for building and exploiting a wide range of next-generation extreme performance computing systems.
- Structuring the efforts of stakeholders for implementing the European HPC strategy
- Reinforced cooperation in international endeavours on HPC software and systems towards exascale
- European Excellence in High Performance Computer Architecture

Type of action: Coordination and Support Action (100% funding)

FETHPC 3 - 2014: Targeted Opening with Russia

Specific challenge: Collaboration with Russia on mathematics and algorithmic as well as on common HPC programming interfaces and interoperability of tools.

Scope: Research work should cover one or more of the following areas:

- New mathematical and algorithmic approaches for existing or emerging applications for extreme scale systems
- Programming models and APIs for extreme scale systems
- Development of common tools for extreme scale systems

Expected impact:

- Alignment of research in mathematics and algorithms for extreme parallelism and extreme data with Russia
- HPC tools interoperability with Russia

Type of action: Research and Innovation Action (100% funding)

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

H2020-FETFLAG-2014-2015

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 that require cooperation among a range of disciplines, communities and national, regional and European programmes. FET Flagships require partnerships extending over a long period (in the order of 10 years duration) that enable effective coordination of efforts.

The FET Flagships are expected to provide European leadership in their domains. They should lead to a more efficient ERA, reducing fragmentation and optimising complementarities between EU and national programmes. They should aim, therefore, at establishing a closer link with similar activities at national and regional level and at ensuring a proper coordination and integration of all the research activities that contribute to the Flagship.

The selection of the FET Flagships has been carried out through a competitive process driven by scientific excellence that was initiated after the Commission's communication "Moving the ICT Frontiers"5. This has resulted in the final selection of two FET Flagships through a call in 2013 (FP7-ICT-2013), namely Graphene and the Human Brain Project. A first project funded by the EU, bringing together the best brains in Europe, has been launched for each Flagship in October 2013, with the aim of building up the initiative during a ramp-up phase which lasts until spring 2016.

The **Graphene** FET Flagship constitutes a major effort of Europe to achieve a leading position in this scientific field and in related technologies with great potential for future industrial applications. It will exploit the properties of Graphene, a revolutionary carbon-based material which has the potential to become the wonder material of the 21st century, finding its way to a vast range of applications from electronics to ultra-lightweight materials for aeronautics, super capacitors for energy applications and artificial retinas. The initial consortium consists of 75 research organisations and industrial partners from 17 EU Member States and Associated Countries, with 136 principal investigators, among which 4 Nobel laureates. Graphene builds on existing national research programmes in the area of Graphene, which show a rapid increasing in funding (in the order of 50M euro in 2012). More details about Graphene and the research roadmap can be found at http://www.graphene-flagship.eu.

The goal of the **Human Brain Project** (HBP) is to combine all existing knowledge about the human brain and to reconstruct it in supercomputer-based models and simulations. The models will offer the prospect of a new understanding of the human brain and its diseases and of completely new computing technologies. The initiative will produce brain-inspired 'neuromorphic' computing systems with revolutionary properties, including resilience and drastically reduced power-consumption and costs. In response to the urgent need in healthcare to combat brain disease and its associated costs to society, HBP will identify new drug targets and test personalised treatment through simulation. The initial consortium involves 80

[5] COM(2009) 184

European and international institutions from more than 22 countries. More details about HBP and the research roadmap can be found at http://www.humanbrainproject.eu/.

The Graphene and Human Brain Project FET Flagships will establish large-scale long-term European partnerships. They complement the public-private partnerships (PPPs)6 as they are science-driven at the outset, while the industrial participation will build up over the ten-year duration of the Flagships. The partnerships between the EC and the institutions involved in the Flagships will be formalised through a Framework Partnership Agreement7. Within this framework, the EC will organise calls in view of establishing specific grant agreements to support the Flagships. The overall EC contribution to each Flagship initiative in Horizon 2020 is expected to be around 50 M€/year, subject to budget availability and performance of the action. An ERANET project ("FLAG-ERA", call FP7-ICT-2013-11) involving national and regional funding agencies aiming at support to the two FET Flagships has been launched in 2013, providing a basis for calls for complementary transnational projects and for strengthening the synergies with national funding programmes. A call inviting for a follow-up to this ERANET project is foreseen for 2016.

The topics in this call are aimed at ensuring the continuation of the two initiatives after the ramp-up phase:

- Establishing a Framework Partnership Agreement with each of the two Flagships (topic 1)
- Providing EU support through a core project to each of the two Flagships (topic 2 and 3)
- Providing EU support for policy development actions for FET Flagship (topic 4).

FETFLAG 1 - 2014: Framework Partnership Agreement

Specific challenge: The objective is to establish, for each of the FET Flagships, a structured partnership between the EC and the Flagship partners who commit themselves to establish, maintain and implement the strategic research agenda of the flagship. These partnerships will be based on a Framework Partnership Agreement (FPA).

The consortia responding to the call may include research institutes, universities, foundations, industry, SMEs as well as other organisations that can play a role in the realisation of the Flagships. These consortia will have a substantial autonomy and are expected to define their own internal organisation, e.g. through an independent legal entity. In this way they should be able to provide the required coherence, integration and leadership, consolidate and formalize the relation between consortium members, organise and administer the initiative, maintain the research roadmap and monitor progress, ensure collaboration with projects funded from different sources and create links with relevant external initiatives.

The Framework Partnership Agreement will set out:

- The general and specific objectives of the partnership;
- The commitments made by the participants in the Flagship, which would be complementary to EU/national contributions;
- The key performance indicators and the expected results, including the impacts in terms of exploitation in Europe;

[6] COM(2013) 4942

[7] Commission Delegated Regulation (EU) No 1268/2012 of 29 October 2012, Article 178

- A monitoring and review mechanism, using these key performance indicators and with a possibility for adjustment. This will also provide the basis for the Commission to terminate a partnership in case the parties fall short on their commitments;
- The indicative financial envelope for the Union contribution for the period 2014-2020 (subject to approval by the Budgetary Authority through the annual budgetary procedure);
- The governance structure, including the mechanism by which the Commission will seek advice from the Flagship participants on the research and innovation activities to be proposed for financial support under Horizon 2020.
- Provisions for evolution of the consortium.

Scope: The proposal is expected to include key elements of the FPA, such as

- The proposed consortium and how it maps into the Flagship's scientific objectives and research roadmap
- The proposed organisational structure, how this would be governed and managed and how this would enable the achievement of the objectives of the Flagship
- Provision of or access to resources provided through the consortium
- Key performance indicators that measure progress towards the expected results
- The way the consortium will foster complementarities, foster synergies and enhance the overall outcome of regional, national, European and international research programmes
- The way the consortium addresses ethical and legal issues
- The ability of the consortium to seize exploitation opportunities

Expected impact:

- Stable and structured environment for the benefit of the realisation of the Flagship
- Overall continuity and coherency in the execution of the Flagship

Type of action: Framework Partnership Agreement (no funding)

FETFLAG 2 - 2015: Graphene FET Flagship Core Project

Specific challenge: The objective is to support the implementation of the Graphene FET Flagship through a project in the context of the framework partnership agreement detailed above. The consortium should be based on the Framework Partnership Agreement for Graphene as indicated in the call conditions.

Proposals should progress the Graphene FET Flagship in accordance with the defined roadmap. This includes the complete range of scientific and technological challenges involved, in particular development and exploration of material aspects of Graphene, health and environmental issues, fundamental science for Graphene, the production of Graphene or Graphene film, high-frequency electronics, optoelectronics, spintronics, sensing, flexible electronics, energy applications and nanocomposites. Other 2D materials may also be considered.

Scope: A core project that implements a core of the research work of the strategic research agenda and takes a coordinating role within the initiative, which may include support to the functioning of an organisation which implements the Flagship.

The coordinating role should include in particular (i) actions to ensure the overall continuity and coherence in the management of the Flagship initiative, including the cooperation with future actions launched in the form of complementary projects, (ii) the governance of the

Graphene FET Flagship initiative, and (iii) the collaboration of the programme with other initiatives or programmes at regional, national, transnational or global level. This includes in particular collaboration with related ERANET project(s).

Proposals should describe how they will continue the activities carried out during the ramp-up phase involving the relevant disciplines and stakeholders, how resources brought together in the ramp-up phase will be used and/or strengthened, and how they will provide efficient coordination under strong scientific leadership. Proposals should also detail activities in areas such as education, innovation, dissemination, ethics and societal aspects.

Expected impact:

- Contribution to the strategic goal of the Graphene FET Flagship and the realisation of its research roadmap
- 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

Type of action: Research and Innovation Action (100% funding)

FETFLAG 3 - 2015: Human Brain Project FET Flagship Core Project

Specific challenge: The objective is to support the implementation of the Human Brain Project (HBP) FET Flagship through a project in the context of the framework partnership agreement detailed above. The consortium should be based on the Framework Partnership Agreement for HBP as indicated in the call conditions.

Proposals should progress the HBP FET Flagship in accordance with the defined roadmap. This includes the complete range of scientific and technological challenges involved, in particular development of the neuroscience platform; elaboration of an internet accessible 3D mouse brain atlas and encyclopaedia; federation of data and knowledge on the human brain; mathematical and theoretical foundations of brain research; further development of the models, simulators and building tools for the brain simulation platform; further development of the HPC platform; maintenance of the 4 other HBP platforms' environment and architecture; further development of the Medical Informatics Platform; federation of clinical researchers, hospitals and industries; data collection regarding the multi-level organisation of the mouse and human brains; neuromorphic Computing; neuro-robotics; future neuroscience applications and future medicine applications.

Scope: A core project that implements a core of the research work of the strategic research agenda and takes a coordinating role within the initiative, which may include support to the functioning of an organisation which implements the Flagship.

The coordinating role should include in particular (i) actions to ensure the overall continuity and coherence in the management of the Flagship initiative, including the cooperation with future actions launched in the form of complementary projects, (ii) the governance of the HBP FET Flagship initiative, and (iii) the collaboration of the programme with other initiatives or programmes at regional, national, transnational or global level. This includes in particular collaboration with related ERANET project(s).

Proposals should describe how they will continue the activities carried out during the ramp-up phase involving the relevant disciplines and stakeholders, how resources brought together in

the ramp-up phase will be used and/or strengthened, and how they will provide efficient coordination under strong scientific leadership. Proposals should also detail activities in areas such as education, innovation, dissemination, ethics and societal aspects.

Expected impact:

- Contribution to the strategic goal of the HBP FET Flagship and the realisation of its research roadmap
- transformational impact on science and technology and substantial benefits for the European economy and society in the area of neuroscience, brain medicine and neuromorphic computing
- European leadership in the area of neuroscience, brain medicine and neuromorphic computing
- strengthening of the interfaces between ICT, neuroscience and other disciplines

Type of action: Research and Innovation Action (100% funding)

FETFLAG 4 – 2014-2015: Policy environment for FET Flagships

Specific challenge: The overall challenge is to foster a common European effort by contributing to dissemination efforts, impact assessments and other actions which support and strengthen the FET Flagship initiatives. This also extends to enhancing the interplay between FET Flagships and other Union policies and the transfer of technologies towards exploitation. Any proposal has to demonstrate that it adds value beyond the activities implemented in each the FET Flagships Graphene and HBP.

Scope: Actions supporting the FET Flagship concept. Proposals should cover one or more of the following:

- The dissemination of information on the FET Flagship initiatives and their results
- Supporting collaboration between the FET Flagships and international programmes
- Assessing the impacts of FET Flagship initiatives, including through metrics and indicators
- Analysing market potential and supporting technology transfer
- Collection of information need for policy making, e.g. through consultation actions and surveys
- Supporting the functioning of an organisation which implements a Flagship initiative

Expected impact:

- enhanced flow of information from FET Flagships towards in particular policy makers and the wider public
- enhanced complementarities between FET Flagships and related initiatives, in particular those at a global level
- improved understanding of impacts of FET Flagships on science, technology, economy and society
- Better use of opportunities for technology transfer, innovation and exploitation
- Improved availability of information need for policy making
- Stable and structured environment for the benefit of the FET Flagships

Type of action: Coordination and Support Action (100% funding)

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

B1. External expertise and studies

This action will support:

- The use of appointed independent experts for the evaluation of project proposals and, where appropriate, for the reviewing of running projects.
- The setting up and operations of the FET Advisory Board to advise on or support the design and implementation of FET-related policies and future workprogrammes.
- Studies related to FET

Type of action: Expert contracts and procurement