ISTAG REPORT on

Orientations for Work Programme in FP7

Final Version

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CONTENTS

EXECUTIVE SUMMARY

The Report presents orientations for preparing the first Work Programme for research & technological development (RTD) in ICT in FP7 based on a substantiated analysis of strategic requirements for ICT research strategy for Europe. It focuses on strategic issues rather than the detailed content of specific research domains; these will be addressed by the Commission later in the FP7 planning process.

Realising the Vision

The opportunity: transformation through ICT

The Report builds on an accompanying ISTAG document[1] which presents a vision for the future of information and communication technologies (ICT) in shaping Europe's society and economy. ICT is the constitutive technology of the first half of the 21st century, shaping, enriching and becoming an integral part of almost everything we do. Rapid, sustained and accelerating progress in ICT offers us the opportunity not just to improve European society but to transform it.

Shaping specific, long-term solutions to Europe's societal challenges

Advances in ICT will enable us to find innovative solutions to address Europe's socio-economic challenges, and allow us to shape the answers to Europe's specific needs for many years ahead. Only by enthusiastically embracing digital technologies in all areas of our economy and society will Europe and Europeans achieve their true potential.

Our focus in this Report is how this vision for ICT research and innovation in Europe should be reflected in the FP7 Work Programme.

The Changing Environment for ICT Research

Major changes in how we organise and do research …

The environment for ICT research, development and innovation has changed significantly over the last two decades. Over this time, there have been astounding advances in components and devices, especially in capability, mobility and even usability. Advances in ICT system building have not been so rapid, and significant challenges still remain in building robust, flexible and heterogeneous ICT systems. In addition:

- The research environment is now global, with countries, sectors and firms having to focus on areas in which they have a comparative advantage. Standardisation and interoperability are particularly important in the global context.
- ICT technologies, markets and value chains are becoming increasingly complex. Consequently, the act of doing research, too, is becoming more complicated, requiring greater emphasis on partnering.
- New more flexible and more open models of innovation are emerging, with lead users and innovation communities having significant roles in user-centred innovation processes.

…with important implications for the research system.

These trends have important implications for the way we do ICT research. In addition to technology progress, ISTAG sees innovation coming from the new ways of using ICT. This requires a new approach to address applications research in ICT tothat

[1] *Shaping Europe's Future Through ICT*, Information Society Technologies Advisory Group, March 2006

give better value and be more effective. Such research must also be embedded in the wider socio-economic context.

in addition to supporting ICT progress in the key technology fields, ISTAG proposes that European ICT Research should, **initiate a new effort in the application-oriented research fields that drive ICT innovation. These should be focused on grand socio-economic challenges,** so as to better exploit the value points in the emerging digital networked society and economy. As part of such an approach we need to create a new dialogue with the demand side, involving it more directly in research to ensure outcomes meet user and societal needs.

ISTAG believes this is the key and radical practical change necessary for the ICT Work Programme in FP7. In doing this, the Research programme will be compelled to:

i. *Address complexity and follow a systems approach*. In particular, new avenues of research in integration should be opened up to accelerate the market take-up of research results.

ii. *Foster interdisciplinarity and synergies*, so that the range of interactions around ICT research becomes both wider and deeper.

iii. *Create an open engagement with users*, putting users firmly at the centre of ICT innovation processes.

iv. *Stimulate the consumption side* (services and content), so as to fully exploit the potential of infrastructure investments; and

v. *Focus on the whole business value chain and ecosystem*, so as to better accommodate the market perspective within ICT research.

Whilst these issues are all essential in strengthening the focus on societal-scale ICT solutions, they are also important to the future development of ICT in general. Such an approach can be expected to produce many spin-offs. By confronting these issues head-on through ‘grand challenges’, in Europe we give ourselves a head start in coping with them in the wider context.

A Strategic Work Programme

Strategy and ambition

The FP7 Work Programme must be strategic, setting an ambitious agenda that answers Europe’s needs for the future. It should:

- Improve innovation through a strong focus on integration and applications;
- Strike the right balance by accommodating a wide range of research;
- Be sensitive to disruption; and
- Involve much simpler processes.

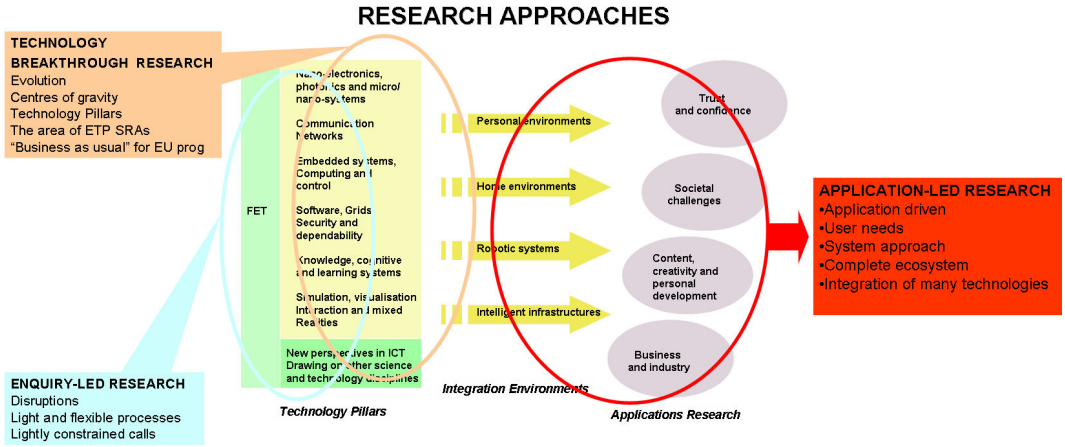
Three pillars

ISTAG proposes three types of research that allow the ICT research challenges to be addressed at several different levels:

1) **Application-led Research**: Focused research for end-to-end systems and applications directed towards major societal and economic challenges in areas with a high potential impact.

2) **Technology Breakthrough Research**: Strategic research directed towards removing roadblocks and improving the capability of generic technology components, solutions, systems & platforms.

3) **Enquiry-led Research**: An open and flexible approach to collaborative research that offers new insights on strategic areas and keeps alert to disruptions.



Greater range, responsiveness and flexibility

With this multi-faceted approach, the Programme would at the same time be both **more focused and directed**, and **more open and flexible**. The end result will be a Programme that has much greater range: one that is more responsive both to societal needs and technological & research potential.

Mobilising the Stakeholders through Innovation Communities

Capturing innovation in the use of ICT

Innovation at the societal-scale presents new demands in terms of technological complexity, market complexity, and investment scale. ISTAG believes that the success of the proposed approach requires new mechanisms to capture innovation and provide a stronger voice for users in how technology is developed and applied.

To achieve this we recommend the creation of Innovation Communities, new, large-scale, multi-stakeholder ICT initiatives focusing on areas with major socio-economic impact. They will provide platforms within the European ICT Research Programme for world-leading initiatives to develop innovative ICT solutions based on concrete and realisable goals. To retain their focus and value, it is essential that there are a **limited number** of such initiatives: probably 4-5 across the whole Work Programme.

New stakeholder initiatives with concrete and realisable goals

The Innovation Communities will mobilise the stakeholders to develop **a grand vision** to address a major European issue. Through dialogue, they will then set **a tightly-defined programme of action** to realise the vision, which will be implemented through **roadmaps with clearly defined milestones**. Driven by **applications and users**, the Platforms will be **magnets for technology** and will play a **key role in integrating outputs from the European Technology Platforms (ETPs)** and **driving standardisation**.

Innovation Communities will be supported through:

- Applications-led Research Projects which focus on integrating technology developments in a particular application field; and

- Technology-neutral, ‘goal-driven’ projects that provide overall coordination and structuring, acting as the “customer” for technology research in FP7 projects and also encouraging the definition of necessary standards.

Strengthening the Emphasis on Emerging Technologies

Stronger research effort in emerging technologies

Emerging technologies – those at the beginning of the technology lifecycle – hold the greatest potential for innovation and economic growth for 'the day after tomorrow'. As part of a balanced programme, ISTAG considers that Europe must strengthen its research effort here. Emerging technologies research under FP7 should embrace a wider range of technology fields, and greater efforts in integration and exploitation. Strong links with industry and with other research actors will be essential.

Making the Programme Simpler and More 'User-friendly'

Streamlining of Programme procedures

Finally, ISTAG concurs with other observers that the Framework Programme is unnecessarily bureaucratic and, for many organisations, increasingly unattractive. A significant simplification of administrative and financial procedures is urgently needed. Streamlining of administrative procedures and reporting requirements, more flexible evaluation criteria, improvements in calls and in project co-ordination and continuity of funding are all areas needing to be addressed.

CHAPTER 1: A VISION AND STRATEGY FOR ADDRESSING EUROPEAN CHALLENGES

1.1 The Report

A strategic approach

This Report has been prepared by the Information Society Technologies Advisory Group (ISTAG), at the request of the European Commission, to provide orientations on European ICT research under the Seventh Framework Programme (FP7).

The Report presents orientations for preparing the first Work Programme for research & technological development (RTD) in ICT in FP7 based on a substantiated analysis of strategic requirements for ICT research strategy for Europe. In particular, it draws on the work of the ISTAG Working Group "Visions for Europe", which has set a vision for the future of information and communications technologies (ICT) in Europe.

ISTAG's work has focused on strategic issues rather than the detailed content of specific research domains; these will be addressed by the Commission later in the FP7 planning process through detailed consultations with domain experts.

1.2 A Vision for Europe: Shaping the Future through ICT

ICT will shape our future

In an accompanying report[2] ('the Vision report'), ISTAG presents a vision for the future of ICT in shaping European society and economy (see Box 1.1).

Our message, essentially, is that the nature of ICT is changing and so is the scale of the resulting economic and societal impact. Continued and accelerating technological progress, market changes arising from globalisation and convergence, and a growing societal acceptance of the new technologies, amount to a step-change in what we able to achieve with ICT. The next wave of the digital transition, on which we are just embarking, offers us **the opportunity not just to improve European society but to transform it**.

Matching innovative solutions to societal challenges

Echoing the findings of the recent Aho Report[3], the Vision Report emphasizes that research alone is not enough to realise the potential economic and societal benefits from new technologies. We also need a wide range of other measures to support and attract investment in ICT research. In particular, stimulating the development of lead markets will help ensure innovative ICT solutions are matched to key societal challenges.

Building effective societal-scale systems

Our focus in this Report is **how to use European ICT Research under the Framework Programme as a vehicle to help translate this Vision and Strategy into action**. **In particular, we focus on the challenge of building effective societal-scale systems**. The challenges here are at two levels: the technical level – how do we actually put together systems that are sufficiently flexible and robust; and the organisational level – how can we mobilise all the stakeholders (the user community) to turn the research into effective solutions.

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[2] *Shaping Europe's Future Through ICT*, Information Society Technologies Advisory Group, March 2006.

[3] *Creating an Innovative Europe:* Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit, January 2006. See: http://europa.eu.int/invest-in-research/

BOX 1.1: SUMMARY OF THE ISTAG 'VISIONS' REPORT

ICT As A New Social Paradigm

ICT offers a means to respond to the economic and societal challenges facing Europe. **It is the "constitutive technology" of the first half of this century**, much like electricity or combustion engines were in the last. ICT does not just enable us to *do* new things; it *shapes* how we do them. It transforms, enriches and becomes an integral part of almost everything we do.

As ICT becomes more deeply embedded into the fabric of European society it is starting to unleash massive and far-reaching social and economic change. Only by enthusiastically embracing digital technologies in all areas of our economy and society will Europe and Europeans achieve their true potential. The future is knowledge-based and we have to allow ICT to shape it.

Research to Shape Innovative ICT Solutions

Research is essential to realising these constitutive effects. Research in ICT will enable us to knit together the technology developments to achieve a step-change in the capabilities of the resulting applications and systems. Research is also required to bridge between ICT and other disciplines (bio-/nano-/cogno- sciences), from where many radical innovations will come.

Building on and extending the ambient intelligence vision, technology developments are proceeding along well characterised paths: Systems and services that are:

1) **Networked, mobile, seamless** and **scalable**, offering the capability to be always best connected any time, anywhere and to anything;
2) **Embedded** into the things of everyday life in a way that is either **invisible** to the user or brings new **form-fitting** solutions;
3) **Intelligent** and **personalised**, and therefore more centred on the user and their needs;
4) Rich in **content and experiences** and in **visual** and **multimodal** interaction.

Strategy and Actions To Mobilise Europe's ICT Research Community

To step up and improve Europe's research effort in ICT, ISTAG proposes a set of concrete measures aimed at mobilising resources in the private and public sectors to invest more and better in ICT research: Specifically, we recommend:

- ***Stimulating the development of lead markets for innovative ICT solutions addressing Europe's key societal challenges.*** This includes initiatives in areas such as health, ageing, transport & mobility, manufacturing, energy, environment, security and digital content. These initiatives should use a combination of measures to attract and facilitate investment in ICT research and the deployment of innovative ICT solutions.
- ***New efforts to define strategies and agendas for research*** from which all actors can benefit, using the European Technology Platforms as the main framework. The implementation of these agendas should be based upon excellence and sufficient market acceptance and they should leave space for technology discontinuities and breakthroughs.
- ***Better coordination of national programmes and policies in ICT research.*** The Framework Programme should be a means to strengthen cooperation between industry and academia across Europe. To be efficient, ICT in FP7 needs to be steered towards the achievement of challenging goals preparing Europe for the next wave of technology innovations.

In terms of priorities for research investment, ISTAG recommends to focus strategic research around certain 'centres of gravity' - areas where the natural development paths of ICT intersect with areas of European expertise and industrial capacity.

For the full report see: "Shaping Europe's Future Through "CT", Information Society Technologies Advisory Group, March 2006. Available at: cordis.europa.eu/ist/istag.htm

CHAPTER 2: THE RESEARCH ENVIRONMENT

Research is essential, but it is not easy. The days when significant advances could be achieved by the lone researcher or inventor are long gone. Research today is undertaken in the global arena, involves mastering complex technology and value chains, and requires intimate understanding of customers and markets.

Major changes in the research environment

This is especially the case in ICT, where the environment for research, development and innovation has changed beyond recognition over the last two decades. There are three main trends:

- The globalisation of the environment for ICT research, development and innovation;
- The increasing complexity of ICT technologies, markets and value chains;
- The emergence of new more flexible and more open models of innovation.

These trends – which are addressed in more detail below - have important implications for how Europe's research community approaches the research and design of societal-scale ICT systems. The progress seen over recent years in components, devices and applications has not been matched by similar advances in building large-scale ICT systems. Yet more robust, flexible and dependable systems will be essential to realising the ISTAG Vision of ICT focused on societal challenges.

2.1 Maximising European Value in Global ICT Research

2.1.1 ICT Research Goes Global

Firms must play to their strengths in a global environment

Mirroring the globalisation of sales and of production, research and development activities are organised increasingly on a global scale. Faced with growing international competition, firms are increasingly obliged to relocate their research facilities to any country or region offering competitive advantage. Researchers, too, are more mobile internationally, including from the less-advanced economies, and this mobility of human capital is now a key element in knowledge transfer.

In this new global environment, countries, sectors and firms have to play to their strengths, focusing on those parts of the value chain in which they have a comparative advantage. The challenge for Europe in this context is how to get best value from its research investments. Research is expensive and we must maximise the return for every euro spent.

Getting best value from Europe's research investment

In the Vision report, ISTAG has set out in some detail its prescription for maximising European value from Europe's ICT research effort. Stimulating lead projects to help overcome the fragmentation of European markets, becoming the location of choice for ICT investment and researchers, nurturing the talent of young researchers, and creating an environment conducive to technology entrepreneurs: all of these have an important part to play in enabling Europe to invest more and better in ICT research.

These messages apply equally to European programmes as to national efforts. Maintaining a world-class research infrastructure, encouraging researcher mobility, recognising the role of lead users, and stimulating entrepreneurship are all important considerations for ICT research in FP7.

European value is especially important in the context of convergence, which is leading to one global market for digital products and services. It is essential that Europe masters the new value chains emerging from convergence and from new societal applications so as to produce the best returns both at home and internationally.

2.1.2 Standards as a Route to Global Leadership

Standards present a huge opportunity for Europe

Standardisation and interoperability are particularly important in the global context. In the fast-moving world of ICT, worldwide leadership positions (in some cases near-monopoly positions) have been built by the early introduction of "*de facto"* industry standards. If Europe can 'get its act together' across the 25 Member States, it has a huge opportunity to influence standards within European markets and further afield.

Contributions to standards - in all their different forms, from formal specifications to tools and architectures - are a key part of the European added value that can arise from EU R&D projects. GSM, ADSL, DVB and MPEG are just some of the areas where European projects have shaped the standards agenda. But the contributions are not as significant as they might have been and in certain cases important opportunities have been missed.

EU projects must target standards outcomes

More needs to be done to align research outcomes to European and international standards bodies and to ensure the standards adoption cycle is as short as possible. We need an environment within EU projects that brings technology providers and developers "naturally" to standardisation.

2.2 Mastering Complexity

Complexity at many different levels

Complexity is another inherent feature of today's ICT research environment. We see this in a number of different contexts:

- *Technological complexity:* Progress in ICT requires, more than ever before, the mastery of increasingly complex technology chains that span across a range of components, devices, infrastructures and services. We see this complexity at many levels: from semiconductors with more and more processing power; to ICT networks with ever larger numbers of nodes; and software with hundreds of millions of lines of code. We need new approaches and engineering methods to design and build modern ICT systems, to integrate a large number of heterogeneous elements and, eventually, to provide such systems with the ability to evolve and self-organise.

- *Market complexity:* Markets, too, are becoming more complex, with increasing interdependencies between technology, products and services. Successful exploitation of ICT research results requires their integration in services and solutions to be applied across an ever wider range of sectors and markets. To accelerate market uptake, ICT research must be reliably and sustainably anchored in the applications. This requires technology development to be tightly coupled to non-technological elements such as organisational processes and individual users.

- *Research complexity:* Partly in response to these other two trends, the act of doing research, too, is more complicated than in the past. Researchers have to move much faster, collaborate more and be more interdisciplinary. They

have to make use of the latest research infrastructure, and work much closer to the market. Partnering – between different institutions, disciplines and countries – is now a key feature of the research scene in ICT.

2.3 More Flexible and Open Innovation

2.3.1 New Models of Innovation

The innovation environment is becoming more open

Globalisation and the ever faster pace of technological and market change are forcing firms to find more flexible ways to innovate. Rather than generating, developing and commercialising all their ideas in-house, firms are opting to embrace innovations from outside, to partner in developing them, and to look beyond their traditional markets. "Spin off, spin out, buy in" is the new mantra. Thus, the innovation environment is becoming more open.

An open approach to innovation allows a free flow of ideas and results into and out of the firm. By leveraging these external knowledge and technologies, firms are able to shorten development cycles and gain competitive advantage. Open innovation is being adopted in an increasing range of firms and industries. While there is arguably an element of hype around some aspects, it is also clear that the open innovation phenomenon is a reflection of real and deep-rooted cultural change.

'Open' does not necessarily mean 'free'; and a commitment to open approaches does not negate the value of intellectual property and proprietary technologies. Open and collaborative approaches to innovation should be seen as a spectrum, with the open source movement – one of the more obvious examples – towards one end. Further along the spectrum, between 'fully closed' (i.e. traditional) and 'fully open', there is room for a wide range of co-operative and collaborative behaviour. Open standards, for instance, are being pursued by industry in a number of areas.

2.3.2 The User Community in Innovation

Users as Drivers of Innovation

Users play a key role in innovation processes

Partly as a reflection of these more open models, users are increasingly seen as important drivers of innovation processes[4]. It is observed that product and service users – both individuals and firms – are increasingly able to innovate for themselves. Open APIs (e.g. Web 2.0) is one example of this. However, there is growing evidence that innovation is actually being "democratised" quite broadly: we see the same for physical products as well as information products like software.

These user-centred innovation processes appear to offer a number of advantages over manufacturer-centred innovation development systems. Lead users (i.e. those at the forefront of their marketplace) and innovation communities are found to have particularly significant roles in combining and leveraging user-centred innovations.

ISTAG has long been concerned with the ICT-user relationship. The vision of ambient intelligence, which has been championed by ISTAG, is predicated on the need to put the user at the centre of system development. More recently, we have commented on the role of users within the development process itself, noting the

[4] See for instance: *Democratizing Innovation*, Eric von Hippel, 2005. MIT Press, ISBN 0-262-002744.

need for a novel two-way relationship to be established between those that develop new technologies and those that use them[5].

Users in Societal Scale Systems

The shift in focus from discrete systems to large-scale societal systems brings a new dimension to the users' role in the innovation process. Focusing on individual end-users – as is generally the case under ambient intelligence scenarios – is no longer sufficient. As we move from the level of individual users to society as a whole, the range of user, or more specifically demand-side, considerations increases. This will require a major change to the way that we approach research in the application-led domain.

Our proposal here is to focus research efforts on creating solutions to societal challenges. The eventual success of this approach will be measured by how effectively such solutions are implemented on a societal scale. To achieve this, we will need to involve the whole user community (not just the end-users) right from the outset. In this case, the community of users includes:

- Domain experts (e.g. medical experts, healthcare administrators) who will participate in the definition and architecture;
- The purchasers (e.g. national ministry of health, or local health authorities);
- The operators (e.g. GPs, healthcare professionals).

Societal-scale challenges will require a societal-scale response.

2.4 Implications for the Research Environment

These trends have important implications for the way we approach ICT research in Europe. They underline the need to:

Integration is key to successful exploitation

1) **Address Complexity and Follow a Systems Approach:** Research must deliver new solutions to address the growing pervasiveness of ICT and increasingly complex technology chains. The successful exploitation of technologies requires their integration in managed services and solutions to be applied across a broadening range of sectors and markets. Thus, increasingly research needs to follow a systems approach.

   Implications for FP7

   - Open up new avenues of research in integration to allow research results to reach the market more effectively.
   - Find mechanisms to ensure the successful, seamless integration of components and their convergence into new types of systems and environments.
   - Develop architectures, methods and tools capable of combining technologies into these systems.
   - Elaborate new approaches to integrate technologies across different usage environments.

[5] *ISTAG Report on Experience and Application Research, 2004. Available at: cordis.europa.eu/ist/istag.htm*

Wider and deeper interactions in ICT research

2) **Foster Interdisciplinarity and Synergies:** As ICT's horizons get ever broader, Europe must foster and stimulate a more interdisciplinary approach to ICT research. Research should draw ICT researchers into interactions with a greater range of disciplines and the range of interactions around ICT research should be both wider and deeper.

Implications for FP7

- Foster stronger involvement of domain expertise, since more and more innovation comes from the use of ICT in a broadening range of application domains.
- Stimulate greater interaction with other science and technology disciplines, since further advances rely increasingly on exploration at the frontiers between ICT and other fields.

New models for engaging with users

3) **Create an Open Engagement with Users:** The critical role of users as drivers of innovation is increasingly apparent. New and open means of engagement need to be found between those that develop new ICT and those that use it. Users should be integrated into the processes of research and development, and new product creation and introduction. Users should be at the centre of the innovation process, a source of ideas, and not just a resource to evaluate ideas generated by professionals.

Implications for FP7

As noted previously by ISTAG, there is a role for 'experience and application research' covering the following aspects:

- User-related research in interaction technologies: research on design processes for ambient intelligence, development of methods for usability testing.
- Development of prototypes, based on the results of basic research, and integration into quasi-realistic environments.
- Usability tests of components in quasi-realistic environments.
- Feasibility tests and validation of solutions in field environments.
- Encompassing all stages of the product cycle, not just R&D.

Services and content as a key focus for research

4) **Stimulate the Consumption Side (Services and Content):** As infrastructure investments mature and the capabilities of networks and devices increase, services and content becomes a more important part of the overall picture.

From the economic perspective, through serious investment here there is the potential to create a virtuous circle: growth on the *consumption side* (content and services) should boost user demand, which will automatically create growth on the *investment* side (infrastructure upgrades).

Implications for FP7

- Exploit properties such as mobility, connectivity, embedded intelligence, personalisation, and interactivity as the basis for a new generation of service delivery platforms, managed applications and support services with much enhanced capabilities.

- Capitalise on networks becoming service- and application-centric and invisible to the user.

Accommodating the market perspective in ICT research

5) **Focus on Value Chains:** With technology, products and services becoming more interdependent, accommodating the market perspective is essential. What do European users – at a societal level – *really* want and need? Thus, research must take account of at least the value chain, and increasingly the whole business/service ecosystem.

   Implications for FP7

   - While keeping user needs centre-stage, shift the user focus from discrete systems to the value chains of which they are a part and the societal challenges to which they are applied.
   - Ensure the exploitation of ICT research results focuses on innovative business models as well as innovative technology.

While these issues are all essential in strengthening the focus on societal-scale ICT solutions, they are also important to the future development of ICT in general. By confronting the issues head-on through 'grand challenges', in Europe we give ourselves a head start in coping with them in the wider context.

2.5 The Innovation Landscape

This latter point brings us to another important consideration for the Work Programme: how it relates to the innovation landscape. Here we discuss the role of 'technology-push' versus 'application- or market-pull' in shaping the nature of ICT research. We also distinguish between the roles of 'emerging' and 'disruptive' technologies.

2.5.1 Combining Technology Push with Application-/Market- Pull

The innovation spectrum

Innovation – the development of new products, services and business models – is often characterised as a spectrum. At one end there is 'technology push': results from research and incremental development seeking articulation and deployment within the marketplace. From the other side there is 'application or market pull': users specifying their demands and seeking products and services meeting those requirements.

In reality, of course, the situation is much more complicated. Any particular innovation opportunity is likely to involve a combination of technology-push and application-pull. Furthermore, the process is not linear but systemic, with the route from technology to final application being mediated by a whole variety of non-technological factors (skills, funding, standards, intellectual property issues, etc).

Technology research alone is not enough

The research priorities – 'centres of gravity' – identified by ISTAG imply the need for more attention to the application side of the equation. Each involves a multi-faceted set of issues, encompassing technology, organisational processes, business models, social interactions, etc. Technology research alone will not be sufficient to deliver realistic and effective solutions to European challenges. Applications perspectives will be required to orient the research and ground the results in real-world problems and issues.

In addition to work at the network and systems levels and on embedded technologies, there will be a substantial emphasis on application-drivers, services, content and experiences. Indeed, while a number of application-drivers can and should be considered as generic, in many cases the local environment and changing laws and social systems will require a continuous adaptation of these applications. This will constitute a major challenge for application development in terms of timing, flexibility, adaptability, productivity, and reliability.

The priority: a new effort in application-oriented research

Hence, future ICT research must make room for both 'technology push' and 'application pull' approaches. The global and research trends discussed above dictate a need for much more emphasis on the latter.

in addition to supporting ICT progress in the key technology fields, ISTAG proposes that **European ICT Research should initiate a new effort in the application-oriented research fields that drive ICT innovation. These should be focused on grand socio-economic challenges,** so as to better exploit the value points in the emerging digital networked society and economy. As part of such an approach we need to create a new dialogue with the demand side – both the end-customers and domain experts – involving it more directly in research to ensure outcomes meet user and societal needs. **ISTAG believes this is the key and radical practical change necessary for the ICT Work Programme in FP7**.

2.5.2 Emerging vs Disruptive Technologies

Finally, we turn to two distinctive areas of the innovation landscape: newly emerging technologies and disruptive technologies.

Characteristics of emerging technologies

Emerging technologies are situated in the early stages of the technology lifecycle (Figure 2.2), and include components as well as systems and services. As such they have a low market impact and high risk (i.e. high elimination rate). They may involve strong public funding and a strong link with the science base, and be suitable for joint industry-academic research. Since they are not yet fully deployed in the marketplace, emerging technologies may also be subject to "hype" – i.e to over-estimation of their actual social and economic impact.

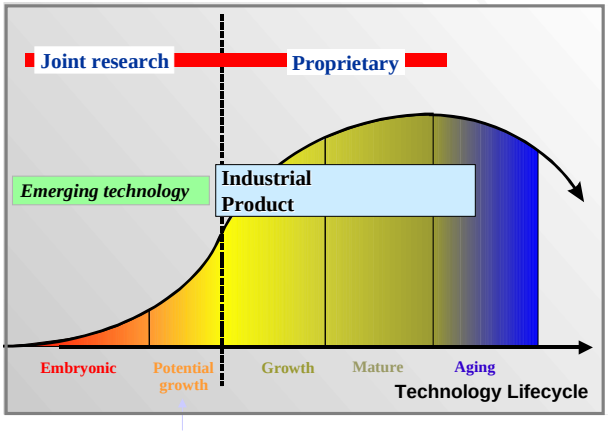

Figure 2.2: The Technology Lifecycle

At present, emerging technologies in ICT can be found mainly in three areas:

- *End-of-roadmap technologies*: These extrapolate present technology trends towards smaller or larger scale; higher performance; higher complexity; added functionality, etc. Examples are emerging nanodevices (beyond Moore's law), advanced computing architectures, and complex networks.
- *Technology interfaces*: The boundaries between different technologies hold a strong potential for innovation, therefore multidisciplinary domains are likely

to contain emerging technologies. Examples in ICT are nanotechnology, mixed reality environments, and semantic web.

- *Converging technologies*: Linked with the previous point, but here the emphasis is on the merging (i.e. interdisciplinarity) of existing technology domains. Examples are biomimetics, cognitive systems, and autonomic communications.

Disruptive technologies

It is important to note that **emerging technologies are not necessarily disruptive technologies** and in general the two have very different characteristics. Disruptive technologies are generally more mature and closer to market introduction. Their arrival is generally unforeseen and they have a "cutting-through'' market impact rather than a standard lifecycle. Emerging technologies may become disruptive, however, once they reach a certain maturity.

Actions for FP7

Within the IST Programme, emerging technologies research is concentrated in the Future & Emerging Technologies (FET) action. We note a number of implications here for similar activities under FP7:

- *Need for renewal*: FET covers a relatively limited range of emerging technologies and has remained on essentially the same tracks (nanodevices, complex systems, bio-inspired IT, etc) from one FP to the next. Some diversification is necessary in view of the fast-changing technology landscape.
- *Need for reorientation*: More focused applications-oriented research should be included in the Work Programme to align with global ICT balance. .
- *Need for integration*: Links should be developed with new actors such as the European Technology Platforms and European Research Council, while also keeping the interface with DG Research (especially on nanotechnology, energy, environment, transport). Further joint calls should be considered.
- *Need for networking with industry*: FET is well positioned to provide shortcuts between SMEs and venture capitalists to promote the growth of innovative start-ups. Further efforts could also be made to build strategic links between industry and academia: research centres could be useful as transmission gear. This would also contribute to the structuring of the European Research Area (ERA).
- *Need for follow-up*: There should be a clear path to further exploitation of promising deliverables. This could be achieved by introducing take-up schemes for results: link to IST programmes for further development, industrial stage, IP protection, etc.

CHAPTER 3: A STRATEGIC WORK PROGRAMME

3.1 Aims of the Work Programme

What's different now?

The context for the next European Research Programme in ICT has changed significantly from that in the past. Europe's economic and social malaise gives an added sense of urgency to the need to find a new model through which to translate ICT's benefits for the European economy and society. Globalisation and the ever fast pace of change require the European research system to be more agile and responsive. Complexity in technology, markets and industry value chains dictate that we cast the research net wider and seek new approaches. Now, more than ever, it is vital that ICT research delivers for Europe.

Re-orienting the Programme to meet future needs

In the Visions report ISTAG set out its recommendations for how the European research system as a whole could and should respond to these challenges. We should be similarly demanding of the European ICT Research Programme itself. We need to re-orientate the whole programme around the constitutive technology vision: recognising ICT as a new social paradigm with the potential to transform the European economy and society.

The FP7 Work Programme, therefore, must be strategic. It should set:

1. ***An ambitious agenda…****:* Research should be ambitious and far-reaching. We need to define a Work Programme that:
    - is sufficiently attractive to mobilise all stakeholders;
    - improves the effectiveness of our **use** of ICT as well as delivering new solutions;
    - aims for a bigger impact on societal challenges and wealth creation;
    - capitalises on major global and wide-ranging trends such as convergence.
2. ***…answering Europe's needs…***: Research must identify target constituencies and contribute to major European Union policies.
3. ***…for the future***: Research must address major changes since FP6 in terms of the evolution of technology and markets and emerging requirements.

Key issues for the ICT Work Programme

To achieve this, the ICT Work Programme needs to take account of a number of major issues. It should:

- *Improve innovation*: Research alone will not deliver transformational change for Europe; we also have to apply the results of research in innovative products, services and processes. Thus, the Work Programme must not only facilitate R&D but also find ways and means of improving the downstream impact. This implies a strong focus on integration and applications. It also emphasizes the importance of user communities/stakeholders as means of linking research to user needs.
- *Be sensitive to disruption*: The European Technology Platforms (ETPs) are a major development in European research. However, their approach is

essentially evolutionary not revolutionary. The Work Programme must provide a means to track and exploit developments which may 'fall between the cracks' of the ETPs. In particular, it must be open enough to detect emerging and disruptive technologies and flexible enough to respond.

- *Get the balance right*: A strategic Work Programme needs to accommodate a very wide range of research. On the one hand, there should be application-led research which is relatively near to market. Here, factors such as standardisation and user needs are key elements influencing success. At the other end of the spectrum is research into emerging and breakthrough technologies, which may come from any discipline and any part of the world. These have a wholly different dynamic and require a different approach.

- *Implementation*: The European R&D Programmes have become hugely bureaucratic and are drowning in paper. We must make the ICT Programme easier to access and to manage: a massive simplification in procedures and processes is needed.

ISTAG has visited many of these issues before. For instance, in a previous report[6] we noted the need to stimulate the full cycle of innovation, which we defined in terms of three timeframes: 3-5 years (deployment); 5-10 years (integration and Grand Challenges); and 10+ years (basic research). We also commented on the need to open up significant new avenues of research in integration for research results to reach the market effectively.

In the same report, we noted the pervasive nature of software and the importance of secure, robust, common and open standards in ICT development. We also commented on the "blurring frontiers between ICT and other disciplines". In a separate report[7], we have set out the potential of "Grand Challenge" projects in ICT as a means to stimulate research & development and innovation in key areas and to help the EU to achieve its social and economic goals.

Our proposals thus represent the conclusion of detailed work by ISTAG over an extended period.

3.2 The Components

3.2.1 Programme Structure

Three pillars

The FP7 Programme Proposal for ICT research and development is structured into three main elements:

1. *Technology Pillars (TPs):* covering research into core ICT building blocks;
2. *Application Research (ARs):* covering ICT research in key application domains; and
3. *Integration Environments (IEs):* covering ICT research for integration into systems in various environments and contexts.

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[6] *ISTAG report on Strategic Orientations for ICT Research in Europe, 2004. Available at: cordis.europa.eu/ist/istag.htm*

[7] *ISTAG report on Grand Challenges, 2004. Available at: cordis.europa.eu/ist/istag.htm*

In addition, provision is made for a continuing action on Future & Emerging Technologies (FET) to support research at the frontier of knowledge in core ICT and in their combination with other relevant areas and disciplines; to nurture novel ideas and radically new uses and to explore new options in ICT research roadmaps.

The proposed structure is shown schematically in Figure 3.1.

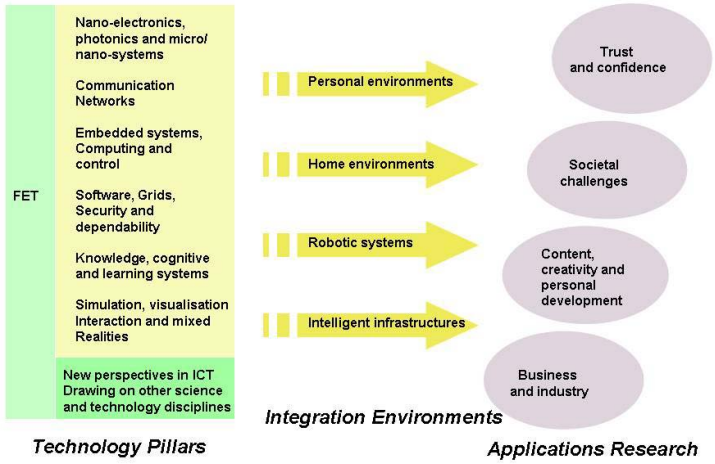

Figure 3.1: Proposed Structure of ICT Research in FP7

Knowledge flows are implicit in this structure and should be two-way. A Technology Pillar should be capable of addressing many applications. Similarly, Applications Research has to feed user needs back into many TPs. Integration Research provides the channel for this two-way flow.

Although not yet finalised, no major changes have been proposed in the funding schemes used to implement the Programme: Collaborative Projects, Networks of Excellence, and Coordination and Support Actions are foreseen.

3.2.2 Research Approaches

How can we implement this Programme structure – the programme elements and associated instruments – in a way that reflects the strategic requirements?

ISTAG believes the answer rests on effectively translating and preserving three key principles:

- flexibility,
- a strong application orientation, and
- a balance between continuity and innovation.

Three approaches to ICT research

Three types of research are proposed that allow the ICT research challenges to be addressed from several different angles:

1) **Application-led Research**: Focused research for end-to-end systems and applications directed towards major societal and economic challenges in areas with a high potential impact.

2) **Technology Breakthrough Research**: Strategic research directed towards removing roadblocks and improving the capability of generic technology components, solutions, systems and platforms.

3) **Enquiry-led Research**: An open and flexible approach to collaborative research that offers new insights on strategic areas and keeps alert to disruptions.

The scheme is summarised and mapped to the Programme structure in Figure 3.2.

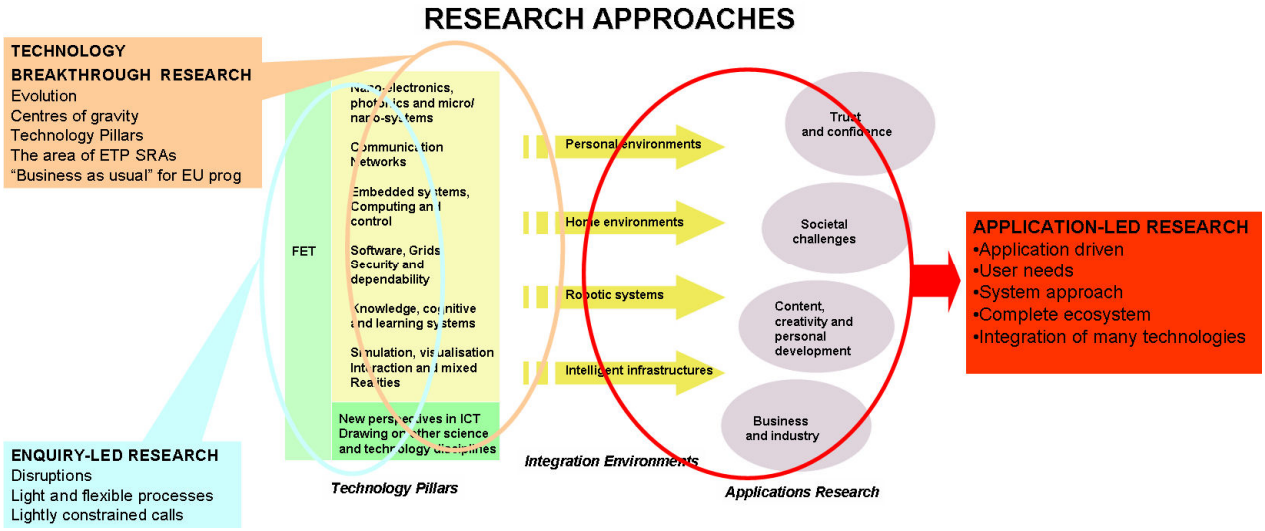

Figure 3.2: Approaches for ICT Research in FP7

With this multi-faceted approach, the Programme would at the same time be both more focused and directed, and more open and flexible. The end result will be a Programme that has much greater range: one that is more responsive both to societal needs and technological & research potential.

3.2.3 Technology Breakthrough and Enquiry-led Research

"Business-as-usual" and …

The Technology Breakthrough Research is mostly "business-as-usual", essentially a continuation of the approach under FP6. Research should proceed along an evolutionary path, with a main focus on the 'centres of gravity' identified by ISTAG. The main contributing Programme components are the Technology Pillars. In FP7 such activities will receive important input from the strategic research agendas of the ETPs.

…a new open and flexible scheme

The Enquiry-led Research would be a new scheme, but would be fairly straightforward to implement. Calls would be lightly constrained and would merely set out the scope of the target field, similar to the current open & proactive schemes in FET. For instance, proposals could either be invited within a particular subject or could allow a "free-form" approach to one or more Strategic Objectives.

Collaboration is essential in new and emerging areas and should remain a distinguishing feature of these pathfinder activities. Moreover, intensifying collaborative enquiry-led research within the European ICT Research Programme

does not detract from the need to mobilise the ICT Community to engage with frontier research activities sponsored by the new European Research Council.

In the remainder of this section we comment in detail on the most demanding approach: Application-led Research.

3.3 Application-led Research and Innovation Communities

3.3.1 Innovation Communities: Addressing European Challenges

Mobilising stakeholders through Innovation Communities

The success of Application-led Research relies on a strong coherence between research outcomes and socio-economic objectives. Achieving this requires a new type of high-level initiative, which we call an 'Innovation Community'.

The Innovation Communities will be large-scale, multi-stakeholder initiatives focusing on areas with major socio-economic impact. They provide a platform within the European ICT Research Programme for world-leading initiatives to develop innovative ICT solutions. Their distinguishing feature is in having **concrete and realisable goals**, which will be met through a tightly defined programme to address a major European issue.

The Innovation Communities should mobilise and focus Europe's research assets in a way that is not possible through any other means, and therefore provide European added value. To retain their focus and value, it is essential that there are a **limited number** of such initiatives: probably 4-5 across the whole Work Programme. The choice of the initiatives should reflect:

- A clear rationale for a European level activity, which in turn will be reflected in the goals. For example, the Communities will help define important standards and interfaces.
- A clear opportunity for European leadership (not catching up / levelling the playing field).

The Innovation Communities should embrace a wide range of activities over different timescales: short-term ("what can we do with today's technology" – innovation-related); medium term ("what will we be able to do based on today's research"), and long-term ("what will we be able to do using emerging technologies from tomorrow's research"). Roadmaps should set out how and when these milestones will be met.

3.3.2 Characteristics of Innovation Communities

Key issues for Innovation Communities

ISTAG sees a number of key issues in relation to how the Innovation Platforms are selected and implemented:

- *Focus and Scope:* **The Communities should have focus and intent**. They must have a clear vision within their application domain and mobilise the stakeholders to work together towards this vision. To do this they will need to span the whole innovation landscape, from encouraging greater integration of existing and new technologies, through to pioneering long-term visions. In all cases sub-goals will be required. Thus, **the scope of the Communities will need to be carefully defined**: too narrow and they will not have sufficient impact; too wide and they will lose focus.

- *Building the Market:* Innovation Communities would aim to bring together all relevant stakeholders and set the vision in relation to particular applications. Rather than technology development, Innovation Communities would focus on building a market for the applications that are emerging.

- *Mobilisation of Europe's research assets and resources*: The Communities will need identities to be able to mobilise the research community and oversee the innovation vision. Industry is likely to be especially interested in the Innovation Communities, since they could provide access to new lead markets.

- *Relationship with ETPs*: The Innovation Communities will be magnets for technology. They will require contributions from across the ETPs and **will essentially be integration environments for the ETPs' outputs**. The ETPs will provide the building blocks and the Communities will propose how they can be used. 'Lighthouse projects' (sponsored by one or more ETPs) within the Community could help fast-track developments while a roadmap is being developed.

3.3.3 Candidates for Application-led Projects and Innovation Communities

Suggestions for Innovation Communities

ISTAG suggests the following as potential candidates for Application-led projects and Innovation Communities. Example objectives and scope for these are described further in Annex 1.

- ***Well-Being in the Ageing Society***: Aiming to facilitate the new paradigm of personalised healthcare within the context of an ageing population. It includes elements such as personalised and home-based care, preventative health management for all, and new models for e-care/social care for the elderly.
- ***New Media Paradigms for Digital Leisure***: Aiming to develop and exploit new forms of content and experiences for global networks. It will allow Europeans to enjoy new leisure time experiences that meet their personal needs and talents, while enabling European industry to be world leaders within emerging value chains for digital content.
- ***Digital Service Ecosystems***: Aiming towards the next generation of digital organisations which are service based. Focus is on the common challenges faced by traditional service industries, manufacturing, and public services in leveraging digital processes to deliver personalised product & service offerings. Key features are personalisation/customisation, and the seamless bridging between the physical world and the digital information space.
- ***Sustainable European Mobility***: Aiming towards integrated solutions to make transport in Europe more economically, socially and environmentally sustainable. The focus is on using ICT to deliver real and lasting change across a number of areas: traveller behaviour; design of vehicles and transport systems; and management of transport infrastructure.

3.4 Implementing the Innovation Communities

What will the Innovation Communities look like? How will they actually work? Below we offer a number of perspectives on how these Communities would operate and what they might achieve. These views are not mutually exclusive since, as large multi-stakeholder initiatives, they will operate at many different levels and mean different things to different people.

3.4.1 The Building Blocks: Application-led Projects

Innovation Communities as Application-led research projects

Integrated Projects (IPs) are a highly successful innovation introduced within FP6. The escalation in the scale and ambition of research allowed by the IPs has been a welcome development. Under FP6, IPs have helped Europe build critical mass in key areas of ICT research.

Within the current portfolio we see several different types of IPs. Some are technology-led, being directed towards highly focused technical goals. Others are application-led and more designed to integrate emerging technologies and create solutions. Their outcomes are generally demonstrators that can be used by the end-users, and can be exploited by the partners in the project. One such is Healthy Aims, an IP on microsystems for health (see Box 3.1).

Such Application-led IPs provide an important model for FP7. Community building is an essential feature of any successful IP. As a channel that links technology providers with end-users, they should be one of the main stakeholders in an Innovation Community.

Box 3.1: Case Study: Healthy Aims - A User-Driven Integrated Project

Healthy Aims (www.healthyaims.org) is an FP6 Integrated Project on microsystems for health. With 26 partners, including 6 SMEs, across 9 EU countries, the project covers the whole supply chain – technology developers, manufacturers and end-users. These partners are developing a range of medical implants to help the aging population and those with disabilities. The initiative grew out of Nexus, the user-supplier club for health microsystems launched under previous Framework Programmes.

The project allows technology providers to engage with end-users (e.g. surgeons) leading to many different types of outputs: some are concrete and capable of being rapidly developed or commercialised. Others are “blue sky” and require development over a much longer period.

While it can be fruitful, the project has found that this engagement with users presents a stumbling block. It involves many different technologies and many different partners – often from different cultures - and so tends to be costly, time-consuming and unpredictable. The project has used roadmaps to focus and direct knowledge flows between the different stakeholder groups.

Although the Healthy Aims roadmap was developed some time ago many of the necessary building blocks are only becoming available now. Other enablers, such as computing and telecoms, are close to maturity, allowing the project to think of developments on a different scale. The project is now focusing on integrating the different building blocks and enabling technologies and on better understanding user needs.

To be successful Application-led IPs will require:

- ***Strong focus on integration****:* Projects should have a strong focus on integration of technologies to provide solutions to known problems. This will include work in: fabrication, assembly and test to produce demonstrators; standards and protocols; approvals; interfaces; software/hardware/firmware;

trials and evidence gathering. Where technologies need adapting for the specific application or where technologies are missing then this work should also be included.

- ***Clear understanding of market needs****:* Clear market needs must drive the project, and end-users should be involved as early as possible to ensure that the final solutions meet the requirements. End-users should also test the demonstrators and provide the evidence necessary for future product acceptance. This is all part of building a 'community of business interest'.

- ***Supply chain approach****:* Projects should have cross-disciplinary consortia which cover the entire supply chain, as well as all relevant technical disciplines. Representation from across the supply chain will ensure that product concepts can be designed, manufactured, assembled, tested, and validated in their specific applications.

  SMEs are recognised as innovative and fast-moving, and hence should be included at various stages of the supply chain: for example, as part of the early stage concept development or as a system manufacturer. Procurement groups should ideally be included to ensure that the final product has a potential future route to market.

- ***Flexible management****:* Management of large Application-led projects requires a flexible approach. Exploitation strategy should be clearly defined and visible from the outset. A roadmap should provide a vision of what the project aims to achieve and should be regularly updated during the project.

3.4.2 Innovation Communities: Innovation to Meet Societal Challenges

Innovation Communities as a means of innovating on a societal scale

Application-led Integrated Projects can attack a project scale problem, and have demonstrated success in delivering results from technology providers to users. However, the societal challenges facing us are larger problems with many dimensions:

- Technical: The problems are serious challenges facing society. Each contains many subsidiary challenges and alternative approaches that require coordination and leadership.
- Complexity: Delivery systems are complex, and successful innovative solutions must meet the needs of all stakeholders (users, domain professionals, administrators).
- Investment and scale – in the end, it is unlikely that challenges will be met without sizeable investments (public and private) on a national scale.

We need new mechanisms to face up to these larger issues, and Innovation Communities can play a leading role in this.

An Innovation Community is a grouping of stakeholders connected to each other by a shared focus on the societal challenge. Their role would be to accelerate the development and introduction of innovative solutions to the societal challenges. Initially this would require a broad dialogue amongst stakeholders from the technology research communities, domain professionals, administrators, purchasers and users. The Innovation Community would use this interaction to:

- *Define future requirements and innovative solutions:* Bring together the stakeholders to define the requirements and describe the technology landscape, while maintaining overall technology neutrality.
- *Define roadmaps*: Create a roadmap for the topic, (as a living document) covering both research challenges and key steps to introduce solutions.
- *Drive innovation*: By acting as a "customer" for technology research in FP7 projects and encouraging the definition of necessary standards.
- *Facilitate integration:* Sponsor integration exercises to clarify key challenges or define important interfaces.
- *Pilots, trials and national introduction*

Thus, the Innovation Communities would bridge technology and applications and give stakeholders a mandate to 'make something happen'.

Innovation Communities would be supported through Applications-led Research Projects and/or as Accompanying Measures that provide overall coordination and structuring. The Communities themselves would sit outside of the European Research Programme so as to develop their independence and sustainability.

Support to Innovation Communities would be part of calls and would have a role in coordinating the work of IPs towards achieving the set goals. They would draw on current technologies and emerging results from whatever source, including from outside of EU R&D programmes. Key areas of interest would be: roadmaps, technology interfaces, customer requirements, procurement and standards.

3.4.3 The Route to Innovation Communities

We recognise that community building at this scale is a demanding and long term task. European countries organise delivery of services in different ways, with different stakeholders, and operate to different standards and regulatory regimes. But overcoming this fragmentation is exactly **why** the Innovation Communities are needed.

There is no single model to follow: the most appropriate approach will differ from one challenge/application domain to the next. We suggest the following as potential starting points:

- Networking coordinators of national application/sector ICT programmes and other stakeholder groups (in a similar way that the National ICT Directors Forum does for the European ICT Research Programme as a whole).
- Setting up of industry-led application initiatives, similar to the European Technology Platforms.
- Use of coordination instruments such as EraNets, 'Article 169' and Joint Technology Initiatives (JTIs).

Most probably a mixture of these approaches will be required. In addition, we note a need to understand more about the workings of 'lead markets': Who are the key players? What factors dictate success or failure? How can they help drive innovation through standards and public procurement?

CHAPTER 4: IMPLEMENTATION

4.1.1 Need for Simplification

The Framework Programme is bureaucratic and must be simplified

ISTAG fully supports the idea of significantly simplifying the general operation of the European research programmes, as outlined in the FP7 Proposal. This was also a specific recommendation of the "Five Year Assessment of IST-RTD"[8], which explicitly stated that "*EU Research in Information Society Technologies is vital for competitiveness, but needs more investment and less bureaucracy*".

For many organisations, the Framework Programme is simply not attractive. There is an urgent need to reduce the overhead related to project submission and, as the project progress, to administrative procedures and evaluation.

More specifically, we note that there seems to be **an increasing lack of trust** in EU-funded projects between researchers and the Commission, resulting in more and more demanding reporting and administrative constraints. This is hurting not only the efficiency of the projects themselves, but also the productivity of the Commission's project officers. POs are often swamped by reports and are not allowed the flexibility to adapt reporting requirements to the type of project or research being undertaken. This prevents them from focusing on the key aspects of each individual project.

This lack of trust has many consequences, including:

- Increasing bureaucratic load on EC project participants ***and*** Commission personnel.
- Increasing difficulty to motivate key players in industry and academia to be involved in either research projects or project evaluation.
- Accumulation of rules that will not improve the quality of the project, the consortium or the end results.

The situation is especially critical for SMEs, who simply cannot afford to waste time in meetings and reporting. SMEs don't need to be told by non-experts what to do and how/when to do it (including how to protect their intellectual property); and they don't want larger participants to impose onerous contract conditions. Big discrepancies can arise between SMEs' actual needs (including research) and the artificial requirements created under EC contracts.

4.1.2 Making the Programme More User-friendly

Re-establishing trust with project consortia

We urgently need to re-establish trust in the relationships between the Commission and project consortia. While formal procedures have some part to play in this, other aspects are also important, such as common motivation, personal/community knowledge (e.g. previous experience with project coordinators/partners, reputation, recognised networks of excellence and/or winning teams, etc); and joint involvement (working together towards well defined, common objectives).

[8] http://europa.eu.int/comm/dgs/information_society/evaluation/rtd/5_year_assessment/index_en.htm

To meet these objectives, several issues need to be addressed in relation to efficiency, effectiveness, and usability and sustainability. Specifically, we recommend:

- *Simplification of administrative procedures* (contracts, claims, etc) to make them more flexible and less time consuming for both project consortia and the Commission.
- *A significant reduction in the number of project reports*. The current set of reports could be considered as a guideline or reference, rather than as a mandatory requirement. Consortia, especially SMEs, could also be further supported in providing the necessary documentation.
- *More flexible evaluation criteria*. This should include a shift towards a degree of self-evaluation, based on key and measurable indicators of research, development and dissemination outcomes.
- *Improvements in calls* to make proposal submission less burdensome, for instance through a two-step procedure.
- *Improved communication/coordination* across similar or complementary projects.
- *Funding projects over a longer period*, so as to encourage the formation of truly European research communities with common visions and successful, long-term collaborations.

These changes are necessary under existing frameworks and will be even more essential for the effective running of the proposed Innovation Communities. SMEs (including end-user SMEs) should form a key part of any Innovation Community. But engaging them requires a shift in procedures, and also to some extent, of mindsets. Attempting to introduce dynamic, responsive, user-driven initiatives on the basis of current procedures is not a recipe for success.

We note with interest that proposals to simplify the programme are being made, and we suggest that some concrete performance measures are introduced to monitor the effect of any changes.

CHAPTER 5: CONCLUSIONS & RECOMMENDATIONS

A Work Programme that reflects the ISTAG vision

The Vision for ICT in Europe put forward by ISTAG is compelling. It recognises the challenges facing Europe at present, both at the societal level and at the economic level as a consequence of globalisation and convergence. It also recognises that these very challenges represent significant opportunities for the European ICT industry, if we attack them with focus and vigour.

To realise this vision it needs to be fundamentally reflected in the priorities of the Work Programme for European ICT Research under FP7.

Our analysis has highlighted a number of conclusions and recommendations on how this might be achieved, which we summarize again here:

Scaling up the research effort

1. **Refocus the Research Effort at the Societal Scale: In addition to supporting progress in the key ICT technologies,** European ICT Research should initiate a new effort in the application-oriented research that drives innovation. These should be focused on grand societal challenges. Such an effort must address the technical challenges of how to build robust and flexible large-scale ICT systems: it must also mobilise the stakeholder communities to turn the research into effective solutions. In doing this, the European ICT Research Programme will be compelled to:
    i. *Address complexity and follow a systems approach*. In particular, new avenues of research in integration should be opened up to accelerate the market take-up of research results.
    ii. *Foster interdisciplinarity and synergies*, so that the range of interactions around ICT research becomes both wider and deeper.
    iii. *Create an open engagement with users*, putting users firmly at the centre of ICT innovation processes.
    iv. *Stimulate the consumption side (services and content)*, so as to fully exploit the potential of infrastructure investments; and
    v. *Focus on the whole business value chain and ecosystem*, so as to better accommodate the market perspective within ICT research.

    Addressing these issues will be essential not only in strengthening the focus on societal-scale ICT solutions, but also for Europe to be at the forefront of world-class ICT developments in general.

Achieving balance through a multi-faceted approach

2. **Implement a Three-pronged Approach to ICT Research:** ISTAG recommends three types of research that allow the ICT research challenges to be addressed at several different levels:
    - *Application-led Research*: Focused research for end-to-end systems and applications directed towards major societal and economic challenges in areas with a high potential impact;
    - *Technology Breakthrough research*: Strategic research directed towards removing roadblocks and improving the capability of generic technology components, solutions, systems and platforms;

- *Enquiry-led research*: An open and flexible approach to collaborative research that offers new insights on strategic areas and keeps alert to disruptions.

Innovation Communities as societal-scale ICT initiatives

3. **Mobilise the Stakeholders through Innovation Communities:** Application-led Research should be implemented through Innovation Communities, new large-scale ICT initiatives that will mobilise the stakeholders – lead users and technology visionaries – to develop a grand vision to address a major European issue. Through dialogue, they will set a tightly-defined programme of action to realise the vision, which will be implemented through roadmaps with clearly defined milestones. Driven by applications and users, the Communities will be magnets for technology and will play a key role in integrating outputs from the ETPs and driving standardisation. To retain their focus and value, it is essential that there are a limited number of such initiatives.

New models for user-driven innovation

4. **Create a New Dialogue with Users:** The success of societal-scale ICT innovation – under the Innovation Communities and more generally – will require a greater emphasis on user innovation. European ICT Research must seek new models through which to create a dialogue with users, involving them more directly in research to ensure outcomes meet user and societal needs.

A greater effort in emerging technologies research

5. **Strengthen the Emphasis on Emerging Technologies:** Europe must strengthen its research effort in emerging ICT technologies, which hold the greatest potential for innovation and economic growth for 'the day after tomorrow'. Emerging technologies research under FP7 should embrace a wider range of technology fields, more applications-oriented research, and greater efforts in integration and exploitation. Stronger links with industry and with other research actors will be essential here.

A simpler Programme to access and work in

6. **Make the Programme Simpler and More 'User-friendly':** The Framework Programme is simply not attractive for many organisations and a significant simplification of administrative and financial procedures is urgently needed. Streamlining of administrative procedures and reporting requirements, more flexible evaluation criteria, improvements in calls and in project coordination, and continuity of funding are all areas needing to be addressed. We note with interest that proposals to simplify the programme are being made, and we suggest that some concrete performance measures are introduced to monitor the effect of any changes.

ANNEX 1: APPLICATION RESEARCH CHALLENGES

The Annex presents examples of candidates for Application-led Research Challenges under future European ICT Research. The candidates summarize:

- The Challenge Vision – How focused research in ICT that mobilises all stakeholders could contribute to a major European societal issue.
- The Challenge Goals – Key stepping stones in achieving the Vision over a 10-15 year timeframe.
- Scientific and Technology Challenges – Requirements of ICT to meet the Challenge Goals.

The presentations are indicative of the types of grand socio-economic challenges that could and should be addressed through large-scale initiatives, but are by no means exhaustive.

WELL-BEING IN THE AGEING SOCIETY

The Challenge Vision *(ICT contributing to a major European societal issue)*

The aim is to facilitate a new paradigm of personalised healthcare within the context of an ageing population. EU citizens will be enabled and supported to live more healthy lives, minimising time in hospital, at local doctors or in care homes. Europe's increasingly elderly population will be able to live more independently in their home environment, overcoming isolation and minimising their reliance on carers. For health and social care providers, services will be focused around more personalised and preventative health management, rather than treatment, while containing the overall cost of delivery.

The Challenge Goals *(Stepping stones in achieving the Vision)*

Short term goals (to 2010) include:

- Better monitoring regimes for chronically ill patients, through monitoring of vital signs, to reduce the number of medical emergences.
- Wider use of in-home and mobile health alarms by the elderly, allowing older people to live independently while being supported by carers, health and emergency services.
- Common medical record system across the EU, enabling people to receive medical treatment anywhere within the EU without having to contact their local doctor or hospital.
- Wider use of implantable systems as replacements for non-functioning nerves and muscles.
- Automatic drug delivery systems for the elderly and those with drug-dependent care regimes.

Medium term goals (2010-2015) include:

- Improved diagnostic equipment to reduce the effect and cost of treating medical conditions, e.g. cancers.
- Improved treatments to minimise the effect of surgery and subsequent healing, so reducing the patient's stay in hospital.
- Home monitoring becomes more widely available for people considered at risk. Target sectors for these systems – which would be on the body - include new born babies and the elderly.
- Lifelong implants for a more extensive range of nerve or muscle failures, ultimately to enable the citizen to live an active life without medical or care assistance.
- Modelling and simulation of all aspects of the human body so as to better understand medical conditions and develop (personalised) treatment options.

Long-term goals (2015-2020)

- Introduction of advances from stem cell and genome research into medical practice, through precision surgery, biomaterials and intelligent micro-nano systems.
- Next generation of functional stimulators and intelligent systems, including for drug delivery.
- Wider use of medical robots for a range of hospital treatments.

Scientific and Technology Challenges (*Requirements of ICT to meet the Challenge Goals)*

- Development of a wide range of micro- and nano components (sensors, interconnects, power sources), bio-materials and data communication systems
- Data communication, including wireless systems that integrate with sensor networks meeting both the medical standards and the clinical requirements.
- Embedded systems as the basis for smart medical implants, home monitoring systems, medical robots and other health-related applications.
- Development of advanced simulation, visualisation and modelling, including Grids, to provide new solutions for medical applications.
- Networking solutions to access, search and manipulate huge distributed datasets, including the integration of clinical, biomedical and genomic information.
- Incorporation of organisational perspectives (health management, social care management, etc) into the development of new ICT technologies, services and applications.

Ethical and regulatory issues will be prominent in all areas of research.

NEW MEDIA PARADIGMS FOR DIGITAL LEISURE

The Challenge Vision *(ICT contributing to a major European societal issue)*

The aim is to develop and exploit new forms of content and experiences for global networks. Europeans will enjoy new leisure time experiences that meet their personal needs and talents, while enabling European industry to be world leaders within the digital content value chain. The next 20 years presents huge opportunities to embrace and support new forms of digital media that will be more interactive and more personalised than those we know today.

As well as current media forms - text, photos, audio, animations and video – new digital media will comprise multimedia and multimodal "experiences", including systems that evoke the sense of touch and smell in association with sights and sounds. These new media paradigms will offer users novel means of creative, artistic and social expression.

The focus here is in consumer markets, where the opportunities span many new applications and services in the creative & media industries, culture, education, business and tourism. Although entertainment is and will continue to be the largest market, mass penetration of new technologies into the home for entertainment will not necessarily be rapid. Experimentation and development for business markets will therefore fund early developments.

The Challenge Goals *(Stepping stones in achieving the Vision)*

- *Participation media:* Consumers will increasingly become part of the content, through their activity and through their communication. This is an extension of trends discernible from participation TV; from users embracing VOIP and messenger services as leisure-time activities rather than communication tasks; and from the huge popularity of interactive, user-driven online video and computer games.
- *Sharing and the remix culture:* The availability of cheap consumer electronics and the association of broadband with television displays will bring the creation, editing, mixing and sharing of digital content from the world of the amateur hobbyist to become the everyday norm across all walks of life. Consumers will spend more time working with professionally captured video content, remixing to create new versions that they will wish to share with friends. Communities and families will make and share all forms of content.
- *My Content:* Consumers will increasingly have to manage their content. They will expect it to be accessible wherever they are, on any device and to be personalised by them to suit their preferences at both a scheduling and presentation level but more interestingly at a narrative level also. With virtual access to content collections and their metadata, consumers will meet each other and form communities in new ways.
- *Freedom from the schedule:* Consumers' use of media will become increasingly ad-hoc. The demise of scheduled presentation of media through TV and radio schedules will mean consumers will need help in finding media that they might enjoy.
- *Screens everywhere:* Consumers will be able to casually engage in screen-based entertainment in many locations both inside and outside the home. These may be short burst, intensive entertainment 'fixes' or, perhaps particularly in the home, from low-level activities such as the ability to occupy and communicate with your chosen community of contacts within a visually-engaging shared space. Digital leisure services will offer users new means to communicate and 'be with people' from within the home.
- *Learning and education:* Consumers will find it easier to indulge in informal learning supported by video. This will, through an attendant focus supporting individual learning styles and paces, become increasingly personalised. Home and school environments will be significantly more integrated, and users will increasingly be able to learn in a variety of settings.
- *Immersion:* Content has always enabled people to sample, or escape to, different worlds by entering into highly engaging stories. As means of representing images change and large flat screens are joined by on-to-retina projection and other more immersive visual experiences, future digital leisure may enable people to experience places without having to enter a crafted

narrative. Consumers will take part in immersive virtual reality interactive experiences within the home, such as the ability to experience a live event from any viewpoint or 'virtual travel' to far-away destinations.

Scientific and Technology Challenges (*Requirements of ICT to meet the Challenge Goals)*

As new media paradigms emerge, challenges will confront the creators/collaborators producing the content and experiences, those storing and adding value to the archives, as well as to the target audiences/users of the content. Key issues to be addressed through research are:

- How to archive/compress and store media that is from many sources, for different uses
- Finding the content or experience one wants
- Numerous formats require interchanging (transcoding) systems and standardization
- Personalisation technologies putting content or users at risk
- New business models, how to charge for small increments, contribution of experience
- Protection (of users and of rights holders)
- Lower cost sensors and devices to produce experiences
- Computer human interfaces to reduce learning curves associated with complexity
- Legal and financial implications of active creators, collaboration (ownership)

Specific technologies include:

- Next generation compression algorithms, using faster processors for encoding and decoding (e.g. for HDTV)
- Content search, indexing and retrieval, incorporating more information such as intended uses, contextual and non-verbal cataloguing
- New, portable, high resolution and low cost capture/display systems (flexible displays, wearable screens, advanced capture devices)
- New portable, high fidelity, low cost audio output/input
- Sensing and communications integrated within consumer devices (miniaturised positioning systems, wireless tagging and sensor technologies)
- Digital rights management technologies for privacy, protection/authentication, and micro-payments. Also simple and secure identity management.
- Presence research and representation within shared spaces.

SUSTAINABLE EUROPEAN MOBILITY

The Challenge Vision *(ICT contributing to a major European societal issue)*

The aim is to achieve a world where transport is sustainable as judged from social, environmental and economic view points.

From the social perspective people will continue to want and need to travel. Travel will need to be efficient, comfortable, productive/entertaining/enjoyable, safe, secure, and reliable. While people probably will continue to travel for an average of about one hour per day, they will expect to travel faster and further. Transport will continue to be an essential service required for society to function. The behavioural aspects of travel will be key to change: the expectations, journey planning decisions, demand for choice, the reasons for travel, etc.

Environmental sustainability in transport will be imperative. Transport will be viewed as a scarce resource. Reduction of carbon emissions (eventually tending to zero) and the conservation of resources such as energy and water will increasingly drive changes in behaviour, government policy, research & development, corporate social responsibility and international co-operation. Society will view the consumption of scarce resources holistically, while governments will take a more innovative approach to supply and demand.

The economic effects of problems such as congestion and the high cost of freight transport will drive inexorable change. The real cost of transport will be factored into the economics of business and social activities. Dramatic improvements in operational efficiency will be required from transport operators and authorities. Service assurance, security, the upgrade of ageing infrastructure, corporate social responsibility and regulatory compliance obligations will rise up the agenda for businesses.

The Challenge Goals *(Stepping stones in achieving the Vision)*

Short term goals (to 2010) include:

- Operational efficiency, secure transport infrastructure, travel substitution, and traveller and operations information, requiring efforts in:

  Supply and demand management, traffic flow management, congestion management, and workforce management.

Medium term goals (2010-2015) include:

- Dynamic traffic management, fully integrated transport services, scarce resource management, carbon / energy trading, emissions control, traveller behaviour, and communicating sensors, devices, vehicles, and field assets, requiring efforts in:

  Real time information, real time supply and demand management, real time disruption management, and event messaging, middleware and the data storm.

Long-term goals (2015-2020) include aspects such as:

- Driverless vehicles, zero environmental impact vehicles (surface and air), automated freight transport, virtual tourism, ultra-high speed vehicles, and intelligent infrastructures, requiring efforts in:

  Co-operative vehicle highway systems, alternative fuel and battery technologies, next generation logistics / supply chain management, virtual reality, safety control systems, and self-organising systems.

Scientific and Technology Challenges (*Requirements of ICT to meet the Challenge Goals)*

- New human-machine interface concepts and tools for private cars
- Advanced driver assistance systems (ADAS) for driver support and information provision
- Intelligent tracking and tracing devices
- Intelligent information management systems (demand management, travel planning/routing, intermodal planning and booking systems) and their integration into info-mobility services
- Security and trust technologies in support of privacy, safety and dependability.

DIGITAL SERVICE ECOSYSTEMS

The Challenge Vision *(ICT contributing to a major European societal issue)*

The aim is to create the next generation of service-based digital organisations. The vision addresses the common challenges faced by traditional service industries, manufacturing and public services in leveraging digital processes to deliver personalised product and service offerings. It focuses on the whole ecosystem of digital services that will underpin future business processes across a range of business and service value chains.

This change in service industries will affect Europe significantly as a majority of employment today is in service industries, including government and public services. Manufacturing too is becoming more service-oriented, with market demands for products to be more customised/personalised, and products themselves being endowed with communication and sensing capabilities which enrich opportunities for service support ('the internet of things').

Initial experiences of doing business online, such as filing a tax report or remotely accessing a CRM system, are evolving rapidly towards a whole ecosystem of digital services. Supported by vast availability of wired and wireless broadband, these services will be available to all users, anytime, anywhere. In the near future, very complex services built with bigger numbers of service components could be traded via ecosystems that demonstrate "one face to the customer".

Existing IT infrastructures need to be extended to support these service ecosystems, e.g. service marketplaces, B2B hubs, hosted application platforms, intelligent and smart products. We need to know how to register and advertise potential services in such an ecosystem, and how the services and components should be composed, delivered and maintained within new business channels. In particular, we need seamless bridging between the physical world and the digital information space.

The Challenge Goals *(Stepping stones in achieving the Vision)*

For service providers, IT support through a service ecosystem would provide much higher visibility of their components in the final services, differentiated by the market channels they use. There would be special benefits for SMEs as they would participate in the economies of scale of the whole ecosystem.

For users, the service ecosystems would bring competitive pricing and a huge choice of best-of-breed service delivery components. Supported by adequate IT, this would enable improved and innovative service composition and delivery to customers.

In manufacturing, service ecosystems would provide a means to respond to major economic and societal trends: increasing demand for differentiation and personalisation (for My Product); a shift in value from products to services; and the long tail of niche markets which create opportunities for niche/boutique suppliers. Opportunities opened up by the ecosystem approach include:

- Agile manufacturing, increasingly including the customer in the design (user specification and co-design).
- Building service hooks into the product and support for a (often local) service industry.
- Manufacturing and service platforms for third-party providers to offer personalised and differentiated products and services (personalised / boutique / niche manufacture).

Such ecosystems could also lead to products that are sustainable, by improving possibilities to continually upgrade rather than throw the product away.

Scientific and Technology Challenges (*Requirements of ICT to meet the Challenge Goals)*

- Service ecosystem frameworks (allowing service discovery, negotiation, ordering, authentication, payment and customer support, etc), including for eGovernment services.
- Integration with real-time systems, such as shop floor systems
- Overcoming major obstacles regarding interoperability
- Strong support for security, trust and performance
- Business models for future service platforms (service marketplaces, B2B hubs, hosted applications)
- Scalability of service-oriented architectures among very large and more loosely-coupled user communities.