EUROPEAN COMMISSION

ICT - INFORMATION AND COMMUNICATION TECHNOLOGIES

A Theme for research and development under the specific programme "Cooperation" implementing the Seventh Framework Programme (2007-2013) of the European Community for research, technological development and demonstration activities

Work Programme 2009-10[1]

Agreed by ICT Programme Committee

http://cordis.europa.eu/fp7/ict/

[1] The budget amount for call 4, part of the amount for call 5, part of the FET Open call and the joint call ICT-Energy are from the 2009 budget under the condition that the appropriations foreseen in the preliminary draft budget for 2009 are adopted without modifications by the budgetary authority. The remaining amount for call 5, call 6 and FET-Open is expected to be added from the 2010 budget for which a new financing decision to cover the budget for that year will be requested at the appropriate time.

3.13 Links with other Programmes

Links with ICT in the CIP

The ICT theme in FP7 is one of the two main financial instruments in support of the i2010 initiative that is the Union's policy framework for the information society. The other main financial instrument is the ICT specific programme within the Competitiveness and Innovation programme (CIP). ICT in the CIP aims at ensuring the wide uptake and best use of ICT by businesses, governments and citizens. ICT in FP7 and ICT in the CIP are therefore complementary instruments aiming at both progressing ICT and its applications and at making sure that all citizens and businesses can benefit from ICT.

Links with the Research Infrastructure part of the Capacities Programme

Support will be provided to ICT-based research infrastructure (eInfrastructure) under the Research Infrastructures part of the Capacities programme. This will build on the success of the GEANT research network and the research-Grids infrastructure supported in FP6 and in the first phase of FP7 and will provide higher performance computing, data handling and networking facilities for European researchers in all science and technology fields. Coordination between this activity and the ICT theme in the cooperation programme will ensure that the latest and most effective technology is provided to European researchers. Support will also be given to other ICT research infrastructure under the targeted calls of the Capacities programme. These will cover areas such as ICT Living Labs, clean rooms for nano-electronics and Embedded Systems research facilities.

Links with other Themes

This work programme includes a joint call between the ICT Theme and the Energy Theme that covers novel ICT solutions for Smart Electricity Distribution Networks.

Links with the other Specific Programmes in FP7

In addition to the ICT theme in the Cooperation Specific Programme, the ICT research and development community will also be able to benefit from the other specific programmes that are open to all research areas including the Ideas, People and Capacities programmes.

4 Content of calls

4.1 Challenge 1: Pervasive and Trustworthy Network and Service Infrastructures

The 'Future Internet' is emerging globally as a federating research theme. The current Internet architecture was not designed to cope with the wide variety, and the ever growing number of networked applications, business models, edge devices, networks and environments that it has now to support. Its structural limitations in terms of scalability, mobility, flexibility, security, trust and robustness of networks and services are increasingly being recognised world-wide. The challenge is to comprehensively and consistently address the multiple facets of a Future Internet, with energy efficiency also appearing as an important societal concern. Clean slate or evolutionary approaches or a mix of those can be equally considered.

From a networking perspective, this entails a need to rethink architectures such that performance bottlenecks are overcome, a wider variety of service types can be supported, novel types of edge networks such as wireless sensor networks may be integrated, and constraints imposed by new types of media applications such as 3D virtual environments can be supported. Mobility and ever higher end to end data rates also emerge as important design drivers, and so does security and trustworthiness. At network level, a clear challenge will be to provide the Internet with the flexible and ad-hoc management capabilities that have never been part of the 'best effort' paradigm driving the original design. Novel radio and optical systems are important components of this overall network perspective.

These network infrastructures need to support an Internet of dynamically combined services with worldwide service delivery platforms and flexibly enable the creation of opportunities for new market entrant. The 'third party generated service' is emerging as a trend supporting the move towards user-centric services, as shown by the advances in Service-Oriented-Architectures and in service front-ends as the interface to users and communities. Virtualisation of resources remains an important research driver enabling the delivery of networked services independently from the underlying platform, an important issue for service providers. Advances in these domains also require breakthroughs in software engineering methods and architectures addressing complexity in distributed, heterogeneous and dynamically composed environments, as well as non-functional requirements.

Networks and service platforms will become increasingly vulnerable as current developments lead to more complex and large-scale heterogeneous networks with massive distributed data storage and management capacity. They need to be made *trustworthy* which is defined in this context as: secure, reliable and resilient to attacks and operational failures; guaranteeing quality of service; protecting user data; ensuring privacy and providing usable and trusted tools to support the user in his security management. Trustworthiness needs to be considered from the outset rather than being addressed as add-on feature. Societal and legal issues increasingly impact technological choices. ICT must be developed to ensure a society based on freedom, creativity and innovation, whilst providing security for its citizens and critical infrastructures.

As the Internet has revolutionised the access to multimedia content and enabled collaborative user-generated content, requirements in this field have huge impact on a Future Internet. Advances in 3D processing give rise to innovative applications notably in gaming technologies and in virtual worlds. These place new types of traffic demands and constraints on network platforms, create new requirements for information representation, filtering, aggregation and networking. They drive demand towards novel search tools and raise issues of identity management, ownership and trading of virtual digital objects as well as right of use. These environments coupled with their usage rules drive the research towards a '3D Media Internet' as a basis of tomorrows networked and collaborative platforms in the residential and professional domains.

The Internet is also revolutionising the Enterprise and businesses environments, with the introduction of RFID technologies enabling more automated processes. These open the way towards an Internet of things, where multiplicity of tags, sensor, and actuators provide physical world information enabling new classes of applications combining virtual and physical world information. Open architectures supporting such environments as well as understanding of their impact on the Internet hence emerge as research drivers. Integration with the mainstream business management platforms as well as integration of multiple businesses in collaborative and ad-hoc environments needs to also be taken into account.

Finally, there is an increasing demand from academia and industry to bridge the gap between long-term research and large-scale experimentation through *experimentally-driven research*. A fundamental need in this approach is the set-up of *large-scale experimentation facilities*, going beyond individual project testbeds, which help putting together different research communities in an interdisciplinary approach, anticipating possible migration paths for technological developments which may be potentially disruptive, discovering new and emerging behaviours and use patterns in an open innovation context, as well as assessing at an early stage the socio-economic implications of new technological solutions. For their demonstration and experimentation, proposers under Challenge 1 are encouraged to use the dynamically evolving Future Internet Research and Experimentation (FIRE) facility and to federate their project testbeds within this facility.

Technologies developed under this Challenge are expected to be tailored to meet key societal and economic needs.

Objective ICT-2009.1.1: The Network of the Future

Target Outcomes

a) **Future Internet Architectures and Network Technologies**

Overcoming structural limitations of the current Internet architecture arising from an increasingly larger set of applications, of devices and edge networks to be supported.

- ***Novel Internet architectures and technologies*** enabling dynamic, efficient and scalable support of a multiplicity of user requirements and of applications with various traffic patterns, variable end-to-end quality of service, point-to-point or point-to-multipoint distribution modes, and supporting legacy and future service architectures. The target architecture should support personalised rich media networking, machine-to-machine communication, wireless sensor networks, ad-hoc connectivity networks as well as personal and body area networks. It should also be wireless-friendly, natively support mobility, be spectrum- and energy-efficient, support future very-high-data-rate all-optical connections as well as heterogeneous wired/wireless access domains. Routing and location-independent addressing or naming, dynamic peering, signalling, resource virtualisation, and end-to-end content delivery techniques are related research issues.

- ***Flexible and cognitive network management and operation frameworks*** enabling dynamic, ad-hoc and optimised resource allocation, control and deployment, administration with accounting that ensures both a fair return-on-investment and expansion of usage, differentiated performance levels that can be accurately monitored, fault-tolerance and robustness associated with real-time trouble shooting capabilities. The management architecture should target self-organised and self healing operations, cooperative network composition, service support and seamless portability across multiple operator and business domains.

Migration paths and coexistence through overlay, federation, virtualisation and other techniques should be investigated to support several network and management architectures including legacy systems. Benchmarking capability of the proposed architecture(s) is to be considered from the onset. Clean slate or evolutionary approaches, or a mix of these, can be equally considered.

If third country partnership is felt relevant by proposers, priority should be for those third countries having established programmes in this field, notably Japan and the USA.

b) **Spectrum-efficient radio access to Future Networks**

- ***Next-generation mobile radio technologies*** that are cost-, spectrum- and energy-efficient and adapted for implementation in future high-capacity mobile radio systems. Key technology building blocks expected to be addressed are adaptive modulation and coding schemes, multiple antenna and user detection schemes, cross-layer design and low–latency transmission schemes. They are expected to be complemented by co-operative technologies at base station and/or terminal level, novel network topologies and related dynamic channel modelling and estimation. Integrated projects are expected to take a comprehensive approach to the key technology building blocks and develop system evolution paths by jointly designing radio transmission techniques and radio interface protocol stacks and considering spectrum co-existence and sharing.

- ***Cognitive radio and network technologies*** reducing the management complexity and enabling seamless service provision in a radio environment with a large number of heterogeneous radio access technologies. These should support environment-aware, self-reasoning- and learning-capable mobile devices that can change any parameter or protocol based on interaction with the environment with or without network assistance.

- ***Novel radio network*** architectures enabling the innovative usage of licensed, unlicensed or unused radio spectrum with the aim of radical cost- and energy-reduction. Target environments range from short to medium distance including systems based on femto-cells, ad-hoc networks and vehicular networks, up to wide-area terrestrial and satellite-based radio access networks.

c) **Converged infrastructures in support of Future Networks**

- ***Ultra high capacity optical transport/access networks*** based on state-of-the-art photonics with transparent core-access integration, optical flow/packet transport, dynamic wavelength allocation and end-to-end service delivery capability, overcoming the limitations of segmentation between access, metro and core networks and domains, lower cost optical access and the need for energy efficiency. Integrated projects are expected to address also a network control plane supporting flexible management capability of multi-domain and multi-operator contexts with end-to-end carrier grade performance.

- ***Converged service capability across heterogeneous access:*** Breakthrough technologies and architectures for seamless ubiquitous broadband services, integrating wired and wireless, fixed and mobile technologies in hybrid access networks, including hybrid-satellite networks. These enable generic support for service portability and continuity across composite networks through the service-network interface, with ubiquitous access from any network, from any technological or administrative domain, from any location and with a variety of access devices.

d) **Coordination/ Support actions and Networks of Excellence**

– Coordination of research efforts to explore synergies across on-going national initiatives and with third countries (priority is with the USA and Japan); support actions to channel efforts towards standardisation initiatives and a coherent approach towards take-up and testing of new concepts leading to a European-led Future Internet.

– Support to integrated satellite and terrestrial systems with a focus on supporting both public service and private communication requirements.

– Research roadmaps, organisation of scientific and/or policy events, strategy and policy formulation.

– Networks of Excellence in new and emerging topics, with a clear and limited focus, requiring interdisciplinary teams of researchers.

<u>Expected impact</u>

- Strengthened positioning of European industry in the field of Future Internet technologies and reinforced European leadership in mobile and wireless broadband systems optical networks cognitive network management technologies.

- Increased economic efficiency of access/transport infrastructures (cost/bit)
- Global standards, interoperability and European IPRs reflecting federated and coherent roadmaps.
- Wider market opportunities from new classes of applications taking advantage of convergence.
- Accelerated uptake of the next generation of network and service infrastructures.

Funding schemes

a), b), c): IP, STREP; d): NoE, CSA

Calls and indicative budget distribution[10]

- ICT call 4 - target outcomes b) and c):
  - IP/STREP: EUR 110 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs
- ICT call 5 - target outcomes a) and d):
  - IP/STREP: EUR 71 million; of which a minimum of 50% to IPs and a minimum of 30% to STREPs
  - NoE: EUR 6 million; CSA: EUR 3 million

Objective ICT-2009.1.2: Internet of Services, Software and Virtualisation

Target outcomes

a) **Service Architectures and Platforms for the Future Internet**

- ***Service front ends*** enabling communities of networked users easily to compose, configure, share and use services and providing device and context aware service adaptations. They facilitate the development of, search for and interaction with services, cover the service life cycle and take account of social network users having different levels of expertise.

- ***Open, scalable, dependable service platforms, architectures, and specific platform components,*** enabling automatic service description, discovery, composition, and negotiation with a multiplicity of reusable services, which may be mobile, multi-device, multi-modal, multi-context or nomadic. Evolution and interoperability of service platforms are also needed, and scale and complexity in dynamic, distributed heterogeneous environments, including open service networks, should be addressed. System management functionalities such as Service Level Agreement (SLA) management, Quality of Service (QoS), access rights and customer charging have to be supported, as should semantic interoperability and access to service repositories. Full account should be taken of the convergence of IT/telecom/content systems and opportunities for breaking down the barriers between the web telecommunication and hybrid services.

- ***Virtualised infrastructures*** extending the capabilities of distributed computing, storage and communication infrastructures to manage a multiplicity of underlying hardware and software

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resources and seamlessly integrate them within the composite service orientation paradigm enabling operations across heterogeneous technological and business domains. These virtualised infrastructures allow the flexible, dynamic, dependable and scalable provision of advanced services to support the various resource requests/needs of service platforms, including software as a service, resource as a service and other approaches.

b) **Highly Innovative Service / Software Engineering**

- Service / Software engineering methods and tools covering automatic support at run-time for decisions and changes that are currently adopted at design time. Focus is on innovative approaches to very large, dynamic open service networks, user development of services/software, systems evolvability and acquisition, reasoning and incorporation of domain knowledge in all phases of the service/software life cycle. High-level description and executable languages for services/software with support for adaptation and technologies for improving system response time, performance and throughput are in the scope of the research,

- ***Verification and validation*** methods, tools and techniques assuring the quality of open, large-scale, dynamic service systems without fixed system boundaries, addressing the complete service and software life cycle.

- Methods, tools and approaches specifically supporting the development, deployment and evolution of ***open source software.*** Investigation into the use of open source approaches for improving service engineering, deployment, management, evolution and take-up.

c) **Coordination and support actions**

- Support for standardisation and collaboration. Identification and support of actions relating to the need for interoperability. Support to cross-sector coordination on convergence of IT, telecom and media; specific actions to build concepts and critical mass for services in the Future Internet.
- Maximisation of impact of projects in this area, including SME-oriented technology transfer actions such as dissemination and training.
- Application of open source models of development and innovation through rapid cycles of reuse and improvement to service engineering.

Expected impact

- A major contribution to the Future Internet in terms of service development, management and interoperability in an environment of converged IT, telecom and media platforms.
- Deep technological advances in software/service engineering. New software technologies for improving scalability and predictability of distributed systems, improving responsiveness and throughput. A more competitive environment including infrastructure operators moved up the value chain with innovative service offerings on scalable infrastructure.
- Lowered barriers for service providers, in particular SMEs, to develop services through standardised open (source) platforms and interfaces.
- Massive uptake of high-added value services through innovative service front ends and a higher user empowerment and more advanced and dynamic online communities through platforms enabling "third party generated services".
- A strengthened industry in Europe for software, software services and Web services, offering a greater number of more reliable and affordable services, enabled by flexible and resilient platforms for software/service engineering,

design, development, management and interoperability. Technologies tailored to meet key societal and economical needs

Funding schemes

a), b): IP, STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 107 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs

- CSA: EUR 3 million

Call

ICT call 5

Objective ICT-2009.1.3: Internet of Things and Enterprise environments

Target outcomes

a) **Architectures and technologies for an Internet of Things**

- ***Architectures and technologies using open protocols, which enable novel Internet-based applications*** including – but not restricted to – business/enterprise scenarios. They should use information generated at the periphery of the network from the virtual and physical worlds with aggregation of those, and allow action on the physical world. Physical world event information are generated by tags, sensors, actuators and wireless devices. Related processes and applications may be object- or location-centric and cover management capabilities of various classes of events, such as real world events (sensor based), behavioural/people events, or business events. For business scenarios, traceability networks correlated with logistics and order or billing flows are of particular importance.

- ***Optimised technologies covering distribution of intelligence*** between the edge network and the more centralised business/process information system. This includes service discovery systems as well as scalable, secure, open middleware necessary to put real world data into the context of various Internet applications with event processing, separation and filtering. Of particular importance are the integration and interoperability with the mainstream business/process management platforms and tools and the necessary management of varying data ownership across the edge device/object life cycle.

- ***Architectural models*** enabling an open governance scheme of the Internet of Things, without centralised gatekeeper lock-in of critical business/process functionalities.

If third country partnership is felt relevant by proponents, priority should be for those third countries having established links with the EU in this field and providing mutual benefits, including the U.S., Japan, Korea, China, and India.

b) **Future Internet based Enterprise Systems**

Software platforms supporting highly innovative networked businesses on top of an Internet of Services. These platforms should enable increased flexibility of the resources managed by virtual organisations and facilitate dynamic outsourcing with third parties capability to aggregate services, act as intermediaries for delivery, and provide innovative new channels for consumption. Collaboration and interoperability are key features of these dynamic ecosystems supported by next generation knowledge management services, making use of semantically enriched information, including object/sensor information.

c) **International co-operation and co-ordination**

- Strategic visions covering the Internet of Things and/or integrated businesses going beyond current process-based or analytical approaches to include frameworks based on fuzzy logic, decisional or systemic approaches; research roadmaps, organisation of events.
- RFID: Exchange of best practices from field trials or the deployment of pilot projects as well as collaborative pre-normative research aiming at global standards, as part of the 'Lighthouse priority project' decided at the EU-US Transatlantic Economic Council in April 2007. Organisation of the European follow-up of this initiative to support the established dialogue.

Expected impact

- Strengthened competitiveness of European businesses in all sectors of the economy through more automated processes, new classes of applications, and more generic and open architectures, and through the support to standards as well as dynamic and composite business models for the delivery of customisable high added value products or services.
- European leadership in the supply of integrated business solutions exploiting the fast development of RFIDs and smart tags and taking advantage of fusion between the real world and the virtual web-based world.

Funding schemes

a), b): IP, STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 35 million; the objective is to support at least 2 IPs
- CSA: EUR 2 million

Call

ICT call 5

Objective ICT-2009.1.4: Trustworthy ICT[11]

Target outcomes

a) **Trustworthy Network Infrastructures**

- Trustworthy network infrastructures as well as communication, computing and storage infrastructures in the context of the development towards the Future Internet as a conglomerate of heterogeneous networks and systems. Work includes development of novel architectures with built-in security, dependability and privacy; secure interfaces and scalable dynamic security policies across multiple networks and domains; and trustworthy management of billions of networked devices, 'things' and virtual entities connected in the Future Internet.
- Trustworthy platforms and frameworks for autonomously monitoring and managing threats, which need to be typically cross-border, cross-organisational, scalable, distributed, dynamically evolving and collaborative.

[11] *Trustworthy* is defined in this context as: secure, reliable and resilient to attacks and operational failures; guaranteeing quality of service; protecting user data; ensuring privacy and providing usable and trusted tools to support the user in his security management.

- Whilst developing technologies, projects should give adequate attention to aspects of usability, societal acceptance and economic and legal viability, through appropriate research, experimentation or demonstration in realistic, complex and scalable scenarios and contexts.

b) **Trustworthy Service Infrastructures**

- Trustworthy and privacy protecting service systems, platforms and infrastructures as part of the development towards the Future Internet, which support adaptability, interoperability, scalability and dynamic composition of services for citizens and businesses. Work includes flexible and dynamic mechanisms and risk-based methodologies to respond to threats and vulnerabilities, as well as to changes and conflicting demands in operating conditions, business processes or use practices through the full life cycle.
- Interoperable frameworks for identity management for persons, tangible objects and virtual entities, with emphasis on user-centricity and respect of privacy for personal users.
- Whilst developing technology, projects should give adequate attention to aspects of usability, societal acceptance, human behaviour and principles of human rights and legal and economic viability. This could involve multi-disciplinary research activities, experiments or demonstration in realistic, complex and scalable scenarios and contexts.

c) **Technology and Tools for Trustworthy ICT**

- In highly distributed networked process control systems and in networks of very high number of things. Understanding threat patterns for pro-active protection.
- For user-centric and privacy preserving identity management, including for management of risks and policy compliance verification.
- For management and assurance of security, integrity and availability, also at very long term, of data and knowledge in business processes and services.
- For assurance and assessment of the trustworthiness of complex and continuously evolving software systems and services.
- In enabling technologies for trustworthy ICT. This includes cryptography, biometrics; trustworthy communication; virtualisation; and certification methodologies.

d) **Networking, Coordination and Support**

Support to networking, road-mapping, coordination and awareness raising of research and its results in trustworthy ICT.

Priority will be given to: (i) Emerging threats and vulnerabilities in the Future Internet, (ii) Security and resilience in design, performance and scalability of future software-based service systems, (iii) Economics of security addressing cost effectiveness and market compliance of security solutions, (iv) Promoting wide use of standards, certification models and best practices, (v) Legal and societal aspects related to technology development of trustworthy ICT; (vi) Coordination of national research actions in the field; (vii) International cooperation in fields where global action will create added value.

Networks of Excellence could be particularly relevant for the areas of (i), (ii) and (iii).

<u>Expected Impact:</u>

For IPs:

- Demonstrable improvement (i) of the trustworthiness of increasingly large scale heterogeneous networks and systems and (ii) in protecting against and handling of network threats and attacks and the reduction of security incidents.

- Significant contribution to the development of trustworthy European infrastructures and frameworks for network services; improved interoperability and support to standardisation. Demonstrable usability and societal acceptance of proposed handling of information and privacy.

For all projects:

- Improved European industrial competitiveness in markets of trustworthy ICT, by: facilitating economic conditions for wide take-up of results; offering clear business opportunities and consumer choice in usable innovative technologies; and increased awareness of the potential and relevance of trustworthy ICT.
- Adequate support to users to make informed decisions on the trustworthiness of ICT. Increased trust in the use of ICT by EU citizens and businesses. Increased societal acceptance of ICT through understanding of legal and societal consequences.

For networking, coordination and support actions (NoE/CSA):

- Improved coordination and integration of research activities in Europe or internationally in areas where that is beneficial for European research and innovation capacity. Broad support to research roadmaps and activities relevant for longer term research in the field of trustworthy ICT.

Funding schemes

a): IP; b): IP; c): STREP; d): NoE, CSA

Indicative budget distribution[10]

- IP/STREP: EUR 80 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs

- NoE, CSA: EUR 10 million.

Call

ICT call 5

Objective ICT-2009.1.5: Networked Media and 3D Internet

Target outcomes

a) **Content aware networks and network aware applications**

- Architectures and technologies for converged and scalable networking and delivery of multimedia content and services dynamically optimised with policies taking into account the content and adaptation needs, the user contexts, requirements and social relational network for a variety of contents, services that may include home management, applications, locations and mobility scenarios. They enable multiple user roles as content producer, user or manager.

- Maintaining the integrity and quality of media across media life cycle to optimise quality of experience in collaborative media creation and delivery scenarios, with optimised sharing, storage, retrieval, fusion capabilities. Open architectures making the most of both the ever increasing device/edge processing power and network bandwidth, especially for real time highly demanding immersive collaborative environments (e.g. games). Enhancement of 2D scalable video coding, multi view point coding, 3D coding that can achieve optimised network awareness and device delivery are within scope.

Expected impact

- Reinforced positioning of industry in Europe in networking and delivery of multimedia content and services, in 3D media Internet technologies, and in networked search. Strengthened European industry in multimedia experiences beyond HDTV and in electronic cinema.
- Wider uptake of networked and collaborative platforms based on a '3D media Internet'.
- Global standards and European IPRs reflecting federated and coherent roadmaps.
- Wider market opportunities, including for content-related SMEs, arising from innovative business and societal applications (e.g. games, entertainment, or education, culture, and service creations) based on novel networked media technologies and systems.

Funding schemes

a), b), c), d): IP, STREP; e): NoE; f): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 70 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs

- NoE: EUR 6 million; CSA: EUR 4 million

Call

ICT call 4

Objective ICT-2009.1.6: Future Internet experimental facility and experimentally-driven research

Target outcomes

a) **Building the Experimental Facility and stimulating its use**: Building the prototype of the Future Internet Research and Experimentation (FIRE) experimental facility to support research for the Future Internet at different stages of the R&D cycle based on the design principle of 'open coordinated federation of testbeds'.

   The facility shall allow for: large scale experimentation with and comparison of visionary approaches for network architectures and technologies, service architectures and platforms, networked media and trustworthy infrastructures for the Future Internet; experimentation with systems based on cross-layer or non-layered approaches; direct involvement of user communities; assessment of the socio-economic and environmental impact of changes to the Internet. The facility should be dynamic, sustainable, open at all levels and based on open standards. Participation from INCO countries in particular at use level is encouraged.

   a1) **FIRE Components**: an operational prototype facility should be provided at an early stage in the project. Normally, at least 20% of the resources should be earmarked for gradually expanding the functionality of the prototype in a demand-driven and open way by federating testbeds providing additional functionality within the facility.

   a2) **FIRE Users**: using the mechanism of open calls, it is expected that another 20% of the resources are used for extending the use of the experimental facility for research groups that propose innovative usage scenarios exploiting the multiple dimensions and scale of the facility. These activities should exhibit a high degree of innovation in the use of the Facility, including system level experiments making a comprehensive use of several components of the facility, large scale experimentation, broad involvement of user communities, and assessment of socio-economic and other non-technological aspects. The results, lessons learnt and recommendations drawn must be of mutual interest, serving the needs of the users as well as helping the Facility operators to refine the concept of 'open coordinated federation of testbeds' and the services provided by the Facility. Support of individual experiments should be focused on the setting up and running of the experiment and should typically not exceed EUR 200000 per experiment.

b) **Experimentally-driven Research**: Visionary multidisciplinary research, defining the challenges for and taking advantage of the Experimental Facility above, consisting of iterative cycles of research, design and large-scale experimentation of new and innovative network and service architectures and paradigms for the Future Internet from an overall system perspective. The refinement of the research directions should be strongly influenced by the data and observations gathered from experimentation in previous iterations.

   Research should consider the Future Internet as a complex system and therefore address all the associated aspects in a holistic vision and at all relevant levels and layers. This includes the definition of relevant metrics as well as taking into account energy, low cost, environmental or socio-economic aspects. This research will be an important driving element of the Experimental Facility.

c) **Coordination and support actions**: Coordination of related EU-level and Member States / Associated Countries activities, international co-operation with other initiatives in industrial and emerging countries, and collaboration on standardisation in order to exploit synergies; multidisciplinary networking of research communities addressing both technological and socio-economic and environmental aspects of the Future Internet; co-ordination of experience research and user-driven open innovation activities establishing common concepts, roadmaps, methodologies and tools, including the sharing of best practices across pilots and sectors.

<u>Expected impact</u>

- Improved European competitiveness in Future Internet research and development by providing European researchers, in industry and academia, with a unique operational, sustainable, dynamic, and integrated large scale Experimental Facility, which is used by a significant number of Future Internet research projects in European and national programmes and beyond.
- Establishing the methodology of experimentally-driven research for the investigation of innovative concepts for the Future Internet taking a multidisciplinary and holistic approach.
- Assessment at an early stage of the technological, societal, economic and environmental implications of changes to the Internet.
- Strengthened European competitive position on experimentation environments through targeted international co-operation.
- Increased acceptance and use of the concept of user-driven open innovation through demonstrated benefits from complementary approaches of open testbeds, pilots, experience research, etc.

Funding schemes

a): IP; b): STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 45 million of which EUR 25 million for IP (target outcome (a)) and EUR 20 million for STREP (target outcome (b))

- CSA: EUR 5 million

Call

ICT call 5

4.2 Challenge 2: Cognitive Systems, Interaction, Robotics

Engineering systems with the capability to sense and understand an unstructured environment is a challenge which goes beyond today's systems engineering paradigm. Present day systems engineering relies on specifying every eventuality a system will have to cope with in the execution of its task(s), and programming the appropriate response in each case. With the abundance of ever cheaper, smaller sensors, actuators and wireless tranceivers that link systems to the real world and with other systems, this approach faces serious limitations:

- The **real world** is generally too nuanced, too complicated and too unpredictable to be summarised within a limited set of specifications; there will inevitably be novel situations and the system will always have gaps, conflicts or ambiguities in its own knowledge and capabilities.
- Even in situations where unpredictable events are less likely, the problem of **extracting meaning and purpose** from bursts of sensor data or strings of computer code arises, because we don't have a formalisation of information processing that embodies semantics.

Challenge 2 aims to extend systems engineering to the design of systems that can carry out useful tasks (e.g. manipulation and grasping, exploration and navigation, monitoring and control, situation assessment, communication and interaction), autonomously or in cooperation with people, in circumstances that were not planned for explicitly at design time. Specifically, such systems should be:

- *more **robust**:* performance should not degrade when they are presented with unexpected data;
- *more **adaptive**:* performance should be open (within reasonable constraints) to changing service requirements, without the need for extensive human intervention;
- *more effective:* performance should improve because they can predict or **anticipate** what might happen at some point in the future, near or far;
- *more natural:* performance should be tolerant to the ambiguity and **uncertainty** that is a consequence of dealing with humans, and performance should improve with time.

System capabilities in dimensions such as deliberation and learning, and innovation and creativity, would appear to be necessary to meet this aim. This clearly calls for design that shares some characteristics with the higher-level **cognitive** processes of the brain. For the purposes of this work programme a cognitive system can cope with the uncertainty (in the system's environment) that makes robust and adaptive performance difficult to achieve. It should also be borne in mind that it makes no sense to speak of robustness or adaptability without first **specifying the requirements** of interest: a robust lawnmower is different to a robust operating system or a robust planner.

Research and development efforts should aim at generating actual design principles. They will contribute to establishing scientific foundations for such principles. Alternatively, they may aim to achieve significant engineering progress, e.g. through integration.

Manufacturers of robots of all sorts, autonomous vehicles, smart cameras and sensor networks will benefit from R&D efforts. Europe has strong manufacturing capabilities and a significant share of world market revenues in these sectors. The emergence of service robots and vision systems that operate outside structured manufacturing environments offer added opportunities for market expansion.

Likewise automated machine translation stands to profit from more robust and adaptive methods for natural language understanding. With 23 official languages, the EU is at the forefront of multi-lingualism and it would be unrealistic to assume that the lingua franca in machine translation is, or will remain, English. A strategic challenge for Europe in today's globalised economy is to overcome language barriers through technological means.

Technologies developed under this Challenge are expected to be tailored to meet key societal and economic needs.

Objective ICT-2009.2.1: Cognitive Systems and Robotics

Target outcomes

a) **New approaches towards understanding and solving key issues related to the engineering of artificial cognitive systems – see above**; among these issues are the following:
   - representation / categorisation / recognition / interpretation of objects, events, situations, behaviours and affordances in realistically scaled real-world environments;
   - the role and implementation of memory and learning in artificial systems;
   - adaptive and anticipatory behaviour within incompletely specified environments;
   - goal-setting and strategies for achieving goals;
   - collective behaviour arising from the interplay of (possibly large numbers of) individual subsystems;
   - modelling and design of (multimodal) interaction, communication and collaboration.

   Projects are expected to demonstrate measurable progress on a suitable mix of these issues.

b) **New approaches towards endowing robots with advanced perception and action capabilities**, and towards developing pertinent benchmarks and tests. Of particular interest are:
   - 3D sensing for everyday objects and environments;
   - motion and affordance perception;
   - learning and control strategies for linking perception and action;
   - benchmarking with a focus on navigation and autonomy.

   Projects are expected to demonstrate measurable progress on at least one of these issues.

Expected impact for a) and b)

- Leading-edge research capacity in Europe in cognitive systems engineering and robotics.
- Innovations in service robots, and industrial production and manufacturing processes.
- Widespread comparative assessment of robot performance (for different tasks and technologies).
- New market opportunities, and technologies for increased productivity and efficiency in EU industries.

c) **New ways of designing and implementing complete robotic systems** that operate largely autonomously in loosely structured dynamic environments and, where necessary, in close co-operation with people. Systems may be distributed and should integrate rich sensory-motor skills (for example, grasping, manipulation, locomotion) with high level cognitive competencies (for example, reasoning, planning and decision-making). As appropriate, they should be demonstrably more robust, dependable, flexible and adaptive, and safer than it is possible today, and improve their performance through learning.

d) **New, scientifically grounded system architectures integrating communication, control, and cognitive capabilities** to enable meaningful and self-sustaining autonomous action in real-world environments, natural interaction with people (where necessary), robust adaptation to changing operating conditions, and self-improvement. The viability and scalability of these architectures will be demonstrated through suitable experiments based on physical implementations and/or simulations of complete systems.

e) **A framework to facilitate cross-fertilisation between academic and industrial research efforts in robotics** through widespread experimentation with industry-strength platforms in academic research labs and through the joint definition of longer term scenarios and requirements to direct robotics research towards common goals; to assure a comparative assessment of performance through definition of suitable metrics and through benchmarking (supported by competitions or otherwise).

Expected impact for c), d) and e)

- Integrated and consolidated scientific foundations for engineering cognitive systems under a variety of physical instantiations.
- Significant increase of the quality of service of such systems and of their sustainability in terms of, for instance, energy consumption, usability and serviceability, through the integration of cognitive capabilities.
- Innovation capacity in a wide range of application domains through the integration of cognitive capabilities.
- Improved competitive position of the robotics industry in existing and emerging markets for instance in the following sectors: flexible small scale manufacturing; professional and domestic services; assistance and rehabilitation; construction, maintenance and repair; urban search and rescue; exploration and mining; entertainment, education and training.
- Consensus by industry on the need (or not) for particular standards. More widely accepted benchmarks. Strengthened links between industry and academia. (especially (e)).

Research and development pertaining to targets (a), (b), (c) and (d) will be guided by demanding, yet pragmatic, application scenarios. Target environments may be, for example, difficult terrains, buildings, homes, public spaces, shop floors, power plants and other technical infrastructures. Functionalities include: exploration, monitoring, controlling all sorts of sensors and actuators and communication and interaction with people (also including advanced human-robot interaction).

The applicability of research results is expected to go beyond the scenarios through which they have been obtained. Proposals strictly focusing on applications that are targeted under Challenges other than Challenge 2 are not eligible under Challenge 2.

Pertinent research may be informed by neuro- and behavioural sciences and determine the requirements basic technologies have to meet in order to enable creating the targeted systems. Systems may for instance employ new sensor and sensor networking technologies or 'intelligent' materials to enhance their functionality, performance, and efficiency of resource usage, and bring new functionalities, like self-configuration and self-repair, within reach of industrial realisation. Research will also significantly broaden the remit of machine learning and put stronger emphasis on intelligent process control in real-time.

f) **A 'Virtual Institute'** integrating diverse research areas whose problems, techniques and solutions need to be brought together to understand cognitive systems and design useful new ones; they will develop a requirements- and capability-led understanding of cognitive systems that can be applied across multiple engineering and application domains.

Expected impact for f)

- Leading-edge research in Europe in cognitive systems engineering and robotics.

g) Co-ordinated **co-operation and communication** within a multidisciplinary robotics community in Europe, with concomitant outreach to potential users of robotic systems

h) Co-ordinated **co-operation and communication** within a multidisciplinary artificial cognitive systems research community in Europe, with concomitant outreach to potential industrial applications.

Expected impact for g) and h)

- Stronger cohesion among relevant communities; awareness built among wider (including non-professional) audiences of the potential of the technologies at issue.

Where and as appropriate, activities under this objective, and in particular those aiming at targets g) and h), are expected to contribute to a better understanding of the ethical, social and socioeconomic issues related to the design, deployment and operation of robotic and cognitive systems.

Funding schemes

a)-b): STREP; c)-e): IP; f) NoE; g)-h) CA

Indicative budget distribution[10]

EUR 153 million

Calls:

- ICT call 4: target outcomes (b), (d), (f), (g)
  - IP/STREP: EUR 65 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs
  - NoE: EUR 6 million
  - CA: EUR 2 million

- ICT call 6: target outcomes (a), (c), (e), (h)
  - IP/STREP: EUR 78 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs
  - CA: EUR 2 million

4.3 Challenge 3: Components, systems, engineering

The component and systems business in Europe concentrates on added value operations, on systems integration, on new technologies and on enabling the end user industry to offer new technologies and total product/service solutions. The trends in miniaturisation, diversification, increasing software content and increasing emphasis on a systems approach remain valid and require significant improvements in chip design tools and methods. At the same time new opportunities are emerging in new technologies: beyond CMOS, photonics, organic and large-area electronics, 3D acquisition and visualisation, and new integration techniques. Increased multi-disciplinarity, integrated software/hardware systems, heterogeneous microsystems and the use of widely distributed systems for monitoring and control are growing challenges. In computing, mastering multi- cores and programming for ever-higher performance systems becomes essential. Cross-cutting issues such as efficient energy management and minimising the environmental footprint of manufacturing have become new desirable development objectives and are no longer seen as just an obstacle to performance.

Private equity capital, the increasing cost of manufacturing and research for the next generation of basic ***nanoelectronics*** technologies have been instrumental in the development of a few major global strategic R&D alliances close to manufacturing capabilities. Industrial R&D executed in Europe is shifting towards adding extra functionalities to the basic nanoelectronics technology, towards systems integration and to design innovative products. Institutional research is concentrating on long term or higher risk topics; on exploring multi-disciplinarity and on applied research into understanding and controlling new and complex systems.

Organic and large area electronics have very high market growth expectations with about half of the market for cheap and even disposable electronics, including RFID-tags and sensors. The EU has excellent R&D infrastructures and EU companies came early on the market with e-paper and e-tags products. It is also a leader in large area compound material photovoltaic cell manufacturing and in signage and lighting, expected to account for 20% of the market. The current trends are going beyond organic materials by including inorganic material. The technology is characterised by large area processing, by flexible products, and by the ability to create circuitry with modest upfront investment.

Photonics in core as well as in access networks, is gradually replacing electronics. Photonics is also an enabling technology that exploits advances in lasers, light sources, fibres, detectors, in materials (e.g. nanocrystals, organics, nanotubes) and in architectures / manufacturing processes (hybrid integration, silicon photonics and CMOS compatibility). It promises to play a major role in new areas such as energy saving (e.g. by improving photovoltaic and lighting efficiency), medicine, biology, environment and safety. The possibility to manufacture structures at the nanoscale - far below the wavelength - will radically change the traditional approaches by exploiting physical effects not accessible before. Europe has strong and recognised R&D capabilities in photonics including SMEs.

Microsystems integrate and interface multiple core technologies and related materials to implement a variety of functions. They are implemented through scalable homogeneous or heterogeneous hardware integration technologies in order to advance miniaturisation, functionality and reliability of the sensing, processing, actuating and communicating functions. Power autonomy (consumption and supply) is a common issue. Integration of multiple functions (sensing, logic, energy collection, wireless communication) into traditional materials, in particular textiles, is one of the priorities. In the medium term, there is growing industrial interest to integrate nanosensors in microsystems, mainly due to an increase in sensitivity, a device simplification and the associated cost reduction.

Embedded systems, computing and control: Inexpensive networking, sensing and sophisticated control is moving decision-making to the point-of-action, and value-added functions in software are driving the diffusion of embedded systems in an ever broader range of applications. Recent trends in embedded systems design include enhanced components and model-based methodologies for high-confidence systems able to overcome the challenge of complexity and the resulting low productivity. Computing systems are moving to multi-core and polymorphic architectures where radical rethinking of systems software, programming paradigms and abstractions is needed to overcome complexity. Engineering large distributed systems increasingly requires cooperative networked control systems, and optimisation and decision support methods and tools which are used to modernise physical infrastructures, to control complex processes in manufacturing, or to monitor and control systems performance.

Research addressing this Challenge in particular will encourage international cooperation under the Intelligent Manufacturing Systems (IMS) scheme.

Technologies developed under this Challenge are expected to be tailored to meet key societal and economic needs.

Objective ICT-2009.3.1: Nanoelectronics Technology

This objective focuses on the 'beyond CMOS' field, the advanced aspect of the 'More than Moore domain', their integration and their interfacing with existing technology. It also targets small volume oriented, flexible manufacturing with a high product mix and prepares for the future and for more disruptive approaches. The activities in this area are complementary to the mid term, industrial and more application-oriented activities in the ENIAC JTI[12].

Target outcome

a) **Miniaturisation and functionalisation**

Beyond 22 nm devices, advanced components with lower scaling factors including non-CMOS devices and their integration and interfacing with very advanced CMOS to meet requirements of performance and function of components and a large variety of miniaturised (sub)-systems. Activities with a high risk factor or an industrialisation perspective beyond 2014 and having a generic development focus are targeted.

STREPs should address one or more of the following issues:

- increasing process variability and expected physical and reliability limitations of devices and interconnects;
- the need for new circuit architectures, metrology and characterisation techniques;
- interface and system integration technologies on a single silicon chip (System-on-Chip) and/or integration of different types of chips and devices in a single package (System-in-Package);
- new device structures for non-Si and Si based advanced integrated components to add functionality to circuits and (sub)systems;
- disruptive technologies and functional devices beyond the traditional ITRS shrink path ('Beyond CMOS'): new non-CMOS logic, analogue and memory devices, and their integration in and/or interfacing with CMOS;

[12] The JTI research agenda addresses application-guided industrial cooperative research in the 'More Moore' and 'More than Moore' domains for the next generation components and systems and targets large strategic initiatives. In manufacturing, the JTI targets larger volume fabrication with emphasis on generic manufacturing improvements and equipment development. See http://www.eniac.eu

- specific issues such as electro-magnetic interference, heat dissipation, energy consumption.

A Network of Excellence should address the merging of 'Beyond CMOS' and advanced 'More than Moore' devices and processes to create an extended CMOS backbone, to meet the challenge of the increasingly analogue behaviour of 'Beyond CMOS' devices and of systems partially based on new architectures and on less reliably functioning devices.

b) **Manufacturing technologies**

- *New semiconductor manufacturing approaches, processes and tools* to reduce cycle time, enhance production quality, variability control and productivity; Improved equipment productivity and integration, quality control of novel materials and devices, and reduction of energy use, water and chemicals consumption, waste and environmental impact; Advanced models and simulation tools for flexible manufacturing and heterogeneous integration; interfaces to connect special processes (e.g. MEMS with CMOS); Novel approaches for advanced system integration and functionalised packaging, for thin film technology, 3D integration and wafer level packaging.
- *Joint assessments of novel process/metrology equipment and materials*, in close collaboration between equipment manufacturers, end-users, research institutions and academia, targeting initiatives ranging from proof-of-concept for potentially 'disruptive' approaches to prototype testing.
- *Supporting 200/300 mm wafer integration platforms* hosted and supported by research institutes and short user-supplier feedback loops to the benefit of smaller suppliers.
- Preparatory work for 450 mm wafer processing targeting material and equipment companies including process requirements, metrology, equipment metrics, test wafers, carriers and physical interfaces.

IPs are expected to integrate approaches for flexible and sustainable short cycle time manufacturing. They may also address clustered joint equipment assessments or wafer integration platforms. STREPs should cover focused and complementary semiconductor manufacturing topics. The objective is to support at least one IP in addition to STREPs.

c) **Support measures**

- Roadmaps, benchmarks and selection criteria for the industrial use of 'Beyond CMOS' technologies with the aim to identify research gaps.
- Access for academia and research institutes to affordable silicon in state-of-the-art technologies for prototyping and low volume production, and to related design expertise and commercial tools.
- Stimulation of the interest of young people in electronics careers; training and education, including access for students and PhDs to production lines and research labs.
- Linking of R&D strategies and stimulation of international cooperation, in particular with the USA, Russia, Taiwan and Japan.
- Support and coordination actions for materials and equipment suppliers for preparatory work for 450mm processing and equipment at global level.

<u>Expected impact</u>

- Strengthened competitiveness of the European nanoelectronics industry through risk-sharing in generic developments and collaboration in advanced research between materials, equipment and component suppliers, integrators, semiconductor manufacturing plants and institutes.

- Contribution to the competitiveness and the attractiveness of Europe to investments in components miniaturisation, functionalisation and manufacturing.
- New electronics applications of high economic and socio-economic relevance.
- Maintained European knowledge and skills at the frontier of nanoelectronics technology and in integrated miniaturised electronic systems.
- Increased critical mass of resources and knowledge in fields of European excellence to allow for further European partnership in the world-wide collaboration.
- Contribution to preserving a critical mass of manufacturing capacity in Europe. European research organisations maintained in leading positions.

Funding schemes

a): STREP, NoE; b): IP, STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 27.5 million; the objective is to support at least 1 IP under b) in addition to STREPs

- NoE: EUR 3 million - CSA: EUR 4.5 million

Call

ICT call 5

Objective ICT-2009.3.2: Design of Semiconductor Components and Electronic Based Miniaturised Systems

This objective addresses generic platforms, methods and tools to cope with the design challenges in the next generations of technologies and with heterogeneous integration of different functions. The activities in this area are complementary to the activities in the ENIAC JTI[13].

Target outcomes

a) **Improved design platforms, interfaces, methods and tools** that meet the requirements of semiconductor companies, fab-less design houses and system developers, including :
   - Design of energy efficient electronic systems, and thermal effect aware design;
   - Integration of heterogeneous functions: 3D, System-in-Package, Network-on-Chip, wireless (microwave, mm-wave and THz) systems;
   - Methods for reuse of IP blocks, test and verification;
   - Design solutions for moving the application boundary between hardware and software to fit performance needs;
   - Design platforms and interfaces for mixed/new technologies;
   - New paradigms for design of reliable circuits with less reliable devices;
   - Reliability-aware design including EMR/EMC requirements;

[13] Design activities in the ENIAC JTI target large initiatives to develop tools and methodologies of common interest which will be demonstrated in application specific Sub Programs and specific TCAD, modelling, simulation and design activities embedded in application projects. See http://www.eniac.eu

b) **Modules and tools for embedded platform-based design**

An integrated design environment for embedded systems that can be extended and customised. This covers software, hardware/software and system design tools for holistic design, from applications down to component and platform level. Important challenges encompass flexibility of the platform to support different applications, increased interoperability of tools primarily from SME vendors and openness in order to facilitate the entry of new industry players, support associated standardisation, easily import existing components and/or handle upgrades. Key issues include: (i) technology for efficient resource management, (ii) tools supporting design space exploration, in particular trade-offs when co-developing hardware and software; and (iii) advanced model-driven development.

The objective is to support one IP only to address design tool integration. STREPs should target specific issues or topics.

c) **Coordination of national, regional and EU-wide R&D strategies**

Initiatives to advance the European Research Area and to align research agendas in the field of embedded systems.

Expected impact

- Significantly increased productivity of embedded system development.
- Improved competitiveness of European companies that rely on the design and integration of embedded systems in their products by reducing design costs and time to market.
- Emergence and growth of new companies that supply design tools and associated software. Stimulated high-tech European companies, in particular SMEs, which offer innovative products and services for embedded systems design.
- Reinforced European scientific and technological leadership in the design of complex embedded systems.

Funding schemes

a): IP, STREP; b): IP, STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 27.25 million; the objective is to support one IP only under a) and one IP only under b) in addition to STREPs

- CSA: EUR 0.75 million

Call:

ICT call 4

Objective ICT-2009.3.5 Engineering of Networked Monitoring and Control systems

The activities in this area address engineering technologies for large scale, distributed and cooperating systems for monitoring and control, including wireless sensor networks. These are not addressed as such by the ARTEMIS JTI to which they are complementary[16].

[16] See the ARTEMIS WP sub-programmes at http://www.artemis-ju.eu

Target outcomes

a) **Foundations of complex systems engineering**

To achieve robust, predictable and self-adaptive behaviour for large-scale networked systems characterised by complex dynamic behaviour through the development of novel abstractions and scalable methods for sensing, control and decision-making. The scope covers foundational multi-disciplinary research and proof of concept addressing the whole chain from modelling, sensing, monitoring and actuation, to adaptive and cooperative control and decision making. Activities to encourage and enable multi-disciplinary education in the areas of systems engineering and monitoring and control are welcome.

b) **Wireless Sensor Networks and Cooperating Objects**

To develop architectures, hardware / software integration platforms and engineering methods for distributed systems composed of heterogeneous networked smart objects that are enabled by sensors, actuators and embedded processors. This will contribute to better dependability, safety, security, cost and energy efficiency e.g. in manufacturing, process plants, buildings and large scale infrastructures (including environmental management systems). Research challenges include: methods and algorithms to support spontaneous ad-hoc cooperation between objects; network-centric computing with dynamic resource discovery and management; semantics that allow object/service definition and instantiation; lightweight operating systems and kernels; open wireless communication protocols for harsh (industrial or outdoor) environments; abstractions and support tools to enable (re)programming; virtual sensing and actuation through low-cost aggregation of sensors and actuators; and experimenting with novel large-scale applications of wireless sensor networks.

The objective is to support one IP only to address architectures and integration platforms, including design and demonstration, for very large scale systems of cooperating objects and wireless sensor networks. STREPs should target specific issues or topics.

c) **Control of large-scale systems**

To enable the optimal operation of large-scale dynamic systems through proactive process automation systems. Such systems should be based on process control algorithms, architectures and platforms that are scaleable and modular (plug & play) and are applicable across several sectors, going far beyond what current Supervisory Data Acquisition and Control (SCADA) and Distributed Control Systems (DCS) can deliver today. Pro-activeness requires novel predictive models for higher performance and fault adaptation and recovery. The architectures should facilitate re-use, enable QoS, and reduce the reconfiguration effort. Standardisation of monitoring and control systems in industrial environments is encouraged in all projects.

The objective is to support one IP only to architect, develop and demonstrate a new generation of open and proactive process automation monitoring and control systems, and to address associated standardisation. STREPs should target specific issues or topics.

d) **International cooperation**

Facilitation and promotion of cooperation with the Western Balkan Countries, U.S.A and India (separately) where this provide mutual benefits.

Expected Impact

- Strengthened competitiveness of the industry supplying monitoring and control systems through next generation process automation products that are superior in terms of functionality, accuracy, dynamic range, autonomy, reliability and resilience.
- Higher energy efficiency and reduction of waste and of resource use in manufacturing and processing plants; improved ease-of-use and simplified operation and maintenance of monitoring and control systems, also for non-experts; and more effective management systems for natural resources and the environment.
- Reinforced European inter-disciplinary excellence in control and systems engineering and associated modelling and simulation tools as well as in real-time computing, communications, wireless sensor (and actuator) networks and cooperating objects.

Funding schemes

a): STREP, NoE; b): IP, STREP; c): IP, STREP; d): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 27 million; the objective is to support one IP only under b) and one IP only under c) in addition to STREPs

- NoE: EUR 4 million

- CSA: EUR 1 million

Call:

ICT call 5

Objective ICT-2009.3.6 Computing Systems

Target outcomes

a) **Parallelisation & programmability**

Automatic parallelisation, new high-level parallel programming languages and/or extensions to existing languages taking into consideration that user uptake is a crucial issue. Projects on programmability & parallelism of homogeneous or heterogeneous multi-core and/or reconfigurable architectures should adopt a holistic approach addressing issues related to the underlying hardware, the operating system and the system software. Research areas include beyond static auto-parallelisation by exploiting dynamic (run-time) information; new support environments including testing, verification and debugging, program & performance monitoring and analysis; and specific hardware support for parallel programming models.

b) **Methodologies, techniques and tools**

Continuous Adaptation: Multicore and/or reconfigurable systems that continuously adapt to a constantly changing environment by going beyond the strict separation between compiler, runtime and hardware.

Virtualisation: Virtualisation technologies that ensure portability, flexibility, optimised use of resources, and overcome legacy issues for multicore and/or reconfigurable systems. This includes hardware/software interfaces for efficient virtualisation as well as machine abstractions and performance models for virtualised homogeneous or heterogeneous systems.

Customisation: Rapid extension and/or configuration of existing systems, architectural templates and tool-chains to optimally address specific application needs and performance/Watt envelopes.

c) **System simulation and analysis**

Advanced simulation and analysis of complex multicore systems to drastically improve the simulation speed of new complex, homogeneous or heterogeneous, multi-core systems;

d) **Technology implications**

Advanced system architectures, tools and compilers for next-generation semiconductor fabrication technology (for example, 3D stacking). The key challenge is to bridge architecture, system and technology research efforts.

e) **Coordination of R&D activities and strategies in High-Performance Computing**

Initiatives to align research agendas and coordinate R&D activities in high performance computing in order to advance the European Research Area; taking into account industrial and academic activities and programmes at regional, national and EU level as well as international supercomputing roadmaps.

Expected Impact

- Increased performance, power-efficiency and reliability of homogeneous or heterogeneous multi-core and/or reconfigurable on-chip computing systems.
- Accelerated system development and production, enabling new products to be realised with a considerably shorter time-to-market.
- Reinforced European excellence in multi-core and reconfigurable computing architectures, system software and tools.
- Strengthened European leadership in cross-cutting technologies that are applicable to all market segments of computing systems, from embedded to high-performance computing.
- Contribution to the creation of a European Research Area in High Performance Computing R&D.

Funding schemes

a), b), c), d) STREP e) CSA

Indicative budget distribution[10]

- STREP: EUR 24.7 million

- CSA: EUR 0.3 million

Call

ICT call 4

Objective ICT-2009.3.7: Photonics

Target outcomes

a) **Photonics technologies, components and (sub)systems** driven by key applications/social needs. Cost-effective innovative device and system integration, including electronics/photonics integration (photonics on silicon) where applicable, are overarching issues:

1) *Communications*: the vision is future-proof networks and systems enabling unlimited bandwidth through integration, more optical processing and very high spectral-density photonic transmission and the reduction of power consumption at system and component level. Actions should target developing photonic components for any part of such networks, systems or interconnects with the overall aim of reducing network complexity, increasing protocol transparency, and increasing information throughput.

2) *Lighting and light sources*: (i) highly efficient LEDs and LED-based lighting systems for general illumination offering features like high colour rendering, tuneable output spectrum and adaptable light output level; (ii) efficient solid state laser sources and compact laser-based engines for display (e.g. projection, laser TV) and lighting applications. Specific targeted actions should address a particular technology or approach; larger-scale actions could integrate a broader range of related technologies, components and/or (sub)systems.

3) *Biophotonics*: specific targeted actions on (i) molecular/functional imaging and/or (ii) minimally-invasive / point of care diagnosis and treatment monitoring. Particular emphasis is on the combination of technologies, components, (sub)systems and disciplines for medical and biological applications of photonics.

4) *Cost-effective high-performance imaging for Safety & Security*: specific targeted actions on (i) CMOS-compatible low-power uncooled image sensors with high dynamic range and single-photon imaging capability at video-rate readout speed and/or (ii) compact multi-feature imaging systems based on advanced smart pixel detector arrays with sub-picosecond timing precision, pixel-level hyper-/multi-spectral resolution, polarisation sensitivity, and intra-pixel on-chip pre-processing capabilities.

5) Specific targeted actions on *highly integrated components* for high average and high peak power lasers for ICT and industrial applications: (i) novel concepts for fibres and fibre lasers with integrated functions, such as filters, polarisers, frequency shifters, q-switches, etc.; (ii) diode lasers with new functions integrated in the semiconductor e.g. epitaxial structures for mode selection, Bragg gratings, integrated q-switches and saturable absorbers, etc.

Actions span from advanced research opening new opportunities to application-driven research with a view to industrialisation, with priority given to novel or 'breakthrough' approaches rather than incremental developments.

b) **Cost-effective versatile foundry processes for photonic integrated components based on III-V semiconductors possibly combined with other materials**. The activities may also address the further module integration and packaging. The design/process interface shall be based on widely agreed concepts and standards and the design be supported by design-rule and library based platforms. Application oriented top-down design environments may also be addressed.

c) **ERA-NET Plus action**

A joint call for proposals on a photonics topic of strategic interest, to be funded through an **ERA-NET Plus** action between national and regional programmes.

d) **Coordination and support actions**

- **SME and researchers support** through access to photonics technology and design expertise, prototype components and manufacturing facilities.

- **International cooperation**: (i) Joint definition of procedures to measure and compare research/prototype LED/OLED lighting device performances; (ii) Exchange of best practices from field trials or deployment of mature LED/OLED lighting products; (iii) Development of LED/OLED lighting standards; (iv) International workshops on selected advanced photonics research topics; research roadmaps.

- **Education and training** (excludes direct support of conferences): (i) Secondary school level outreach activities to encourage interest in photonics, especially among girls; (ii) Transnational third level education programmes in photonics, emphasising multidisciplinarity, addressing entrepreneurship, and encouraging the participation of women. The activity includes preparation of partnerships, agreements and curricula but excludes investments in infrastructure.

In view of ongoing activities in this area in Canada, Russia and the United States, the participation of these countries is encouraged, where it is of clear mutual benefit.

Expected Impact

- Actions in photonics technologies should reinforce European leadership and industrial competitiveness in the relevant application domains, or provide opportunities for new practical applications.
- The foundry action should greatly reduce non-recurring engineering costs of photonic integrated components, and should provide a safe, easy and cost-effective access for SMEs, fab-less component suppliers and researchers to production of prototype samples and industrial volumes, with a smooth path from design to prototype and volume manufacturing in Europe.
- The ERA-NET Plus Action should foster closer cooperation and greater alignment between participating states' research activities in topics deemed strategically important and of joint interest.
- The SME and researchers support action should foster the broader take-up of advanced photonic technologies towards innovative products.
- International cooperation activities in photonics should lead to greater cooperation between European players and their counterparts elsewhere on common goals for mutual benefit which will further European interests.
- Education and training activities should foster a new generation with photonics skills and expertise, both technical and with the ability to exploit developments commercially in Europe, including the participation of women.

Funding schemes

a).1), 2): IP, STREP

a).3), 4) and 5): STREP

b): IP

c): ERA-NET Plus implemented through CSA

d): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 47 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs

- ERA-NET Plus: EUR 10 million

- CSA: EUR 3 million

Call

ICT call 5 (for a), b), d))

ICT call 4 for c): ERA-NET Plus. Any funds remaining following the selection of an ERA-NET Plus action will be transferred to *Objective ICT-2009.3.8 Organic photonics and other disruptive photonics technologies*

Objective ICT-2009.3.8 Organic Photonics and Other Disruptive Photonics Technologies

Target outcomes

a) **Organic Photonics**

Specific targeted actions to address organic, polymer, single molecule and carbon-nanotube based photonic components, including organic-inorganic hybrid components.

Actions span from advanced research opening new opportunities to application-driven research with a view to industrialisation, with priority given to proof-of-principle or 'breakthrough' approaches rather than incremental developments.

Work should aim at photonic functional components and can include the necessary research on the appropriate material.

Included are:

- OLEDs (including OLEFET) and lasers for lighting, illumination, projection or display applications[17]. Critical issues are: conversion efficiency, extraction efficiency, colour gamut, lifetime, intensity, wavelength, costs etc.
- Organic photovoltaic cells with conversion efficiencies higher than 10% and a life time greater than 5 years for mobile ICT applications such as PDAs, laptops, and mobile phones. Critical issues are: conversion efficiency, lifetime, costs etc.
- Light guiding structures. Critical issues are: waveguides, integrated circuits, micro-cavities, POF etc.
- Organic photonic sensors, lasers and amplifiers. Critical issues are: lifetime, output power, wavelength regime, electric pumping etc.

b) **Disruptive / cutting-edge photonic technologies and materials**

Specific targeted actions exploiting effects at the limits of light-matter interaction in nanophotonics (i.e. sub-wavelength structures, plasmonics, controlling the quantum degrees of freedom, metamaterials, photonic crystals, biological systems) for transition from advanced research to industrial applications, including photovoltaics;

Actions to structure and integrate advanced research activities across Europe in this area.

In view of ongoing activities in this area in Australia, Russia and the United States, the participation of these countries is encouraged, where it is of clear mutual benefit.

[17] Given the synergies between the areas addressed by objective ICT-2009 3.3 a) on *Flexible, organic and/or large area electronic devices and building blocks* and objective ICT-2009 3.8 a) on *Organic Photonics*, in particular in the work on OLEDs, proposals that address both these objectives are welcome. Proposals should be submitted to the objective where they have their 'centre of gravity'.

Expected Impact

- Reinforced European leadership and industrial competitiveness, and new opportunities for practical application opened in new domains.
- Leading-edge research in Europe in photonic technologies and materials fostered through networking, structuring and integration of activities.

Funding schemes

a): STREP; b): STREP, NoE

Indicative budget distribution[10]

- STREP: EUR 25 million

- NoE: EUR 5 million

Call

ICT call 4

Objective ICT-2009.3.9: Microsystems and Smart Miniaturised Systems

Target outcomes

a) **Heterogeneous Integration**

Integrated and interfaced multiple core technologies and related materials for the next generation of microsystems and smart miniaturised systems. Particular emphasis is on innovative concepts of industrial relevance and crosscutting technological challenges that currently limit industrial take-up.

Focus is on: (i) the heterogeneous combination of elements to integrate higher levels of intelligence into multifunctional microsystems including multisensing, processing, wireless and wired communication, and/or actuation capabilities; (ii) smart systems based on innovative nanosensor devices and components, providing unprecedented levels of performance and representing a disruptive approach to known or new challenges; and (iii) the integration of multiple elements of the value chain of heterogeneous systems - materials, modelling, design, processes, devices, packaging, characterisation, testing - contributing to more efficient manufacturing.

Proposals are expected to be highly innovative and to address exploitation perspectives in multiple application sectors.

b) **Autonomous energy efficient smart systems**

Autonomous smart systems making use of efficient energy management and communication solutions for long-lasting operation.

This includes: (i) innovative approaches to energy scavenging, storage and transmission, power generation, accumulation and consumption, which can satisfy real-life needs, adapt to the environment and operate safely and reliably under a wide range of conditions; and (ii) reconfigurable, low power, adaptive miniature smart transceivers for short- and long-range wireless communications of sensor-based systems.

Projects should preferably address both the energy and the communication challenge.

c) **Application-specific microsystems and smart miniaturised systems**

Technology development will address one of the following application sectors:

1) Biomedical:

Proposals should address one of the following topics: (i) Lab-on-Chip (LoC) platforms, covering the value chain from research to validation in explicit contexts of drug discovery, diagnosis, and/or therapy; emphasis for diagnosis and monitoring applications is on integrating sample preparation and flexibility to multi-type assays; (ii) microinstrumentation for microinjection and cell-manipulation; and (iii) microsystems interacting with the human body, with particular emphasis on autonomous miniaturised active implants, bio-robots and non-invasive body microsystems for monitoring, diagnosis and therapy. Biosensors and microfluidic chips/components as such are not part of this call.

2) Telecommunications:

Proposals should address Microsystems and smart systems for telecommunications and networking. Emphasis is on extreme miniaturisation for multifunctional networked RF applications, such as smart RFID, ultra-low power transceivers and reconfigurable antennas.

3) Environment and food/beverage:

Proposals should address integrated multi-sensing microsystems for environmental applications (including water treatment) or food and beverage quality and safety. Emphasis is on reliability and cost reduction.

4) Transport, safety and security:

Proposals should address (i) safety-critical microsystems and robust smart miniaturised systems for transport applications, with particular emphasis on smart systems for the full electric vehicle, or (ii) advanced sensor- and actuator-based systems for safety and security. Focus is on integrating networking capabilities and the possibility of operating in harsh environments.

5) Smart Fabrics and Interactive Textiles (SFIT):

Proposals should address multi-functional textiles and fabrics, where sensing, actuating, communicating, processing and power sourcing are seamlessly integrated. The focus should be on one or more of the following aspects: (i) advanced solutions to overcome existing functional limitations; (ii) fibre-level components and systems and their integration into smart textiles; (iii) development and integration of stretchable and wearable electronics embedded in textiles; (iv) fully integrated Smart Fabric and Interactive Textile (SFIT) solutions for applications where distributed functions are essential. Proposals should also consider user friendliness, comfort, manufacturability, sustainability, cost and contribution to testing certification procedures, where appropriate.

A balanced coverage of the different application sectors is foreseen.

d) **Coordination and support actions**

- Coordination between technology providers and users representing the whole value chain (R&D organisations, industrial providers and users and, when relevant, ethical experts, health insurance and consumer organisations) in the following sectors: 'in vitro diagnostics' and 'food/beverage quality'.
- Techno-economic analysis of EU, Eureka and national project results in this research area, and recommendations for actions to optimise their joint value.

- Dissemination, promotion (including coordination of service provision) and public awareness of activities in the area.
- Identification of international cooperation opportunities in the area.

Expected impact

- Strengthened global competitiveness of European industry in microsystems and smart miniaturised systems.
- Wider use of smart systems in relevant application sectors, thereby strengthening the competitiveness of the user industries and meeting the societal needs of citizens.

Funding schemes

a) IP, STREP; b): STREP; c) IP, STREP; d) CSA

Indicative budget distribution[10]

- IP/STREP: EUR 77 million with a minimum of 50% to IPs and a minimum of 30% to STREPs

- CSA: EUR 3 million

Call:

ICT call 5

4.4 Challenge 4: Digital Libraries and Content

Digital content is today being produced in quantities that are deeply transforming the enterprise and the creative industries. Conditions for production and consumption are also rapidly changing as more and more content is produced by users. Organisations, public and private, are faced with maintaining, managing and exploiting increasing amounts of data and knowledge, in environments that are continually changing. New ways of expressing and representing cultural and scientific content in digital form are creating new opportunities for people to experience and share assets.

Progress in ***knowledge modelling and processing*** has enabled the creation of innovative commercial and community services and is progressively transforming scientific discovery. Semantic web technologies are likewise starting to be used on an industrial scale by information providers and search engines alike to offer more sophisticated services. Conceptualising and producing digital content as a container of rich objects that can be individually selected and manipulated is emerging as a trend.

This increasingly complex content needs to be safeguarded for future access. ***Preservation*** needs to be intelligently planned, capturing and selection of content need to be automated and hardware and software dependencies must be overcome. Keeping the associated semantics as well as the digital objects, should guarantee the integrity and authenticity of the information as originally recorded.

If these challenges are met, richer content can bring new opportunities to the exploitation and ***sharing of Europe's rich cultural and scientific resources***. New services will engage users in new ways of experiencing and understanding cultural resources. They will enable the aggregation and annotation of objects available in digital libraries. 3D and visualisation will provide access, mainly through virtual re-creations of cultural and scientific artefacts.

More abundant, accessible, interactive and usable content and knowledge, coupled with shifts in demands (future of education and training systems, productivity, time to competency, focus on intangible assets) contribute to ***reshaping the way we learn:*** teaching methods are increasingly focusing on inquiry-based, problem-solving approaches; technologies are suggesting new ways to generate learners' engagement and motivation and to support innovation and creativity; learning is increasingly integrated into business processes, corporate knowledge management and human resources systems. The research is becoming intrinsically cross disciplinary, requiring input from cognitive and social sciences, pedagogy, computer and neurosciences.

Research under this Challenge should take into consideration relevant technologies and other results from successfully completed or ongoing projects.

Objective ICT-2009.4.1: Digital Libraries and Digital Preservation

Target outcomes

a) **Scalable systems and services for preserving digital content**: handling the whole workflow for different types of digital resources, guaranteeing their long term integrity and authenticity. Research should demonstrate the feasibility of systems and services proposed and assess their use by organisations in large scale testbeds (e.g. science, business and financial records, public records, multimedia/audiovisual and performing arts).

b) **Advanced preservation scenarios**: methods, models and tools for managing digital memory, focusing on challenging preservation problems which cannot be adequately handled by current models. These should result in:

- b1/ Methods and tools for **preserving complex objects**, addressing the life-cycle of composite digital information instances (e.g. multiple embedded structures, actionable objects, distributed and interlinked resources and ontologies, transient information and ephemeral data).
- b2/ **Intelligent digital curation and preservation** systems able to learn, reason and act autonomously, integrating tools and methods to support the complex decision making processes for appraisal, selection and management of diverse collections of digital resources. The system should ensure that the representation of the objects and their embedded semantic knowledge in order to support their future re-use. Appropriate verification scenarios should be an integral component of the work.

c) **Innovative solutions for assembling multimedia digital libraries** for collaborative use in specific contexts and communities, enhancing scholarly understanding and experiences of digital cultural heritage. This includes work on the dynamic aggregation of cross-media resources across existing institutional digital libraries and repositories. Research should address scalability, interoperability and distributed architectures, aggregation and semantic search tools. Validation should address researchers and cultural heritage professionals but be open to wider audiences.

d) **Adaptive cultural experiences** exploring the potential of ICT for creating personalised views of various forms of cultural expression, reflecting individual narrative tendencies (i.e. adapt to the background and cognitive context of the user) and offering meaningful guidance about the interpretation of cultural works.

e) **Interdisciplinary research networks** bridging technological domains (e.g. computing models, knowledge representation, visualisation and graphics), information and archival sciences, and social and cognitive sciences to advance the state-of-the-art in well identified and focused application areas (e.g. digital preservation).

f) **Promoting the uptake** of EC-funded research enabling the deployment of new ICT-based cultural and memory preservation services, leveraging the impact of associated national initiatives; **roadmapping** and identification of future 'Grand Challenges'; establishment of a **pan-European network of 'living memory centres'** for validations, demonstrations and showcases.

Expected Impact

- Significant advances in the ability to offer easily customisable access services to scientific and cultural digital resources, improving their use, experiencing and understandings;
- Reinforced capacity for organisations to preserve digital content in a more effective and cost-efficient manner, safeguarding the authenticity and integrity of these records;
- Significant reduction in the loss of irreplaceable information and new opportunities for its re-use, contributing to efficient knowledge production;
- Leading edge research in Europe strengthened through restructuring of the digital libraries and digital preservation research landscape. Leveraged impact of research results.

Funding schemes

a): IP); b) b1/: STREP; b2/: IP; c) IP d) STREP e): NoE; f): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 56 million with a minimum of 50% to IPs and a minimum of 30% to STREPs

- NoE and CSA: EUR 13 million;

Calls

ICT call 6

Objective ICT-2009.4.2: Technology-Enhanced Learning

Target outcomes

a) **Learning in the 21st Century**: large-scale pilots for the design of the future classroom (exploring both technology and teaching practices, for teachers and students, their orchestration for specific, justified age groupings or subjects), supporting individualisation, collaborations, creativity and expressiveness in more active, reflective and independent learning activities. Research should address innovation in learning and teaching, the underlining change processes, relevant new summative and formative assessment methods and novel solutions supporting the active participation of a wider community of stakeholders contributing to a student's growth.

b) **Reinforce the links between individual and organisational learning, and creativity:** innovative solutions embedding learning experiences in organisational processes and practices, through systems embracing talent, knowledge, workflow, collaborative innovation and competency management. Solutions should cover effectiveness of learning content, new forms of collective intelligence and entail deeper understanding of the role of ICT for creativity, informal learning and collaborations (IP). Research should also address new ways of combining creative, cognitive and computational processes (STREP).

c) Innovative **adaptive and intuitive systems for learning** featuring affective and emotional approaches, including related new forms of assessing learning outcomes as well as feedback/guidance mechanisms (innovative diagnostic techniques) to the learner and the teacher. Work may relate to serious games and immersive environments and include advances in the combination of simulation, story telling, and collaborative learning. The chosen field should be well justified in terms of learning efficacy.

d) **Revolutionary learning appliances** (including toys) and advanced cognitive tutors, able to promote specific cognitive processing or abilities. Proposals should address: specific social and learning problems; science, technology and maths; or specific tasks that impose high cognitive demands.

e) Focused **interdisciplinary networks** on specific emerging trends (e.g. serious games/mobility and learning), linking a limited set of established excellences and learning labs, and including appropriate mechanisms for cross-fertilisation between disciplines. These networks should leverage national research activities and achieve demonstrable visibility at international level.

f) **Awareness building and knowledge management** on the results of EU RTD projects in the field; exploratory/roadmapping activities for fundamentally new forms of learning; identification of Grand Challenges; socio-economic evaluations (including transfer and scalability mechanisms, in education and for SMEs); establishment of a pan-European network of living schools for validations, demonstrations and showcases.

Expected Impact

- More conducive, highly motivating and flexible learning places, supporting better education, competency development and employability
- Increased empowerment of both learners and teachers through better adaptation to individual learning needs
- Significant contribution to the global competitiveness of European players in a consolidating market
- Leading edge research in Europe strengthened through restructuring of the technology-enhanced learning research landscape. Leveraged impact of research results.

Proposals must include a methodologically sound evaluation of their expected impact.

Funding schemes

a): IP; b): IP and STREP; c), d): STREP; e): NoE; f): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 39 million with a minimum of 50% to IPs and a minimum of 30% to STREPs

- NoE and CSA: EUR 10 million

Calls

ICT call 5

Objective ICT-2009.4.3: Intelligent Information Management

Target outcomes

a) **Capturing tractable information**: robust and performant technologies to acquire, analyse and categorise extremely large, rapidly evolving and potentially conflicting and incomplete amounts of information. These technologies will extract, correlate and integrate data from diverse sources and formats (multimedia and 3D content; heterogeneous databases; data streams from sensors and scientific equipment; social interactions and networked appliances; information from business processes and software services) while tracing provenance, evaluating trust level and assessing reliability. The scalability, flexibility and performance of such methods and techniques will be demonstrated by rigorous empirical testing over large-scale testbeds.

b) **Delivering pertinent information**: usable and customisable systems to improve the efficiency of the information lifecycle, starting from proactive diagnoses of information gaps and triggering goal-dependent search, acquisition, structuring and aggregation of relevant local, remote and streaming resources. Managing this information and making it actionable requires large-scale reasoning resulting in effective ranking, profiling and interpretation as well as versioning for time-dependent compliance and justification. Such systems will support the navigation, manipulation and consumption of digital information by means of adaptive user-information interactions based on the state of the art in the psychology of human perception and attention. The effectiveness of such systems will be validated with appropriately-sized groups or communities of representative users.

c) **Collaboration and decision support**: efficient and dependable problem solving and decision support systems for critical, information-bound domains in which our ability to share and exploit information is outstripped by the rate of its growth in size and complexity. Intended beneficiaries include organisations with complex business processes and access control policies; scientific communities collaborating on challenging projects and building very large datasets; teams of professional creators working on complex designs or multimedia materials; and web communities with sophisticated cooperation needs. The effectiveness of such solutions will be tested against the requirements of the respective groups or communities.

d) **Personal sphere**: intuitive systems that help individuals secure, manage, visualise and interpret their personal information, attention trail and social history so as to enable the provision of personalised and context-dependent information from multiple sources and services. A specific requirement and design principle is that such systems preserve privacy and implement auditable information disclosure policies that are under user control and whose application can be verified at all times. Their usability and rate of uptake will be monitored by means of verifiable quantitative indicators.

e) **Impact and S&T leadership:** networks and other initiatives designed to link technology suppliers, integrators and leading user organisations. These actions will help develop a common understanding, including vis-à-vis neighbouring disciplines, and ensure proactive cross-fertilisation between EU projects and other relevant industrial and national activities. They will address barriers hindering a wider deployment of research results, work towards establishing or advancing widely recognised standards, reference architectures and benchmarks, and increase awareness of the potential of the technologies at stake within broader audiences.

Expected impact

- Better leveraging of human skills, improved quality and quantity of output and reduced time and cost allowing users to concentrate on more creative and innovative activities.

- Increased ability to identify and respond appropriately to evolving conditions (e.g. in finance, epidemiology, environmental crises …) faster and more effectively. Reinforced ability to collaboratively evolve large-scale, multi-dimensional models from the integration of independently developed datasets.

- Higher levels of information portability and reuse by creating an ecology of systems and services that are dynamic, interoperable, trustworthy and accountable by design.

- Increased EU competitiveness in the global knowledge economy by fostering standards-based integration and exploitation of information resources and services across domains and organisational boundaries.

- Strengthened EU leadership at every step of the computer-aided information and knowledge management lifecycle, creating the conditions for the rapid deployment of innovative products and applications based on high quality content.

Funding schemes

a): NoE, IP, STREP; b), c): IP, STREP; d): STREP; e): CSA, NoE

Indicative budget distribution[10]

- IP/STREP: EUR 62 million with a minimum of 50% to IPs and a minimum of 30% to STREPs

- NoE/CSA: EUR 8 million

Calls

ICT call 5

4.5 Challenge 5: Towards sustainable and personalised healthcare

The health domain and its three main industries, pharmaceuticals, medical devices and eHealth, are dominant economic sectors with respect to employment creation and growth. Sustainable delivery of quality healthcare at affordable cost is a major challenge for European healthcare systems for a variety of reasons such as: (a) demographic change and increasing prevalence of chronic diseases; (b) inefficiencies, inadequate safety standards and quality control; (c) demanding citizens who require best-quality care and cover for the use of latest diagnostics and treatments; (d) current focus on treatment rather than on prevention and (e) reducing workforce, availability and accessibility of skilled nurses and medical specialists. This calls for changes in the way healthcare is delivered and the way medical knowledge is managed and transferred to clinical practice. ICT tools and services are key to implement these changes in such an information-intensive domain.

Advances in basic ICT components and the convergence of ICT-nano-bio technologies allow for the development of life saving applications with great business opportunities. ICT may offer useful capability to improve illness prevention and safety of care and to facilitate active participation of patients, thus opening new opportunities in personalised health and disease management. Recent capabilities of modelling, simulation and biomedical imaging, combined with the latest knowledge about diseases, give rise to a new generation of predictive medicine. In this challenge, support will go to ***highly interdisciplinary research*** aiming at:

- Improved productivity of healthcare systems by facilitating better integrated care and management of chronic diseases at the point of need and quicker transfer of knowledge to clinical practice.
- Continuous and personalised care solutions, addressing the participation of patients in care and prevention processes, and responding to the needs of elderly people.
- Savings in lives and resources by focusing on prevention and prediction of diseases and on improved patient safety by optimising medical interventions and preventing errors.
- New ICT-based environments for biomedical research and predictive medicine that push the boundaries of technologies like grid computing, modelling and simulation.
- Reinforcing the leadership of Europe's eHealth and medical imaging/devices industries and attracting back to Europe research activities of the pharmaceutical industry.

All activities will take into consideration relevant regulations as well as relevant results and work from successful or ongoing projects from EU Framework Programmes or other initiatives such as Joint Technology Initiatives. The centre of gravity of all activities will be in ICT, however, if any efforts are required in other directions such as data collection or basic clinical, medical, biological or nanotechnology-related research, these will represent less than 25% of the total effort. Successful outcomes will contribute directly to the priorities of the i2010 initiative and will be coordinated with the activities related to chronic disease management under the Competitiveness and Innovation Programme (CIP).

Objective ICT-2009.5.1: Personal Health Systems

Target Outcomes

a) **Minimally invasive systems and ICT-enabled artificial organs:** Solutions to enable diagnosis, treatment and management of diseases remotely, i.e. outside hospitals and care support and predictive models etc. The roadmap should develop recommendations for future research in these areas as well as the expected impact on quality and safety of care.

d2) Interoperability conformance testing approaches and tools for software and systems to enable large scale, consistent and safe health data and knowledge exchange. The roadmap will cover research needed to bring the patient safety aspects stronger into the focus of emerging and future interoperability conformance testing and will address the i) relation and synergy with the certification tools and methods for quality and safety of the electronic health records and other health information systems; ii) the potential of increasing the coverage of existing testing tools to detect and prevent safety threats such as errors and incompatibilities between eHealth software and products before deployment; and iii) semantic interoperability issues. It will take into account existing initiatives on conformance testing and on certification processes reaching out to implementers of connected/networked eHealth solutions. It should seek cooperation with similar developments in other parts of the world.

Expected impacts

- Improved patient safety in surgery through advanced ICT applications for training, pre-operative planning, and computer-aided surgical interventions.
- Earlier detection of adverse events, faster, cheaper and more accurate recruitment to clinical trials, considerable cost savings through reduction in paperwork and duplicative data entry.
- Bridging the gap between clinical research and medical practice, enforcing collaboration between pharmaceutical industry, healthcare IT industry, academic institutions and healthcare providers.
- Enhanced health security through innovative event-based surveillance tools. Accelerated adoption of electronic health record systems supported by more user-friendly interfaces for input and output of health data.
- More efficient mitigating of patient safety risks by providing framework for testing of interoperability solutions for exchange of healthcare information.

Funding schemes

a) and b): IP/STREP; c): STREP; d1) and d2): CSA (SA only);

Indicative budget distribution[10]

a) and b): IP/STREP – EUR 27 million; the objective is to support at least 1 IP under a) and at least 1 IP under b) in addition to STREPs

c) one STREP with maximum EC contribution of EUR 2 million

d1)-d2): one SA for each topic with maximum EC funding of EUR 500 000

Call

ICT call 4

Objective ICT-2009.5.3: Virtual Physiological Human

Target outcomes

Proposals are expected to address one of the following target outcomes:

a) Development of **patient-specific computer based models and simulation** of the physiology of human organs and pathologies. The models should be multiscale by integrating relevant aspects of anatomy and physiology across different levels (from molecular and cellular to tissue and organ levels). The emphasis should be on the integration of existing models rather than on development of new models. The use and benefits of the models must be demonstrated for a specific clinical need covering prediction of disease, prediction of treatment outcome and/or early diagnosis. Any organ or pathology could be targeted as clinical application. Access to existing computing facilities external to the consortium could be supported.

   The objective is to support at least 1 IP to be funded under a).

b) Development of **ICT tools, services and specialised infrastructure for the bio-medical researchers** to support at least two of the following three activities: i) to share data and knowledge needed for a new integrative research approach in medicine (biomedical informatics), ii) to share or jointly develop multiscale models and simulators, iii) to create collaborative environments supporting this highly multidisciplinary field. When necessary, computing power and data management could be sought through access to existing advanced grid infrastructures as well as high performance computing resources such as the emerging petascale computing facilities. New tools, services and applications will also be evaluated on their effectiveness and their ability to interface with existing medical research infrastructures. Their targeted services will facilitate the clinical use of computer based organ and disease models as well as biomedical data. These tools and services will complement and be compatible with existing methods and standards (terminologies, ontologies, mark-up languages) like those used by the Network of Excellence –VPH NoE (FP7-ICT-call 2). International Cooperation in this field is encouraged.

   The objective is to support at least one IP to be funded under b).

c) Support action on **evaluation and assessment of VPH projects**. Assessment proposals will address at least the following three aspects: i) the optimal use and contribution to the shared tools and infrastructure, ii) the clinical achievements, iii) the market potential or penetration. The proposed methodology should take into account existing international efforts and promote global validation framework.

d) Coordination/Support action to develop an **observatory on the achievements and evolution of the broader Biomedical Informatics field** which builds on synergies between bioinformatics, medical informatics, and neuroinformatics. The action should incorporate intensive dissemination and training components and facilitate communication between projects, including VPH projects and those funded beyond the ICT priority, so that a productive, open European environment for cross-collaboration among the different fields involved can be sustained over time. In that respect, the action should take advantage of the achievements of previous Networks of Excellence and other projects funded under FP6.

Expected Impact

- More predictive, individualised, effective and safer healthcare.
- Accelerated developments of medical knowledge discovery and management, development of devices and procedures using *in-silico* environments.
- Improved interoperability of biomedical information and knowledge.

- Increased acceptance and use of realistic and validated models that allow researchers from different disciplines to exploit, share resources and develop new knowledge.
- Reinforced leadership of European industry and strengthened multidisciplinary research excellence in supporting innovative medical care.

Funding schemes

a-b): IP/STREP; c-d): CSA

Indicative budget distribution[10]

a) and b) IP/STREP – EUR 61 million[19]; with a minimum of 30% to STREPs and with more than 50% to IPs, including at least one IP under a) and at least one IP under b)

c) and d) CSA EUR 2 million [1 CSA per area with a maximum EC funding of EUR 1 million]

Call

ICT call 6

Objective ICT-2009.5.4: International Cooperation on Virtual Physiological Human

The objective is to strengthen the international impact of the EC funded research in Virtual Physiological Human (VPH) and to facilitate global cooperation by linking on-going (at the time of the closure of the ICT-FP7 call 4) EU projects with non EU projects and initiatives that reflect common goals and objectives.

Target outcomes

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

a) Interoperability: Joint development of interfaces between relevant scientific databases, web services, mark-up languages such as CellML, metadata and ontologies;

b) Tools and services for global cooperation such as collection and maintenance of tools and methods for modelling and simulation, curated models, and collaborative developments of interconnected libraries and data repositories;

c) Contribution to an international validation environment supporting joint verification and validation of the clinical relevance of the models.

Partners from on-going EU projects which are relevant to the VPH area will be supported to cooperate with partners of on-going international projects that address one or more of the target outcomes a), b) and c). Preference will be given to proposals that address multiscale modelling and keep all results open and free for the research community. The proposal will include agreement from the on-going projects that engage in collaboration. Funding can be requested by all partners, including one or two Third Country organisations, to cover the coordination and clearly specified joint activities that are not undertaken by the projects they represent.

[19] Considering the coverage of the projects already funded in this field, the selection of proposals targeting clinical applications other than cancer and cardiovascular diseases will be given preference in case of proposals with tied scores at the evaluation stage.

4.6 Challenge 6: ICT for Mobility, Environmental Sustainability and Energy Efficiency

Economic growth is increasing the demand for energy. To maintain its prosperity and competitiveness on global markets, Europe has to focus on energy efficiency in the most energy-intensive sectors[20]. The recent liberalisation of the energy market has stimulated the offer of eco-innovative solutions and new economic models at service supply level, at local level (cities, neighbourhoods) and at large.

Society at large is increasingly aware and sensitive to climate change impact and to the importance of a safe, clean and healthy environment to sustain quality of life. EU leaders have pleaded in favour of an integrated climate and energy policy[21]. In addition to reducing its gas emissions, Europe must also take measures to adapt to climate change and minimise adverse impact on people, the economy and the environment[22].

Transport accounts for ~30% of total energy consumption in the EU. While the EU is currently negotiating with the automotive industry on how to reach an average CO_2 emission of 120g/km for the new cars fleet by 2012, ICTs offer a new, complementary way of reducing CO_2 emissions and increasing safety of the whole transportation system. This includes dynamic transport management and control strategies involving multiple interactions with vehicles.

ICT for safe, clean and smart mobility

ICT continues to provide new intelligent systems that assist the driver to avoid accidents, provide drivers with real time information to avoid congestion, and optimise a journey or the engine performance to improve energy efficiency. Autonomous on-board systems are complemented with vehicle-to-vehicle and vehicle-to-infrastructure co-operative technologies and improved, flexible traffic network management. The future transportation system needs cleaner and more efficient vehicles, energy-efficient intelligent infrastructure (including cooperative traffic control and management systems), as well as new mobility concepts. Improving safety remains a key objective.

ICT for energy efficiency

ICT plays an increasing role in reducing the energy intensity of the economy, thus helping to decouple growth from energy consumption and creating new opportunities. Innovative ICT-based energy saving tools and techniques will help the European products and services to become more competitive and will foster the emergence of a new category of jobs and energy efficiency services. The power grid needs new ICT-based monitoring and control systems to take on its growing complexity and distribution and has to incorporate user-oriented energy trading facilities; optimisation in near-real time of the production/demand matching is the challenge to achieve energy positive buildings and neighbourhoods.

ICT for environmental sustainability and climate change adaptation

Improved connectivity of environmental systems is increasingly required as a result of the multiplication of international environmental commitments. Policy formulation and environmental management increasingly rely on distributed monitoring and management

[20] Buildings ~40 %, transport ~30% and industry ~30%.

[21] The European Council of 8-9 March 2007 set the combined targets of (i) reducing greenhouse gas emissions by 20% by 2020 (compared to 1990), (ii) increasing to 20 % the share of renewable energy sources by 2020 (compared to the present 6,5%) and (iii) saving 20 % of the EU's energy consumption (compared to projections for 2020).

[22] Green Paper "Adapting to climate change in Europe – options for EU Action", COM(2007)

systems able to interact with common protocols and semantics and to cope with higher complexity at various scales. ICT offer an enormous potential for bridging information spaces and stimulate environmental services in Europe. Moreover, adapting to climate change and the related more frequent and extreme weather events requires a strong effort to raise the European capacity to mitigate impacts of natural disasters.

ICT and urban infrastructures

Cities represent a particularly complex environment with acute sustainability challenges. Four out of five Europeans live in urban areas which consume about 80% of the energy in Europe. Cities import huge amount of resources through large infrastructures to consume them in various processes creating air, water and land pollutions. Urban transport faces congestion problems and accounts for up to 70% of pollutants from transport. Optimal management of urban complexity requires full integration of a wide range of technologies.

Research under this Challenge should take into consideration relevant technologies and other results from successfully completed or ongoing projects.

Objective ICT-2009.6.1: ICT for Safety and Energy Efficiency in Mobility

Target Outcomes

a) **ICT for Intelligent Vehicle Systems** for further improving road safety and overall performance of transportation systems. This includes advanced in-vehicle safety systems with improved performance and reduced costs, based on open standard elements; systems supporting autonomous driving (first in restricted environments and later on open environments); new approaches to crash avoidance and collision reduction including development of sensors and sensor networks; human machine interface design principles; advanced methods for traffic situation detection and communication (including vulnerable road users); and technologies for addressing digital footprint, data security and privacy of in-vehicle applications; numerical and experimental methods and technologies for design and evaluation of systems under real world conditions; methods for the design and evaluation of systems.

   Projects need to take an integrated approach to safety, considering together the infrastructure, vehicles, drivers and other transport users.

b) **ICT for Clean and Efficient Mobility** for further improving energy efficiency and reducing CO_2 emissions in all modes of transport. This includes new tools, systems and services supporting energy-efficient driving (eco-driving) based on on-board systems and/or co-operative infrastructure and energy-optimised, adaptive traffic control and management technologies and systems for urban areas and inter-urban road networks. It also includes methodologies for assessing the impact of advanced ICTs in energy efficiency and CO_2 reduction, aiming at international harmonisation and standardisation of the methodologies through co-operation with Japan and the USA.

c) **Coordination and Support Actions**

   A common research agenda for energy efficiency by enhancing international cooperation; increased user awareness and dissemination of research results by supporting the Intelligent Car Initiative and the eSafety Forum, by supporting standardisation and by preparing a common showcase for cooperative systems.

Expected impact

- World leadership of Europe's industry in the area of Intelligent Vehicle Systems and expansion to new emerging markets, improving the competitiveness of the whole transport sector and the automotive industry.
- Significant improvements in safety, security and comfort of transport. This includes contribution towards the objective of reducing fatalities with 50% in the EU by 2010, and longer term work towards the 'zero-fatalities' scenario.
- Significant improvements in energy efficiency, emissions reduction and sustainability of transport. This includes contribution to reduction in the energy consumption and congestion in road transport.

Funding Schemes

a) and b)): IP, STREP; c): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 48 million, of which a minimum of 50% to IPs and a minimum of 30% to STREPs

- CSA: EUR 5 million

Call

ICT call 4

Objective ICT-2009.6.2: ICT for Mobility of the Future

Target outcomes

a) **Field Operational Tests for Integrated Safety Systems and Co-operative Systems** to assess improvements in the efficiency of the transport system, in the safety of all road users and in making individual mobility more comfortable. This includes large-scale test programmes aiming at a comprehensive assessment of the efficiency, quality, robustness and user-friendliness of close-to market systems, before their full-scale deployment in Europe. Where needed, performance validation of safety-related co-operative systems can be envisaged in controlled proving ground environments emulating realistic levels of complexity.

   Projects need to collect statistically significant data allowing analysis of user acceptance, performance and benefits for road safety and efficiency of both autonomous on-board and cooperative systems, and to assess especially the impact of integration of in-vehicle safety systems with the co-operative systems including naturalistic driving tests, where possible building on initiatives promoted by Member States and/or Associated Countries.

   The objective is to support at least two IPs to be funded under a).

b) **ICT-based systems and services for Smart Urban Mobility and new Mobility Concepts** to address the environmental footprint and safety of mobility, while fostering economic growth. This includes innovative new tools, services and methods for demand management, moving from restrictive to permissive systems; ICT tools and services for logistics optimised for urban environments; use of ICT for replacing mobility (virtual mobility, telepresence); and new, multi-modal urban mobility concepts.

c) **Coordination and support actions**

In the framework of the Intelligent Car initiative: research agendas, dissemination of results (user awareness campaigns), assessments of socio-economic impact and training.

d) **International cooperation**

In accordance with the specific cooperation agreements with Japan and the USA, active exchange of information will be fostered through the creation of bilateral task force(s) and regular workshops which will establish a mechanism for mutual validation and exploitation of programme results, e.g. methodologies, draft specifications and standards, and for accessing Field Operational Tests datasets.

Expected Impact

- Improved safety, efficiency and competitiveness of transport systems across Europe, towards the objective of reducing fatalities within the EU.
- Optimised mobility of people and goods in urban environments across different transport modes, through the provision of accessible and reliable logistics information services.
- Improved quality of life in urban environments, through the provision of innovative demand management and traffic control and management systems, as well as new mobility concepts which meet the increased demand, support economic growth, are environmentally sustainable and capable of accommodating future uncertainties and shocks.
- Wider uptake of intelligent vehicle systems and co-operative systems through proof-of-concept to all stakeholders in Field Operational Tests.
- Increased European research excellence by fostering closer cooperation with leading international partners.

Funding schemes

a): IP, STREP, CSA; b): STREP; c), d): CSA

Indicative budget distribution[10]

- IP/STREP: EUR 32 million; the objective is to support at least 2 IPs to be funded under a) in addition to STREPs

- CSA: EUR 5 million

Call

ICT call 6

Objective ICT-2009.6.3: ICT for Energy Efficiency

Target Outcomes

a) **ICT tools for the future electricity market**

Architectures and tools enabling the emergence of an open electricity market that allows new roles for energy brokers, that makes it possible for third parties to operate as virtual power plants and that allows for the establishment of variable energy tariffs in near real-time. This includes specific service delivery platform and uniform energy and information interfaces that are open to different business models and that can self-configure and adapt to the varying requirements of a market still in its definition phase.

4.8 Future and Emerging Technologies

Future and Emerging Technologies (FET) fosters frontier research that will open up new avenues across the full breadth of future information technologies. FET acts as a pathfinder while having the agility to react to new ideas and opportunities, as they arise from within science or society. It promotes the exploration of radically new ideas and trends for future research and innovation and provides sustained support to emerging areas that require long-term fundamental research. It aims to go beyond the conventional boundaries of ICT and ventures into uncharted areas, often inspired by and in close collaboration with other scientific disciplines.

In this spirit, FET can be considered as the home for 'transformative research' that through its initiatives and actions can initiate and lead to a range of exceptional and unprecedented outcomes. For example, it can re-think or revolutionise entire disciplines, shape new ones or disrupt established technologies, practices or theories.

Excellence in collaborative purpose-driven research

FET fosters excellence in foundational and purpose-driven technology-oriented research that combines the best in science and engineering. FET research builds new bridges between science and technology and provides a basis for future research agendas and nurtures the new interdisciplinary research communities that will embrace them. FET improves long-term competitiveness in European ICT by exploring new and alternative technological paradigms that may lead to entirely new fields of economic activities, new industries or first-class high-tech SMEs.

A catalyst for change in interdisciplinary research

Radical breakthroughs in ICT increasingly rely on fresh synergies, cross-pollination and convergence with different scientific disciplines (for instance, biology, chemistry, nanoscience, neuro- and cognitive science, ethology, social science, economics) and with the arts and humanities.

This trans-disciplinary and high-risk research requires new attitudes and novel organisational models in research and education. FET promotes the exploration of such new research practices and methodologies. It encourages the involvement of young researchers and high-tech SMEs in radical interdisciplinary collaborations, and the early take-up of results by decision makers in society and industry, as new ways of achieving impact.

FET Proactive Initiatives & FET-Open

FET operates two complementary schemes that together aim at the consolidation of new and emerging foundational trends future information technologies and their applications, while remaining open and responsive to fresh and unexpected ideas and developments. The bottom-up, light and deadline-free **FET Open** scheme can pick-up new ideas and opportunities whenever they arise. **FET Proactive** nurtures new ideas in selected promising domains, aligned with economic and social challenges and priorities.

FET OPEN

Objective ICT-2009.8.0 FET-Open: Challenging Current Thinking

Target Outcome

FET-Open targets foundational breakthroughs that open the way towards radically new forms and uses of information and information technologies. It flexibly accommodates the exploration of new and alternative ideas, concepts or paradigms that, because of their radical, fragile or high-risk nature, may not be supported elsewhere in the ICT Workprogramme. Research under FET-Open is aimed at achieving a first proof-of-concept and at developing its supporting scientific foundation. The novelty of this research comes from new ideas rather than from the refinement of current ICT approaches.

In addition, FET-Open targets support and coordination activities for high-risk and high-impact visionary research. These activities can be either thematically oriented (for example, stimulating the emergence of a new research community), or they may focus on horizontal issues in FET-type of research (for example, catalysing new visions and ideas, promoting new research modalities, attitudes and practices; or exploring new ways for achieving visibility and impact of the research). They aim at a broad and open participation from within Europe and, where relevant, beyond.

Expected Impact

- For STREP projects: contribution to the scientific foundations of future information and communication technologies that may be radically different from present day ICT. It may, for example, open new avenues for science and technology, or lead to a paradigm shift in the way technologies are conceived or applied. FET-Open research is not required to have direct short-term technological or societal impact but it will take concrete steps towards achieving its long-term vision, supported by a critical exploration of the potential implications for the environment and for society.
- For CSA actions: contribution to catalyse a lasting and transformative effect on the communities and practices for high-risk and high-impact research. These activities will lead to new and more dynamic, engaged and risk-taking research communities that can develop the new and non-conventional approaches that will be key to address the technological, societal and environmental challenges that Europe and the world are facing.
- All FET-Open activities should contribute to securing and strengthening the future potential for high-risk / high-impact visionary research. To achieve this, FET-Open is expected to generate new collaborations involving a broad range of disciplines, the established scientists as well as the talented young ones, and a diversity of actors in research, including small and independent research organisations and high-tech SMEs, whenever relevant in terms of the activities proposed. International collaboration should exploit synergies in the global science and technology scene, to increase impact and to raise the level of excellence world-wide.

Funding schemes

STREP, CSA

Indicative budget distribution[10]

EUR 61 million[26]

Call

Continuously receivable from 1 January 2009 until 31 December 2010.[27] FET-Open applies a two-step submission scheme and FET-Open specific eligibility and evaluation criteria (see Appendix 5 of this document).

[26] Indicative budget which is expected to be committed for successful proposals from the cut-off dates up to and including 26/1/2010.

[27] It is planned that the call will be subsequently extended beyond 31/12/2010.

FET PROACTIVE

FET proactive will spearhead transformative research and support community building, and enhance Europe's innovation potential around a number of fundamental long-term challenges in ICT that will be key to the long-term sustainability of a technological future in Europe. In particular:

- **Computing Systems:** After 40 years of miniaturisation allowing combined gains in performance, cost, power efficiency and size, future computing systems are faced with increasingly conflicting ambitions for further performance improvements and reduced energy per operation, size and cost per function while maintaining data integrity. Research will investigate radically new approaches to computing, based on inspiration from physics in *Quantum Information Foundations and Technologies* and in *Molecular-Scale Devices and Systems*. Research will pursue alternative directions for architectures in *Concurrent Tera-Device Computing,* for individual devices in *Molecular-Scale Devices and Systems*, and focus on power issues in *Towards Zero-Power ICT.*
- **Computing and Communication Paradigms**: New inspirations for architectures, communication and in particular the distributed nature of processing – locally or system wide – are explored to address new requirements on optimisation of resources and mastering system complexity. Awareness in networked ICT systems is addressed in *Self-Awareness in Autonomic Systems,* while management of local interconnections is a key issue in *Concurrent Tera-Device Computing.* Alternative paradigms for communications are investigated in *Quantum Information Foundations and Technologies,* with an emphasis on secure communications. Inspiration for radically new paradigms is taken from the functioning of the brain in *Brain-Inspired ICT* or from chemical networks in cells in *Bio-chemistry-based Information Technology.*
- **Living with ICT**: Unifying the experience of acting with or without ICT support will progress towards harnessing the combined advantages of information processing by humans and by machines in *Human Computer Confluence*. Radically new forms of sensing and interactions will be studied in *Brain-Inspired ICT*, while specific sensing modalities may emerge from work in *Molecular-Scale Devices and Systems* and in *Bio-chemistry-based Information Technology.*
- **Widening the Horizon of ICT**: Opportunities for deploying ICT in new areas will be explored together with technological developments. These will aim for new ways of reaching societal benefits and responding to industrial needs using ICT. Examples include improving human health in *Bio-chemistry-based Information Technology* and in *Brain-Inspired ICT,* new forms of therapy in *Human Computer Confluence,* environment monitoring in *Towards Zero-Power ICT*, high precision sensing in *Molecular-Scale Devices and Systems,* and new forms of cognitive work and entertainment in *Human-Computer Confluence*.

The following themes will be addressed in pro-active initiatives:

Call 4: FP7-ICT-2009-4

ICT-2009.8.1 Concurrent Tera-Device Computing

ICT-2009.8.2 Quantum Information Foundations and Technologies

ICT-2009.8.3 Bio-chemistry-based Information Technology

Call 5: FP7-ICT-2009-5

ICT-2009.8.4 Human-Computer Confluence

ICT-2009.8.5 Self-Awareness in Autonomic Systems

ICT-2009.8.6 Towards Zero-Power ICT

Call 6: FP7-ICT-2009-6

ICT-2009.8.7 Molecular-Scale Devices and Systems

ICT-2009.8.8 Brain-Inspired ICT

Coordination and Support Actions (CSAs) will be called under objective ICT-2009.8.9 to support the coordination of research projects in each proactive initiative. Short duration actions (CSAs) will also be called under objective ICT-2009.8.10 to help identify new trends and directions for the preparation of new proactive initiatives in 2011 and beyond.

Candidate topics for calls in 2011 and beyond include new breakthroughs arising from the initiatives launched in earlier calls of FP7, namely *Pervasive adaptation*, *Embodied Intelligence*, *ICT Forever Yours* and *Complex Systems Science for Socially Intelligent ICT*. Other topics include those presented in the series of consultations held in 2007 and 2008 and not covered by the present work programme, such as engineering social benevolence and creativity, designing socially-adaptive ICT, simplicity as a design principle in ICT, semantic and pragmatic technology for dynamic communities of practice, assembling information systems with bio-bricks and web science.

Use of Instruments and expected participation:

In the domain of FET Proactive, integrated projects will combine different aspects of multidisciplinary research, together with additional actions e.g. on wide dissemination, education, links with industry, international co-operation. They will assemble the set of multi-disciplinary research teams necessary to efficiently carry out the research and other activities. STREP projects will target a focused research topic with a limited set of teams. Involvement and participation of young researchers, high-tech SMEs and industry, as well as international partners from developed and/or emerging economies in any of the FET proactive initiatives is welcomed and encouraged. This will lead to increased European excellence in science and research, and foster collaboration with leading international organisations.

FET-Proactive applies specific eligibility and evaluation criteria (see Appendix 5 of this document).

Objective ICT-2009.8.1: FET proactive 1: Concurrent Tera-device Computing

Integrated circuits and tightly-coupled systems will integrate up to 1000 billion devices by the year 2020. These will provide orders of magnitude improvement in performance and cost only with much higher concurrency and heterogeneous architectures tuned to specific application kernels. In parallel, device variability and failure rates will reach critical levels and power saving methods will be required at all system levels from transistors to architecture and software.

Target outcome

Radically new methods and tools for architecture design and programming of chips and systems beyond 2020, including compilers and run-time systems:

a) **Complexity of design and run-time of many-core heterogeneous systems**: Radically

Expected impact

- Enable the development of ICT systems and devices that utilise interactions between components to assemble complex functional information processing materials.
- Enable a new generation of systems capable of interfacing with conventional IT systems that are self-replicating, self-repairing and/or capable of rapid adaptation/evolution as well as flexible reconfiguration in response to changing conditions.

Funding schemes

STREP

Indicative budget distribution[10]

EUR 7 million

Call

ICT call 4

Objective ICT-2009.8.4: FET proactive 4: Human-Computer Confluence.

The initiative aims to investigate and demonstrate new possibilities emerging at the confluence between the human and technological realms. It will examine new modalities for individual and group perception, actions and experience in augmented, virtual spaces. Such virtual spaces would span the virtual reality continuum, also extending to purely synthetic but believable representation of massive, complex and dynamic data. Human-Computer confluence fosters inter-disciplinary research (such as Presence, neuroscience, machine learning and computer science) towards delivering unified experiences and inventing radically new forms of perception/action.

Target outcome

Proposals should address at least two of the following topics:

a) **On-line perception of and interaction with massive volumes of data:** new methods to stimulate and use human sensory perception and cognition to interpret massive volumes of data in real time to enable assimilation, understanding and interaction with informational spaces. Research should find new ways to exploit human factors (sensory, perceptual and cognitive aspects), including the selection of the most effective sensory modalities, for data exploration.

b) **Unified experience,** emerging from the unnoticeable transition from physical to augmented/virtual reality**:** new methods and concepts towards unobtrusive mixed or virtual reality environment (multi-modal displays, tracking systems, virtual representations…), and scenarios to support entirely unobtrusive interaction. Unobtrusiveness also applies to virtual representations, their dynamics, and the feedback received. Research could also explore how to extend unified experience to synthetic representations of massive volumes of data.

c) **New forms of perception and action:** invent and demonstrate new forms of interaction with the real world, virtual models or abstract information by provoking a mapping from an artificial medium to appropriate sensory modalities or brain regions. This research should reinforce data perception and unified experience by augmenting the human interaction capabilities and awareness in virtual spaces.

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Expected impact

- New methods and tools to act across real and virtual spaces
- New means to present the massive amounts of data which future ICT systems will generate and collect to individuals and groups to allow them to explore and more fully understand the causes and consequences of phenomena
- Improved ability to truly deliver presence experiences contributing both to progress in Presence research and enhancing the foundations for future applications of societal value

Funding schemes

IP

Indicative budget distribution[10]

EUR 15 million

Call

ICT call 5

Objective ICT-2009.8.5: FET proactive 5: Self-Awareness in Autonomic Systems

The challenge is to create computing and communication systems that are able to optimise overall performance and resource usage in response to changing conditions, adapting to both context (such as user behaviour) and internal changes (such as topology). To achieve this, autonomic systems should enable nodes to build up an awareness relating to higher and even global levels, e.g. of patterns of use, system performance, network conditions and available resources. This requires breaking through the tradition of fixing abstraction layers at design time, which hide issues at lower layers (e.g., by hiding mobility, heterogeneity, or drops in performance), but inevitably limit the scope for optimising resource usage and responding to changing conditions.

Target Outcome

New concepts, architectures, foundations and technologies for:

a) **Creating awareness** at the level of autonomic nodes, by allowing them to interactively and selectively collect information about the system, and use it effectively. A central question is how to link awareness of performance, conditions, available resources, etc., to the nature of information that is exchanged.

b) **Dynamic self-expression**, namely the ability to autonomically use awareness to adapt the trade-off between abstraction and optimisation. There is a need for understanding the consequences of this principle on system behaviour and performance, and designing/experimenting with related features.

Projects should investigate how such systems can be embedded in a larger (technical or non-technical) context, and within this context support society and economy. They should take into consideration malicious behaviour and the system's ability to respond to arising needs.

Demonstration of new approaches should lead to a better understanding of their feasibility.

STREPs should address at least one and Integrated Projects should address in an integrated manner both topics.

Expected impact

- Lower management costs of large networked systems through the ability to adapt to changing environments and patterns of use, and through a greater degree of, flexibility and reliability
- More efficient use of resources such as processing power, energy and bandwidth through autonomic decisions based on awareness

Funding schemes

IP, STREP

Indicative budget distribution[10]

IP/STREP: EUR 15 million, of which a minimum of 50% to IPs and a minimum of 30% to STREPs

Call

ICT call 5

Objective ICT-2009.8.6: FET Proactive 6: Towards Zero-Power ICT

New disruptive directions are needed for energy-harvesting technologies at the nanometre and molecular scale, and their integration with low-power ICT into autonomous nano-scale devices for sensing, processing, actuating and communication.

Target Outcome

a) **Foundations of Energy Harvesting at the nano-scale:** Demonstration of radically new strategies for energy harvesting and local storage below the micrometer scale. Exploration and harnessing of potential energy sources at that scale including kinetic energy present in the form of random fluctuations, ambient electromagnetic radiation, chemical energy and others. Research may also address bio-mimicked energy collection and storage systems.

b) **Self-powered autonomous nano-scale electronic devices:** Autonomous nano scale electronic devices that harvest energy from the environment, possibly combining multiple sources, and store it locally. These systems would co-ordinate low-power sensing, processing, actuation, communication and energy provision into autonomous wireless nanosystems.

Expected impact

- Possibility of building autonomous nano-scale devices (from sensor to actuators), extending the miniaturisation of autonomous devices beyond the level of the 'smart dust'
- New applications in a vast number of ICT fields such as intelligent distributed sensing, for health, safety-critical systems or environment monitoring

Funding schemes

STREP

Indicative budget distribution[10]

EUR 7 million

Call

ICT call 5

Objective ICT-2009.8.7: FET proactive 7: Molecular Scale Devices and Systems

The research addresses devices to represent, store, process and exchange information at the atomic and molecular scale, as a basis for fully functional ICT devices and systems. These devices and systems should rely on new scalable concepts and architectures enabled by atomic precision and control, exploit intrinsic properties of atoms and molecules, realise their interconnection, interface them to the mesoscopic world and ultimately have an impact on future information processing systems.

Target outcome

a) Investigation, development and demonstration of **physical implementations,** both at the single-molecule level and with small assemblies of concatenated, interconnected molecules, with the aim of achieving proofs of concept and demonstrating working devices or systems such as molecular computation, single molecular memories, molecule-based sensors, and scalable, functional arrays of molecules.

b) Exploration, design and development of **supporting technologies for molecular-scale information devices and systems** such as: a) **Measurement and control systems**, including atomic and molecular references and precision sensors and procedures to preserve data and operation integrity at design and system level , and b) **Simulation and modelling tools**, including hierarchical modelling (from *ab-initio* and single device to system level).

c) Exploration and demonstration of **radically new characteristics and functionality** of molecular-scale systems by investigating new non-charge based information processing techniques, devices, architectures, self-assembly, programming, supported by experimental implementations.

Specifically, Integrated Project proposals should cover at least two of the above topics and present a long-term vision towards future applied RTD.

Expected impact

- Opening of new avenues and exploration of new possibilities in ICT devices and technologies at the molecular scale
- Experimental demonstration of principle and feasibility of such devices
- New perspectives on potential applications with concrete advantages (e.g. energy consumption, data and operation integrity, speed…)

Funding schemes

IP, STREP

Indicative budget distribution[10]

IP/STREP: EUR 15 million, of which a minimum of 50% to IPs and a minimum of 30% to STREPs

Call

ICT call 6

Objective ICT-2009.8.8: FET proactive 8: Brain Inspired ICT

Recent advances in ICT and neuroscience enable a significant part of the human brain to be studied and modelled *in-silico*. This objective seeks to exploit such advances in order to better understand how the brain processes information and/or how it communicates with the peripheral nervous system (PNS), and to explore potential applications of this.

Target outcome

a) **Development of multi-scale models of information processing and communication in the brain and/or PNS**. Systemic study of the brain, combining recordings/imaging of brain activity on several spatial and/or temporal scales simultaneously. This research may also address higher-level cognitive processes. This multi-disciplinary research should foster joint progress and synergy in ICT and the bio- and neuro-sciences.

b) **Synthetic Hardware Implementations of Neural Circuits** that mimic information processing in the brain or PNS. These implementations should demonstrate either the emulation of significant functionality of a neural system (including a comparison with the biological counterpart) or the performance of other specified processing tasks.

STREP Proposals should address at least one and Integrated Projects both of the above topics.

Expected impact

- Improved design principles for bio-hybrid artefacts involving engineered components that directly communicate with the nervous system, relying less than current implants on brain plasticity or training in order to function.
- Computational systems that emulate human skills (e.g. by using the directed fusion of diverse sensory information) or exploit underlying principles for new forms of general purpose computing. These should demonstrate significant improvements in, for example, performance, fault tolerance, resilience or energy consumption over traditional ICT approaches.
- Improved diagnosis/treatment of neurological disorders through the use of a comprehensive model of neural and brain functioning.
- Experimental data archived with sufficient appropriate meta-data to facilitate re-use in another research contexts.

Funding schemes

IP, STREP

Indicative budget distribution[10]

IP/STREP: EUR 15 million, of which a minimum of 50% to IPs and a minimum of 30% to STREPs

Call

ICT call 6

Objective ICT-2009.8.9: Coordinating Communities, Plans and Actions in FET Proactive Initiatives

Target Outcome

a) Coordination or support actions supporting the coordination and cooperation of the targeted research communities, assessing the impact and proposing measures to