IST Advisory Group
Strategic orientations
and priorities for IST in FP6

Information Society
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Report of the IST Advisory Group concerning

Strategic orientations and priorities
for IST in FP6

CONTENTS

PREFACE

This report is published at a time when confidence in the ICT sector of the economy has been shaken, first by the bursting of the 'dot-com bubble', and then by the knock-on effects of a general decline in business confidence in recent times.

However, the present 'downturn' in ICT — and in technology stocks in general — is not a downturn in the market, but a downturn in the *rate of growth* of the market, and hence in the projected growth of profits, and hence in share values. Indeed the actual growth rate — in the region of 7 % p.a. — is still greater than those of traditional markets.

Furthermore it is not just industrial confidence in the ICT sector which sets the pace of the market: the continued development of other industrial sectors, the modernisation of government and administration, and the improvement of public services are all critically dependent on the use of more and more advanced ICT.

Most analysts predict that with a general recovery of industrial confidence after the events of September 2001, high rates of growth will return, albeit at realistic levels of 10 % p.a. or a little above.

This sector is driven by technological innovation. It is not possible to run a successful ICT business without continually innovating. Like the Red Queen and Alice, businesses must run to stay in the same place.

Those who will come out strongly during the next 'upturn' will be those who have maintained their investment in innovation during the present phase of the cycle.

Moreover, in this report it is anticipated that during the next ten years a new infrastructural paradigm will emerge — the '*Ambient Intelligent Space*'. This is the collection of infrastructural technologies, applications and services that will enable the seamless interoperation of the applications and services of Ambient Intelligence.

There is a real opportunity for Europe to establish a strong position in this new paradigm.

In this context, the report contains ten far-reaching recommendations to guide the Commission's work-programmes during the next phase of research, and specifically the envisaged research into Information Society Technologies.

The report has been prepared by the Information Society Technologies Advisory Group (ISTAG), which provides independent advice to the Commission on orientations and priorities for Community funded research activities. It is one in a series of reports by ISTAG that began with the vision of '*Ambient Intelligence*', first

proposed at the outset of the Fifth Framework Programme in 1999, and the report on *'Scenarios for Ambient Intelligence 2010'* published early in 2001([1]).

The report is timed to coincide with the build-up to the launch of the Sixth Framework Programme and builds on analyses of the IST programme project portfolio during the Fifth Framework Programme and on a recent exercise of internal reflection undertaken by Commission staff.

ISTAG proposes targeted and far-sighted investment *now*: the Sixth Framework Programme must be *acyclic*.

([1]) See http://www.cordis.lu/ist/istag.htm for further information on ISTAG, their recommendations and reports.

1. INTRODUCTION

Taking the previous work of IST Advisory Group on the vision of 'Ambient Intelligence', members of ISTAG participated in debate and discussion over several months in order to develop:

> *'recommendations on how Europe might realise the concept of ambient intelligence given the scope of the IST part of the sixth framework programme, the instruments available within FP6, and the will to realise the notion of the European Research Area (ERA)'.*

ISTAG now makes ten recommendations *(section 2)* which fall into three classes:

- recommendations (1, 2 & 3) for mechanisms and methodology to identify priorities for IST in FP6.
- recommendation (4) for Europe to grasp the opportunity for a significant change in the landscape of IT-based services in the next 10 years, and particularly to take the lead in the realisation of an "*Ambient Intelligent Space*" (AmI space) — the collection of technologies, infrastructure, applications and services which will enable the concept of Ambient Intelligence.
- recommendations for particular actions in FP6, some generic (5, 6, 7, 8 & 9) and some specific (10), which would support realisation of the Ambient Intelligence concept.

The route by which ISTAG came to these recommendations is described in section 3. In this approach, ISTAG considered the requirements for deployment of the AmI vision through consideration of a selection of specific environments — such as the car and the work-place. The particular environments considered are analysed in detail in Annexes 2 to 6. While these are only example environments, they represent important domains for Europe.

A key finding is that the socio-economic challenges will be met only if new services based on new technologies are integrated and managed so that they span the different spheres of life with seamless operation across the various environments. ISTAG proposes to call the collection of facilities and capabilities that enable this 'seamlessness', the *'Ambient Intelligence Space'* and, in Section 4, has elaborated this notion.

The other findings of ISTAG are summarised in Section 5.

2. RECOMMENDATIONS

Recommendation 1: ISTAG supports the concept of 'special initiatives', encompassing, perhaps, one or more Integrated Projects, networks of excellence, and actions in the European Research Area to align national activities with those of FP6.

A major strength for research in Europe is the ability to bring together all the needed actors in a field. It is a unique feature of European research and constitutes a huge asset for the next generation of technologies. The new instruments offer the opportunity — which should be seized — to avoid fragmentation between technologies, applications and services across a collection of isolated projects.

Recommendation 2: Establish mechanisms for co-operation across the European Research Area so as to achieve a common vision of 'strategic domains', and associated road-maps, shared between the Framework Programme, other European programmes — especially Eureka, and national programmes.

Europe is still lagging behind in investment in research in IST. The IST research effort in the USA is three times as much as in Europe, and in Japan it is 50 % more than in Europe. The time has come to increase the effectiveness of resources dedicated to IST RTD.

Not only is the European investment relatively small, it is fragmented: most funding of research and development in Europe is national, and while it is true that R&D funding in Europe has enabled the revival of the European electronics industry, much of that funding came from Eureka, which is funded nationally. Tight co-ordination of national and European funding is unlikely to be achievable and, instead, EU funding might be used to aggregate the efforts of member states and private effort.

Furthermore, SME participation in cooperative research is a key factor in innovation, and while the diversity of the Framework Programme, other European programmes, and national mechanisms within the ERA is supported, they should all accommodate the needs, capabilities and assets of SMEs. *(See ISTAG report "SME participation in IST under the FP6", 2001.)*

While the IST priorities for FP6 are already aligned with the ambitions for eEurope, the concept of the ERA, and the actions to make the ERA a reality, will ensure that the 2010 eEurope objectives and the ISTAG vision are complementary, coherent and compatible.

To achieve these aspirations, the EU should facilitate dialogue between the Commission, member states and the RTD community in order to achieve a shared vision as well as synergistic mechanisms. ITEA and MEDEA, two major Eureka

projects, have jointly offered to co-ordinate with the Framework Programme, and the proposed co-operation could build on this initiative.

Recommendation 3: In order to identify appropriate initiatives, ISTAG recommends the methodology used in preparation of this present report and further recommends that a similar process should be undertaken annually in order to identify further appropriate initiatives and to guide existing initiatives.

The Commission should develop an annual process of SWOT analysis and formulation of recommended responses by ISTAG, taking into account input from DGInfso IRG's and IPPA findings.

Recommendation 4: Europe should seize the lead in the establishment of the 'AmI Space' — the combination of technologies, infrastructure, applications and services which will be necessary for seamless environment deployment and management necessary to realise the concept of Ambient Intelligence.

Infrastructure like this will not be developed and implemented top down: there are too many options and too many players trying to influence its shape. AmI Space will not be designed, yet it requires coherent development across a broad community.

A special initiative on *AmI Space* should detail the vision and concepts and define a more detailed research agenda. This initiative should encompass co-ordination actions across all the pertinent projects so as to exchange experience and ideas in an early phase, and as soon as possible publish the specification of the open API's and protocols, and encourage the open source implementation of framework components.

AmI Space cannot be developed independently of the sector-specific developments coming from the evolution of existing markets. So starting with a selection of Integrated Projects that cover specific physical or social spaces (person, home, private car, tourism, for instance) the *AmI Space* initiative should seek to extend these by adding collaboration between them.

In the Ambient Intelligence Space, on the one hand fluid and spontaneous service and co-operation become more and more natural, while on the other hand security as a synthesis of trustworthiness, dependability, privacy, protection and liability remains essential. If Europe wishes to have an independent position in security, or even acquire a lead position, the route should be via successful management of present and new paradigms of security which are required as part of the *AmI Space* development. *(See report of ISTAG on "Trust, Dependability, Security & Privacy", 2002.)*

In addition, the technologies, products and services in AmI Space will be very different from those of today. If these skills are going to be required in 2010, then preparation for the necessary education and training must begin soon, and it must be informed by the R&D actions as they progress.

Recommendation 5: Establish a process for coherent and visionary yet practical road-mapping to support the formulation of European programmes for enterprise environments and, based on this, facilitate an initiative to realise the concept of the Virtual Enterprise.

There should be a specific action to engage industry leaders concerned with enterprise management in a discourse with a view to developing a longer-term vision of cross-enterprise co-operative processes and new methods of work, taking into account Europe's diversity. Such an action should include not only established players, but also emerging SMEs that provide alternative solutions.

Based on this common vision a research initiative should address the integration of life-cycle approaches encompassing all business processes including manufacturing, design and engineering, and addressing the sociological issues as well as technology. The effort should aim at generic solutions for all businesses. It could be supported by some sector-based developments (e.g. Textile, construction, automotive, aerospace, food industry ...) which should be co-ordinated so as to ensure critical coverage and learning from best practices.

The new 'networking' paradigm for manufacturing and business offers an opportunity for Europe in the research and development of architectures that ensure the interoperability of enterprise applications at all levels and interoperable tools for networked organisations, with support in the medium term for open standards such as those for Web services. To further facilitate industrial usage, European Standards should be established for the interoperability of business processes and the exchange of data and documents — on a technical level as well as on a semantic level — and these should be the basis of a strong European input to the further work of the W3C.

Recommendation 6: A special effort should be made to encourage and facilitate the development of applications and services based on the convergence and intimate integration of wireless and wired (including optical) systems.

While the initiative-based approach in FP6 facilitates the concurrent development of technologies, applications and services, as ISTAG has identified in the report *"Software Technologies, Embedded Systems and distributed Systems", 2002* (see chapter on *"Technologies for Creation of Added Value services")*, there are many outstanding technical requirements in order to reduce the lag between the availability of (hardware) technologies and the availability of applications and services based on those technologies, including support for rapid prototyping, user acceptance trials, real life experiments and demonstrations. However, development of such capabilities should not be performed in isolation and it is strongly recommended to focus on some specific application areas which are dependent on a high proportion of embedded software, such as:

- the (networked, multimedia, intelligent) Digital Home
- the (sensing, self-configuring, communicating) Industry

- (multi-rate/environment/device/...) Mobility
- (sensed, monitored, actuated) Health.

Such application and service development should take account of commercial realities and embody functionality to support billing, charging and relevant aspects of security management.

Recommendation 7:   Establish an initiative to develop the next generation of embedded systems. This initiative should have three principal foci - embedded systems, microsystems and microelectronics, these being the critical enabling technologies.

Embedded systems: smart micro-electronic devices and embedded software will be central to the many devices of the Ambient Intelligent Environment. In parallel to the successful and sustained micro-electronics programme, launch special initiatives for embedded critical or real-time software components, systems or architectures, with the target of transforming European software productivity and mobilising a critical mass of software engineers during the next 5 years.

Microsystems incorporating sensors and actuators: new developments on the body, in the home, and in the car are likely to make use of new sensors and actuators, in which Eastern Asia and the US are making significant advances. In the car, displays and some critical sensors are dominated by Japan and the US while advanced signal processing is dominated by the US. Europe should build on its capabilities in microsystems technology to develop the next generation of sensors, including biometric sensors, haptic devices and sensors for tracking eyes, gestures, the body, and complex scenes.

Microelectronics and components: enabling all other technological developments will be advances in the fundamental performance of microelectronics, achieving ever higher switching speeds, higher storage densities, higher device density, and ever lower power, increasingly using (primarily) ambient energy, at ever lower cost. Thanks mainly to European actions, especially Eureka and, in the Framework Programme, OMI, Europe has successfully revived its electronics industry, but *'we must run to stand still'*.

Note that such initiatives should be closely coupled to any initiative based on the preceding Recommendation 6, so as to maintain the concurrent development of technologies, applications and services and aim for convergent outcomes.

Recommendation 8:   Expand Grid development through integration of national science Grids and extend their application from science and academia to industry, so as to create an environment for the development of EU middleware companies and the creation of SMEs to participate in the provision of products and services for the 'Economy Grid'.

This should be achieved through a coordinated portfolio of Integrated Projects building on the Grid expertise developed in FP5.

In the context of the ERA, national Grids should be interconnected in an infrastructure activity in parallel with continued development of the pan-European GEANT network.

Key target industries for extension of Grid usage to industry are many varieties of engineering, bioinformatics, and the pharmaceutical industry. There must be a special effort during FP6 to encourage take-up by these industries.

Recommendation 9: Establish an initiative to stimulate and facilitate the provision of content.

Availability of marketable content is key to the growth of the markets to enable the Ambient Intelligent Environment. A special initiative on tools for content generation and diffusion and content engineering, involving content providers and distributors, integrating and building on collections of European capabilities (rather than single capabilities) should aim to develop next generation interactive, multi-cultural, multi-domain content creation and management facilities. This should be complemented by a European effort on knowledge processing and organisation that is based on context and semantics.

Recommendation 10: Following the methodology adopted by ISTAG, identify and support a range of specific special initiatives which will contribute to realisation of the AmI vision within a 10-year time frame. ISTAG has identified the following preliminary set of potential initiatives.

Home platform: given the potential market for expanded home-based services and the need for interoperable platforms to enable that market, and with the threat of consumer appliances from the far-east being used as 'Trojan Horses' to establish dominant platforms, Europe should engage in a Special Initiative — perhaps several, linked — to establish a platform alongside applications, combining strengths in high-bandwidth wireless communications, low power devices and novel interfaces, and with an ERA dimension so as to establish standards, harmonised regulation, and an open market.

Accident-free driving: Europe has currently the lead position in Advanced Driver Assistance and in the transition to x-by-wire. A strategic ERA-scale initiative for *Accident-Free Driving* should further develop the range of appropriate technologies, and applications, systems and services based upon them. This should build on the confluence of autonomous and telematics-based systems and services for breakthroughs in driver assistance and vehicle-centric services (incl. continuous "health" monitoring) and on Europe's stronghold in mobile, to gain a significant lead in road accidents/fatalities reduction with its unprecedented consequences for better living, economy and technological advancement. In a supporting

action, Europe should aggressively catch-up in short-range communications for safety-of-life critical applications in transportation, supported by appropriate eEurope regulatory actions.

AmI Transportation Systems: building on the same confluence of technologies, together with Europe's stronghold in mobile and interactive TV, Europe should establish leadership in AmI Transportation Systems (AmITS), targeted initiatives embracing FP6 actions, other strategic European actions, and national efforts via ERA, to provide, for example, seamless service delivery for user-centric services to drivers and passengers across all platforms and across all transportation modes, including intermodal.

The Cyberspace assistant: in the future, instead of a collection of personal devices which occasionally communicate and possibly synchronise with other systems in our various environments, we will each have our virtual personal environment, the physical realisation of which will change as we move between environments and 'wear' different configurations of personal devices. Moreover, people on the move will become networks on the move as the devices they carry network together and connect with the networks around them. This will transform the structure of systems and markets for applications and services. Europe must build on its globally leading position in mobile communications, and wireless in particular, to ensure that technology development for networks, services and applications is undertaken in one major integrated project on personal communications with strong links to initiatives focusing on other environments such as the car and home. ERA action will be required to establish a European-wide framework for regulation and licensing, and the European Commission should assess the possibilities for a European regulatory body coving the scope of ambient intelligence systems.

Games and the game form: Europe should build on its existing presence in the games market and on its technological strengths in virtual and augmented reality and mobile to catch-up through the creation of not just consumer games, but edutainment, training, and the vigorous application of games-like interfaces.

3. METHODOLOGY

A key starting point for ISTAG was the identification of the requirements to realise the AmI vision within a 10-year time frame. Different scenarios for the possible implementations of AmI were analysed in a previous ISTAG report. These scenarios together with the Commission documents related to FP6 were the starting point for further refinement of the requirements.

ISTAG also took into account previous ISTAG recommendations for more coherent — and in some cases concurrent — development of technologies, applications and services, and the desire to avoid fragmentation of development of technologies themselves, and 'fault-lines' between the exploitation of today's technology and the development of new technology, as identified in the Integrated Programme Portfolio Analyses.

The approach adopted by ISTAG has been:

(1) to consider what is required, including technological development, in order to realise the ISTAG vision of ambient intelligence, focussing on addressing the societal and economic challenges in a range of environments

(2) to identify what is required beyond the requirements of specific environments — and in particular to characterise the *AmI Space*

(3) to consider what are European strengths, weaknesses, opportunities and threats associated with realisation of the vision

(4) to identify a proposed response, given this SWOT analysis.

3.1. Ambient Intelligence in multiple environments

The text of the IST priority theme in FP6 highlights the societal and economic challenges that research in this field is expected to address, as well as the technology building blocks that are included in this theme. These two dimensions — technologies and socio-economic challenges — are illustrated by a "mapping matrix" given in Annex 1.

The societal and economic challenges will generally be addressed by collections of services for health, transport, etc. Such services will use collections of applications distributed through the various environments — home, car, working place, the personal, etc.

These various environments are the natural focus for analysis of the requirements necessary to realise the vision. There are particular markets associated with each of them, and typically each of them has specific technological requirements (low power on the person, safety in the car, for example).
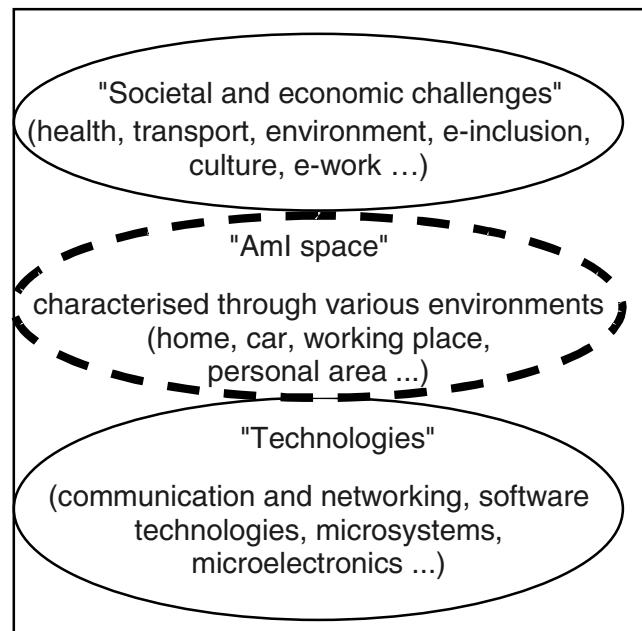
However, the vision of Ambient Intelligence and the 'societal challenges' have been primarily focused on the needs and desires of the individual person, as exemplified by the Ambient Intelligence Scenarios. But manufacturing is important for Europe: we all need goods and energy. How can IST support industry? From where, for instance, will come the methodologies to manage virtual enterprises? ISTAG has therefore considered an additional environment — the 'Enterprise environment'. In addition, ISTAG considered the requirements of Science and Engineering, as the main driver of development of the Grid, which is ultimately expected to play a major part in the provision of services to economic operation beyond science and engineering.

Moreover, the individual will move freely between these environments, while expecting seamless services. ISTAG proposes to call the collection of facilities and capabilities that enable this seamlessness, the *Ambient Intelligence Space*'.

3.2. The *AmI Space* — The 'middle layer' (or medium) bridging the gap between technologies and societal and economic challenges
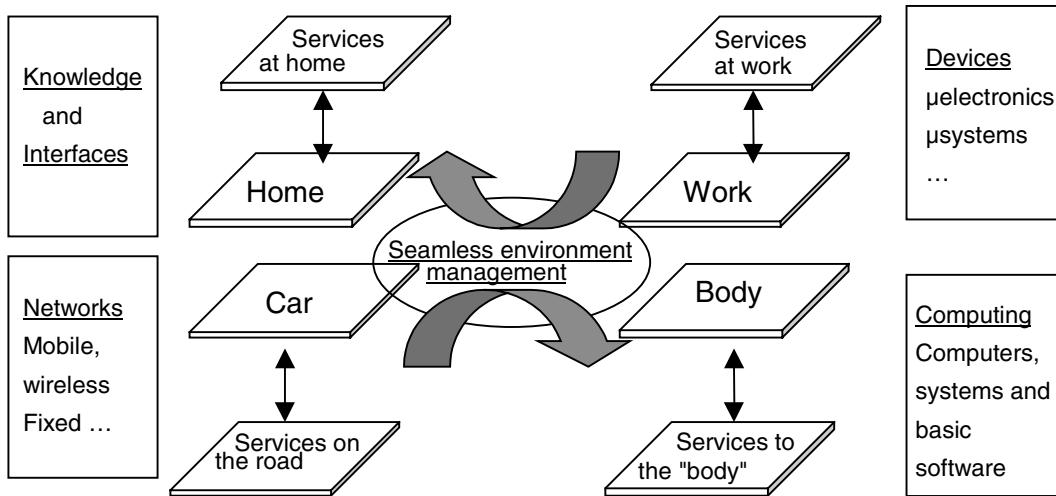
ISTAG has adopted a '3-layer' model, with the societal and economic challenges as the top layer, technologies as the bottom layer, and a 'middle layer' — The *AmI Space*.

This *AmI Space* should not be construed as a physical layer of infrastructures, hardware platforms, services, or applications, but a collection of these things in combination. It is characterised more fully in Section 4.

"Societal and economic challenges" (health, transport, environment, e-inclusion, culture, e-work …)

"AmI space"

characterised through various environments (home, car, working place, personal area ...)

"Technologies"

(communication and networking, software technologies, microsystems, microelectronics ...)

3.3. Analysing the requirements: what is required in order to realise the vision

ISTAG considered the home, car, the person and enterprise environments from the perspective of both the technological requirements in those environments in order to realise the Ambient Intelligence vision, and the demands they make on *AmI Space*.

The environments considered so far are not thought to be definitive: other environments — such as 'public space' (including perhaps street, café, railway station, etc.), hospital or other transport modes — may be considered later if they introduce requirements that have been not captured by the analysis of the environments addressed in the report.

For each selected environment, members of ISTAG, with the support of certain domain experts, updated the vision and characterised the key functional and performance requirements in those environments in order to address the societal and economical challenges within those environments. These are summarised for the various chosen analyses in Annexes 1–6.

The purpose was not, at this stage, to specify which particular technological developments are needed. Instead the functionality and performance requirements will lead to targets for eventual technology development which will be elaborated in other consultations and working groups in preparation for FP6.

The aim at this stage was to gain a coherent view of:

- what technology actions are necessary
- some idea of the applications and services necessary to deploy technology effectively so as to address the societal and economical challenges
- some idea of the non-technological actions necessary to facilitate the introduction of these applications and services (deregulation, open standardisation, etc.).

3.4. SWOT analyses: what is Europe's competitive position?

Having identified the requirements for the various environments and challenges considered, ISTAG made an analysis of the European competitive position in terms of strengths, weaknesses, opportunities and threats. In considering European strengths, weaknesses, opportunities and threats, ISTAG took into account external assessments of European competitiveness, and the drafts of the reports of the Internal Reflection Groups[2].

3.5. Europe's options and priorities: what should Europe now do?

Given the requirements and Europe's present competitive position, ISTAG has begun to consider what the European strategy should be — what response should be made to build on strengths, remedy weaknesses, exploit opportunities and counter threats. This stage of analysis is based upon a combination of extrapolation from the existing situation and capabilities and backtracking from the requirements to the necessary capabilities:

- Where Europe has a strong position, we should generally seek to maintain *leadership*.

- Where Europe has a weak position, or there is a threat to the existing position, then we must consider whether it is possible to *recover*, or whether a '*trade-off*' is preferable. In particular ISTAG has considered whether there is a strategy which avoids head-on competition from a weak position. Such strategies might entail *special initiatives* to encourage the appropriate combination of technology development, application development, service development, regulatory changes and standardisation. Integrated Projects in FP6 may well play a role in such initiatives.

- Where there are opportunities, ISTAG has considered whether their exploitation may be achieved by continuing to support existing developments, or whether a special initiative is required to stimulate developments which might not occur naturally, or which might not occur soon enough to maximise the potential benefit to Europe. *(Such initiatives can be characterised in a way similar to initiatives to address threats, as above.)*

The analyses of the environments chosen are presented in Annexes 2–6.

The proposed responses from these analyses are captured in the recommendations (in Section 2 above) for appropriate Community supported activities, including RTD, taking into account the ERA perspective. The ambition is to encourage coherence and synergy between the Framework Programme, Eureka, and National Programme, and with each type of programme supporting the appropriate activities.

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[2] Internal Reflextion Groups were created by DG INFSO, they notably organised different workshops, see http://www.cordis.lu/ist/fp6/workshops.htm

4. THE AMI SPACE

Originally, *AmI Space* was an abstraction, with properties which could be presumed to be available to specific environments. However, it became apparent to the ISTAG that instantiation of an actual *AmI Space* will be crucial to realisation of the Ambient Intelligence vision. The required characteristics of *AIi Space* were therefore investigated by ISTAG and are detailed in this section. These required characteristics inform the recommendations of section 2, especially Recommendation 4.

The concept of **Ambient Intelligence** is used where intelligence is pervasive and unobtrusive in the surrounding environment. Such an environment is sensitive to the presence of living creatures (persons, groups of persons and maybe even animals) in it, and supports their activities. It 'remembers and anticipates' in its behaviour.

The humans and physical entities — or their cyber representatives — together with services share this new space which encompasses the physical and virtual world, the *AmI Space*. This space needs to be engineered so it has predictable behaviours, so that services can be offered through it, and so it can manage complicated many-to-many relationships.

The *AmI Space* could be seen as the integration of functions at the local level across the various environments, enabling the direct natural and intuitive dialogue of the user with applications and services spanning collections of environments, as well as at the cyberspace level, enabling knowledge and content organisation and processing.

4.1. *AmI Space* goals

The AmI system should enable the adding of value to the enactment of an emergent human story in a public or private way in the physical and virtual world through the mediation of services. A system complying with this has the following behaviour:

- Mediation of services in a pervasive, translucent, understandable and managed way. Seamless and efficient supply-demand matching, (negotiation, brokerage, policy enforcement, etc.) in the face of competing and unpredictable demands, as people move and the networks they use are constantly reconfiguring.

- Sharable by humans, available in all environments, and persists, without noticeable degradation but continuously improving the added value. Seamless environment management and control through management software and services to provide appropriate allocation of resources, quality and security of service, and stability of the global system and its subsystems.

- Conveys the subtleties of public and private space, proximity and encounter of engagement and commitment. Functions according to user preferences and profile while maintaining privacy and confidentiality of the user and security for system and content. Projects a geographic metaphor of virtual space to enable 'places', relationships between physical or social spaces and virtual space, and enables navigation.

- The processes of establishing and re-establishing identity, negotiating and renegotiating roles and relationships, represent changes in practice, not in theory. They involve games, proposals and experiments, the acceptance or rejection of precedents and the establishment of new patterns of interactions, as they are experienced.

4.2. *AmI Space* characteristics

The *AmI Space* is composed of collaborative (location or social based) sub-spaces, of devices (including sensor and actuator systems), services (including their interfaces) and the connecting networks. The *AmI Space* is:

- open, to allow evolution and extendibility with autonomously developed components

- dynamic, to allow constant reconfiguration

- trustworthy, to handle issues of safety, reliability, security, privacy and usability.

This system, composed of *networked* (using a changing collection of heterogeneous network) *embedded systems* hosting *services* which are dynamically configured distributed components (autonomously developed, loosely coupled), must:

- "know itself" — and also its components must also possess a system identity

- configure and reconfigure itself under varying (and in the future, even unpredictable) conditions

- never settle for the status quo — it always looks for ways to optimise its workings

- be able to recover from routine and extraordinary events that might cause some of its parts to malfunction

- be an expert in self-protection since a virtual world is no less dangerous than the physical one

- know its environment and the context surrounding its activity, and act accordingly. It will find and generate rules for how best to interact with neighbouring systems

- not exist in a hermetic environment. While independent in its ability to manage itself, it must function in a heterogeneous world and implement open standards

- anticipate the optimised resources needed while keeping its complexity hidden.

4.3. *AmI Space* functions

The *AmI Space* should contain applications and services to actively support humans in achieving specific tasks using a variety of interaction devices and taking users' preferences and profiles in account in relation to actual situations. Functions and services provided by *AmI Space* are intended to make the development of these applications easier. They should offer capabilities to:

- *Interact with the user* by taking into account the user preferences. Natural interaction with the user replaces the keyboard and windows interface with a more natural interface like speech, touch or gestures.

- *Model the user behaviour* to keep track of all the relevant information concerning a user, automatically builds the user preferences from his past interactions and eventually abstracts the user profile to more general community profiles.

- *Model the environment and sensors available to perceive it*, to take care of the world model. This essentially deals with the list of authorized users, available devices, active devices, state of the system, et cetera.

- *Control security aspects* to ensure the privacy and security of the transferred personal data and deal with authorization, key and rights management.

- *Ensure the quality of services* as perceived by the user.

To accomplish this across different physical (home, private and public vehicles, private and public buildings, on the road …) and social (family, clubs, enterprises …) spaces is not a trivial exercise and it is certainly not only technical. Other issues are:

- availability and protection (DRM) of content (current copyright plan in US contains severe restrictions and have an impact on existing devices as DVD)

- ownership, control, and access of personal data (do we want a kind of central Passport service?, do we need regulations to protect the citizens?)

- regulations on network services (VoIP passed to telephony networks)

- allocation of licensed and unlicensed radio frequencies for wireless networks

- standardisation of API's, protocols and ontology's

- operational and business models on network infrastructures.

Whoever can first devise and implement an AmI Space with such capabilities will be first to realisation of the AmI vision. This ambition forms the basis of the recommendations presented in section 2, specifically Recommendation 4.

5. FINDINGS OF THE ENVIRONMENT ANALYSES

5.1. Specific and generic requirements

The particular environments have particular specific requirements (low power on the person and safety in the car have already been mentioned). These specific requirements are often related to 'local functionality' (i.e. the systems specific to a car, home or office), to physical constraints of the particular environment, and to expectations by the user of the nature of access in a given environment (e.g. lie back/lean forward in the home). Recommendation 10, presented in section 2 above, encompasses a number of suggestions for initiatives which address these requirements in combination for specific environments.

However, while there may be specific requirements in each environment, all the environment analyses reveal a need for and even, in the vision, presume the availability of ever more advanced microelectronics, microsystems incorporating next-generation sensors and actuators, and embedded systems and software. These are generic requirements which form the basis of Recommendations 6 and 7.

When it comes to embedding these environments in a global multi-media knowledge or information service infrastructure, to support extended distribution and mobility, the requirements are more generic. Now, there is not, as yet, a common view on whether there will be a single infrastructure, supporting different sets of service architectures to provide services associated with transport, health, etc., or whether there will be distinct infrastructures, addressing the special needs of particular classes of service such as transport, health, etc. This may just be a matter of language and perspective but, at present, it is probably safest to assume that there will be — conceptually — multiple 'infrastructures' supporting specific services yet allowing the interaction between them to support other services. An example is that of transport, where it is likely that to satisfy the requirements for safety there will be some kind of dedicated transport infrastructure, but this will also, probably, allow for the operation of services other than transport, such as health.

5.2. Ambient Intelligence spanning multiple environments

While most applications and services using those applications are focused on particular environments — the car, the home, the person, the office, etc. — there is an increasing need for complete interoperability and seamless transition in the services when moving among environments. This requires continuation in the trend in service provision from vertical business models to models that combine and compose several services over multiple platforms.

Also, in order to support interoperability across environments in this way, there is a need for management software and services to provide appropriate allocation of

resources, quality of service, and stability of the global system and its subsystems through supply-demand matching, negotiation, brokerage, policy enforcement, etc., in the face of competing and unpredictable demands, as people move and the networks they use are constantly reconfiguring. It will require algorithms and techniques which are not part of technology development *per se*, but nor are they 'mere applications' of technology.

The SWOT analyses for the various environments show that, in general, whilst Europe's industry and research community is clearly well positioned at the device and local level, to realise the AmI vision will require integration across industries and technologies, services which span multiple environments, and the combination of infrastructures, hardware platforms, services, and applications, to provide the capabilities and characteristics of *AmI Space* in section 4 above. These requirements form the basis for Recommendations 4 and 5.

5.3. More is needed than more technology

The requirements identified by ISTAG are not just technological requirements. As expected, there is a need for combinations of applications, services and infrastructure (Recommendation 6).

Content will also be needed for the various Ambient Intelligence markets to be successful. There is a need for content-oriented tools and services to support multi-cultural content generation and its engineering and management, including data-mining, knowledge discovery, and IPR protection, and other tools, perhaps targeted towards specific applications or industries (Recommendation 9).

Moreover, in the analysis of the Enterprise environment *(Annex 5)*, it is recognised that there must be fundamental changes in the form of contracts, in the law, in taxation regimes, and in business practices. These changes will require research other than technological research (Recommendation 5).

While some of these types of requirements for the enterprise environment may be specific to industry and manufacturing, it is likely that there will be common or similar requirements for other types of organisations and services. There is no fundamental distinction between the hours-long Virtual Enterprise for car maintenance during a long journey, and a seconds-long 'Virtual Enterprise' for exchange of traffic information between the vehicle and the transport infrastructure.

Annex 1: MAPPING OF PROGRESS NEEDED IN TECHNOLOGIES TO MEET SOCIO-ECONOMIC CHALLENGES: CHALLENGES AND TECHNOLOGIES (from 'IST in FP6')

Applications \ Technologies	Communication & Networking	Software technologies	Microsystems	Interfaces	Knowledge technologies	Trust and security
Health systems Better individual health monitoring & tools for health professionals	3G and beyond mobile systems Broadband networks	Embedded systems Large scale distributed systems, Computing GRIDs	Bio and medical networked sensors, New materials, Nano-systems	Using all senses Virtual reality and visualisation	Content-based image retrieval	Privacy protection
Transport Improving safety, efficiency and comfort	3G and beyond mobile systems, wireless	Embedded systems Large scale distributed systems	New networked sensors, New materials, Nano-systems,	Using all senses Virtual reality and visualisation Multilingual		Dependability Secure transactions
Environment Efficient monitoring & management		Embedded systems Computing Grids	Nano-sensors, New materials,		Semantic Web/ Knowledge GRIDS	
E-inclusion Supporting disabled, & special needs	Wireless broadband	Embedded systems	Networked sensors	Using all senses Multilingual Virtual reality and visualisation		Privacy protection
Culture Preservation and better access	Broadband networks Audio-visual systems			Using all senses Multilingual Virtual reality and visualisation	Semantic Web. Digital content management.	Secure transactions Rights protection
Science & engineering Performance demanding applications	Broadband networks	Large scale distributed systems GRID computing Cognitive vision	Networked sensors	Virtual and augmented reality	Knowledge GRIDS	Dependable infrastrutures
Learning Broader and personalised access to education and training	3G, and beyond mobile systems broadband networks Audio-visual systems			Using all senses Virtual reality and visualisation		Secure transactions Rights protection
E-business Efficient ecommerce, and value chain management	3G and beyond mobile, Wireless	Robust development tools and platforms, Computing Grids Workflow management		Using all senses, Multilingual	Semantic Web Ontologies Knowledge Management	Secure transactions and payments Privacy and rights protection
E-work New methods of work, team work, mobile workers	3G and beyond mobile, Wireless	Robust development tools and platforms	New sensors, new materials	Using all senses Multilingual Virtual reality and visualisation	Networked Knowledge-sharing	Secure transactions and payments Privacy and rights protection
Micro-electronics: faster, lower cost, lower power consumption						

Economic Challenges

Economic Challenges

N.B. Although some technologies such as 'storage' do not appear explicitly in the short titles used on this chart, the set of technologies is intended to be all-encompassing.

Annex 2: AMBIENT INTELLIGENCE IN THE HOME

EUROPEAN COMPETITIVE POSITION

Strengths, weaknesses, opportunities and threats	Recommended response
Strengths Large, dense market Standards - DVB, GSMSecurity know-how e.g. in SmartCard Interactive TVAudio & Video processing & delivery architectures Networked embedded devices	'Leadership' — Europe is exploiting leading technological capability in all these areas, and this leadership should be sustained
Weaknesses Games	'Recovery' — despite a generally existing weak position, Europe can and should seek a route to recovery (UK supplies 70 % of games software, for instance)
Regulatory barriers to broadband access	*Although not strictly within the scope of ISTAG, it should be emphasised that poor access to broadband jeopardises the concept of 'eEurope'*
Weak European position in PC and PC applications	'Trade-off' — needs a considered strategy to decide where recovery or alternative intercept strategies might be possible
Opportunities Analogue->Digital->3D TV CRT -> flat panel transition Wireless in the home	'Exploit' a European technological capability which can not yet be counted a 'strength' due to low market impact
New forms of interfaces, including Virtual and Augmented Reality	Exploit: a possible candidate for an IP, especially if addressing content (see below)
Expansion of new home-based services. Establish networked home by building on existing strong position in home appliances	Scope for Special Initiatives — perhaps linked — with an ERA dimension so as to establish standards, harmonised regulation, and an open market
Content generation and engineering Seamless Environment Management	Scope for 'Special Initiatives' to integrate and build on collections of European capabilities (rather than single capabilities)

Strategic orientations and priorities for IST in FP6

Threats	
Failure to establish interoperable platforms	See 'Special Initiative' response to opportunity to build on position in home appliances
Consumer appliances used as 'Trojan Horses' for platforms from outside Europe	
Extension of PC platform or existing games platforms to PAN, Car, etc., perhaps	See 'trade-off' response under 'Weaknesses'
Sensors: new developments likely to make use of new sensors, in which Far East is making significant advances	Fight off with a special initiative

2010 updated vision

The home is connected through broadcast and point-to-point communications at tens of megabits per second. Inside the home, the wireless network connects all appliances and displays. The home network interacts with the personal area networks of each person in the home. There is a flat panel display in each room, including a large one in the living room.

Content storage is in all of the network, a home server, and each appliance. It includes audio, video games, TV commercial content, and personal content such as video and images.

From the home, e-work and e-learning (for adults) and e-school (for children) are enabled.

The home is also a work-place.

The home is energy-conscious (heating, lighting monitoring).

Societal and economical challenges

Sanctuary, relaxation and harmony

In a world that changes rapidly, broadcasts negative news, brings pressures of work, has effectively destroyed the nuclear family and in which religious pastoral care is in decline, the home is an important sanctuary. This sanctuary should afford a relaxing and harmonious environment that is secure and private — a place where one can lean back and be passive.

These personal needs are often difficult to achieve even in the normal home and the risk of an over-intrusive ambient intelligent environment must be guarded

against. Sensory immersion and a virtual home space could prove more attractive than an inadequate physical space that is home.

Socialisation space

Home for most people is not just a personal sanctuary but is also about personal relationships and nurturing of children. The supportive home enables the family to communicate, observe, enjoy, respect, learn, be healthy, and wonder about life in safety. In addition to the household members the home is a meeting place for friends and family. These meetings can take on physical presence but also in the AmI vision a virtual presence.

The 'killer application' of the AmI may yet prove to be that which enables enhanced nurturing and socialisation of a virtual nuclear family.

E-Learning

As a species we learn in social contexts and accessibility within that context with a virtual library and broader virtual communities will not only enable children to develop within the home context but also enable a continual life long learning. Different learning styles can be supported through personalisation, through just in time reminders to reflective learning material in many media. In addition isolated homes can provide eSchool or eUniversity opportunities. Through these same mechanisms cultural heritage can be maintained even if a family is at a distance from its roots.

Entertainment

In a laid back mode, either as an individual or in a group, potentially inclusive of those at a distance, entertainment can be proposed, negotiated and brokered. This entertainment can take many forms and media and can fulfil the need for fun and/or learning.

Environmental control

In a society needing to reduce energy consumption and minimise environmental damage an *AmI* house should intelligently manage power and heat consumption depending on usage needs around the house. This function needs to take account of the occupants, such as the elderly and children, to prevent any inadvertent harm.

Accessibility for disabled

There are many forms of disability that up to 10 % of a population have to manage. These include physical malformations, intellectual, visual and hearing

problems. The *AmI* home and its many adaptive interfaces will enable socialisation, access to services and even virtual communities without stigma. There is also a clear link with health related issues mentioned in the 'Personal Environment' (*Annex 4*).

Elderly

With an increasing aging population, and increasing survival to older ages, society must increasingly address social support, health and disability issues. Many elderly people cope better socially, intellectually and have more life satisfaction in their own home. Unfortunately this leaves them exposed from a safety perspective (through disability and health issues) and can leave them isolated. There are many opportunities to support safety through *AmI* sensors, health and disability support (see above) together with participation in virtual communities of carers, friends and family to reduce isolation.

Transport

The support of transport from the home in the AmI environment could support many new paradigms of public transport. By simple monitoring of activity and knowledge of a day's routine, information could be provided on the current status of an expected bus and accurately predict the point to leave home, or actively broker, in the context of the neighbourhood, a 'personalised' transport route on a public service.

In addition this sort of monitoring could also ensure readiness of personal transport to ensure comfort of temperature (e.g. cooling or heating), safety (e.g. defrosting of windows) and pollution (e.g. engine warming).

In the reverse way the personal transport can keep the home informed of your estimated time of arrival and other such information.

Work @ Home

Work at home has become part of many people's lives either through home offices or by bringing work home. The future must improve virtual realities to enhance the participative experience while avoiding over-intrusiveness and preserving privacy.

E-Commerce

Although physical browsing will undoubtedly remain part of the shopping experience, virtual shopping in the *AmI* environment will increase though

automation of shopping for 'basics' with the involvement of *AmI* consumer goods (e.g. the intelligent fridge).

Requirements to realise the vision

Communication and networking

Communications *within* the home will go broadband on the domestic network (wireless, cable line, power line) with bandwidth capable of high definition video (20 megabits per second).

Communications *to* the home will have evolved from dedicated solutions (copper wire for telephony, coax cable for TV) to multiple overlapping and competing communication media — copper wire, coax cable, digital terrestrial, satellite, wireless local loop. Each of these communication media will be capable of voice, data and video. Depending upon the type of homes, the installed base and the national regulations, in order for these to co-exist there will be need for:

- physical interface standards and
- communication protocols for all media:
    – copper wire: xDSL, PLC
    – cable
    – satellite, including 2-way satellite
    – wireless local loop
    – digital terrestrial
    – wireless home LAN.

Software technologies

- New platforms, embodying:
    – operating system independence and/or open software
    – architecture to support heterogeneous service integration.
- Interactive applications on and for home appliances. These applications will require:
    – API standards
    – middleware, and
    – a productive software environment, so as to attract developers.

Microsystems

- Displays: following Moore's law, processing and communication performance will allow image and video in most applications and appliances.

Unfortunately, displays do not follow Moore's law and they therefore represent a large part of the total cost and power consumption of most appliances. Displays are even the blocking point for the volume deployment of new applications. In the home, there is a need for several types of display, all of them being flat displays:

– Large (50 cm to 1 metre diagonal) with high resolution (1,000 lines) for multi-personal viewing of TV, movies, images and games. Relevant technologies are plasma and projection LCD. The major issue is cost.

– Medium size (40 to 50 cm) but still high-resolution displays for desk-top applications (such as a PC monitor) and mono-personal entertainment. The relevant technology today is LCD.

– Small, low-resolution displays with a broad range of sizes, resolutions, colour or monochrome to be used in nearly all home appliances (white goods, home control, audio systems). Relevant technologies are OLED, PLED.

Note: Small, high-resolution displays are assumed to be driven by the personal applications and are not described here.

- Storage:
  – high-capacity, removable storage (e.g. optical disk) (10–100 GB) for audio, video, movies, images

  – fixed, high-capacity, instant access storage (e.g. magnetic disks) (100-1,000 GB)

  – solid-state storage, medium capacity, in most appliances and used as a bridge to personal appliances (1–10 GB).

Interfaces

- The long-distance entertainment type of interface, easy to use by people of all ages at more than 1 metre from the screen (today usually interfacing with an infra-red remote control and a game pad).

- The short-distance mono-personal interface (today with a keyboard and a mouse). This area is today dominated by the personal computer Windows interface.

- Easy-to-use interactivity (an unsolved challenge). Most interactive applications will have to deal with both long-distance and short-distance interfaces. (Deploying solutions derived from the existing personal computers can only create a "digital divide" as these solutions are too expensive and too difficult to learn.)

- Technologies for user interfaces include:
  – voice recognition
  – natural language understanding.

Knowledge and content

- Web content (audio, video, data) today developed for the PC Windows domain needs to be accessible from home appliances.

- Protection of copyrights and commercial content: audio, movies …
    - watermarking
    - secure billing: small and large amounts.

Trust and confidence

- Privacy: in the near future there is a need for a firewall at the home gateway for access control; further into the future the home environment must provide all the *AmI Space* security capabilities of:

    - authentication — of equipment, software and people
    - accountability
    - audit — provision of audit trail and facilities for performing audit
- Secure payment facilities for services and products.

Annex 3: AMBIENT INTELLIGENCE IN THE CAR

EUROPEAN COMPETITIVE POSITION *(taking into account the proposed 50 % reduction in road transportation accidents/fatalities by 2010)*

Strengths, weaknesses, opportunities and threats	Recommended response
Strengths	
Large and demanding European home market	Develop strengths into sustained European leadership
In global lead position in premium segments; good position in mass segments; highly innovative	
Established and competitive European supplier base	
Lead position in Advanced Driver Assistance for accident-free driving	Strategic Initiative to further develop the range of appropriate technologies, and applications, systems and services based upon them
Good understanding of the political bodies and to a lesser extent by the greater public of the criticality of the car industry for Europe's well-being (technologically, economically, better living, environmentally)	
Weaknesses	
Software to large extent dominated by US companies (tools, OS, middleware, standards ...)	Catch-up for European leadership in embedded & connected net software and systems (EmNets)
US in lead in nationwide mobile emergency call (mobile 911). RF spectrum european regulatory issue	Catch-up via e-Europe Action Plan (e-Europe 2005) so as to achieve coherence of national initiatives and harmonisation across Europe
US in lead in short range communications via 802.11X & moving aggressively into safety-of-life critical applications for transport as is Japan	Scope for strategic initiative to catch-up aggressively from good technological base; to be supported by appropriate regulatory actions requiring eEurope actions
Displays and some critical sensors dominated by Japan/US; advanced signal processing dominated by US	Trade-off/catch-up on case-by-case basis
US in lead in mapping and precision positioning technology	Regain leadership, possibly in combination with — but not relying on — Galileo and build-up of 'transportation grid'
Important segments of content dominated by imported enter/infotainment	Trade-off/catch-up, case-by-case, involving content providers
Fragmentation of European markets	Overcome with targeted actions which respect diversity of cultures and business models

Opportunities	
The digital transition ("x-by-wire") to the all-software defined vehicle	For all:
Building on the confluence of autonomous and telematics based systems and services for break-throughs in driver assistance and vehicle-centric services (incl. continuous "health" monitoring) and on Europe's stronghold in mobile	Address via 'special ERA initiatives'. (Scale of actions required is so great that they must not be restricted to FP only, and should span several FP6 IP's and other strategic european and national efforts.)
Gaining significant lead in road accidents/fatalities reduction with its unprecedented consequences for better living, economy and technological advancement	
Seamless service delivery for user-centric services (to drivers and passengers) across all platforms and across all transportation modes (incl. intermodal) building on Europe's stronghold in mobile and interactive TV	
Threats	
Automotive industry probably the most critical industry for European overall competitive position and economic well-being including being the enabler for major other businesses like logistics, tourism, etc.	Maintain healthy world leading automotive industry
Expansion of non-vehicular platforms into the car/vehicle domain	To be addressed via concerted special action spanning all the 'environments'
Losing the content/customer battle	Scope for special initiative
Japan gaining the lead in Intelligent Transportation Systems (ITS) via their national programmes	Monitor closely and regain leadership, possibly via an IP, to be demonstrated in large scale show-off at ITS World 2006 (as Japan does in 2004, in Nagoya)

2010 updated vision

Thanks to the confluence of autonomous and telematics systems and the transition to the all software defined vehicle ('x-by-wire'), the car has not only developed an unprecedented detailed sense of its environment (including other objects like pedestrians, etc.) and level of situation-awareness for the driver but also a sense for traffic, thereby helping to moderate traffic flows at the highest possible safety and flow levels while at the same time meeting environmental constraints and restrictions.

Thanks to the continuous real-time connect to the 'transportation grid' an unprecedented level of vehicle-centric services like continuous 'health' monitoring of drivers and vehicles is enabled and maintained.

The car has established itself as an agent moving through the seamless communication world.

Together these developments have fundamentally transformed the car, the driving experience and transportation and mobility as they are known today.

Societal and economical challenges

Driver support

In the vehicle environment the role of driver has a special status for the passengers as everyone's life and timely arrival at the destination is dependant on the drivers adequate functioning. The starting point is personalisation of the driving seat positioning which is a function in today's upmarket cars, but in the future the individual's characteristics could be ambiently available to all vehicles. Comfort is just the start to the safety challenge. This is a regulatory issue with a 50 % reduction goal in traffic accidents/fatalities by 2010 in the 'accident-free driving' initiative of the European Automotive Industry.

There are number of issues from collision avoidance, through prevention of driving errors, to ensuring driver road visibility in all weathers and driving conditions and dynamically updating the driver on weather issues. In addition there is an important function of minimising driver distraction, which ranges from giving the driver a clear view of children in the back utilising video technologies and head up displays, to ensuring the ambient intelligence does not overload the driver with information and that the interfaces make optimal use of AmI capabilities.

As part of the safety function the drivers' health should be monitored to check for stress, tiredness, alcohol and important disease indicators, such as blood glucose in diabetics. In addition, personal health related issues such as support of disease management, personal health reminders (e.g. medication), and record keeping could help improve the known difficulties for individuals in often complex and confusing situations in supporting self care.

Of course, should the driver fail and an accident occur the car should deploy optimal cocoons and alert appropriate emergency services.

On the vehicle there is a set of information services on the vehicle's functioning that support the driver, such as intelligent range predictions, safety issues such as load balancing and tyre pressure optimisation and monitoring, and various forms of condition monitoring to enable automatic (though probably negotiated) scheduling of maintenance.

Positioning and navigation

Positioning of the vehicle is a critical current technology to build on with increasing accuracy to enable many challenges:

- Re-planning of journeys to enable traffic management and avoidance of problems.
- To support traffic management to enable emergency vehicle traffic flow.
- Planning journey breaks for toilets, food and rest.
- Highlighting passengers interests on the way and directing the driver on detours.
- Pinpointing parking spaces which are optimal to the destination.
- Enabling of scheduling and logistics of commercial vehicles.

In-car environmental control

Everyone has preferences on environmental conditions, temperature, humidity, background noise, etc. Personalising the environment is possible where the number of people is low or microclimates are possible — otherwise there must be a complex negotiation of needs.

In addition there are particular requirements of stationary vehicles, such as to be aware of departure times and prepare the environment in advance, or to ensure the environment is suitable should a pet be left in the vehicle.

Passenger entertainment and learning

Passengers are critical as journeys can be boring. Entertainment or learning can either be provided to an individual or to all passengers, potentially including others at a distance. The AmI in the vehicle needs to present its catalogue then enable negotiation with the passenger prior to brokering the service.

Socialisation space

The support of socialisation is a critical function of the AmI world, to ensure individuals are aware of potential opportunities — to create a meeting space for friends and family. These meetings obviously take on a physical presence with other passengers, whilst being sensitive to the drivers role, but also in the AmI vision a virtual presence may include those at the journey destination or others on the same journey but in different vehicles.

Work

Work in many environments has become part of many people's lives with mobile computers and phones. Linking a workforce together virtually and to work resources is part of today, although the experience still needs to be enhanced.

The future must improve virtual realities to enhance communication as well as to provide computing resources in a distributed way so as to support tasks that local devices cannot support. It should of course be sensitive to the role of the driver and not overload them or distract from driving.

Vehicle avatar

Like a person, the car will participate in a range of subspaces, some of them involving people. An avatar for the car, like avatars for people (see Annex 4), will give the ambient agent of the car a recognisable presence in the virtual world.

E-commerce

The vehicle should act as an agent and purchase fuel, connectivity, and other services as appropriate whilst on a journey. It will, for instance, order food in advance prior to stopping for a comfort break in the journey.

Theft avoidance and retrieval

Information on positioning and the prevalence of thefts will inform parking decisions — and retrieval, should the vehicle be stolen. In addition greater security will come from the use of biometrics in place of keys.

The car in the context of transport

The car will interact with the whole spectrum of transportation to enable seamless intermodal transport.

Requirements to realise the vision

Communication and networking

- Multi-level in-vehicle backbone communication system, including:
  – multimedia broadband (post-MOST, automotive Firewire, high-performance wireless)
  – deterministic high-performance hard real-time bus; ultimately supporting 'back-up free' X-by-wire architectures
  – low-cost highly dependable sensor-bus for e-cocoons (e.g. airbag cocoons)
  – secure intra-backbone gateways for novel integrated safety applications.

- Open and secure smart in-car communications-platform for integrating 'all sorts wireless' (UMTS, Satellite, DAB, short range 802.11 type, car-to-car, car-to-infrastructure, UWB ...) for cost breakthroughs in delivering broadband

content, to and from cars (architecturally this includes significant on-board mass storage capability for supporting connect/disconnect delivery models; => Micro-electronics).

- Open telematics framework for end-to-end service delivery:
  - secure for vehicle-centric services, including continuous safety, performance, condition (e.g. eco standards) and 'health monitoring'; dynamic adaptation/maintenance; and applications like electronic toll collection
  - enabling seamlessness for user-centric services across platforms (interoperability).

- Secure short-range car-to-car and car-to-infrastructure (e.g. traffic lights) communication system — and possibly other in-vicinity objects — for novel safety critical and traffic flow moderation applications, including:
  - instant dynamic *ad hoc* networking between cars and possibly other objects in the immediate environment
  - *guaranteed*, very low latency characteristics
  - *open but reserved spectrum for 'safety of life'* critical applications (*a la US and Japan*).

Software technologies

- Dependable, automotive-grade component-based electronic architecture and real-time operating system, including capabilities for dynamic auto-configuration and dynamic auto-service discovery.

- Knowledge-based advanced software and system engineering systems for verifiable software production, including provably correct software for safety-critical functions.

- Support for software families, agile system development and integration of legacy systems.

- Automotive/transportation XML/UML.

- Multi-level automotive/transportation 'GRID', including automotive-grade middleware and dynamic scalability to very large systems.

Microsystems

- Dynamically shapeable surfaces/forms for tactile 'switches' and force feedback.

- Low-cost, high-integrity, highly integrated automotive-grade GPS/INS platform for precision positioning applications (or UWB-based; but certainly much later).

- Many new sensors and actuators; one particularly interesting development line being the 'arrayization' of sensors and actuators of the same type, e.g. microphone arrays, speaker arrays, micro-radar arrays, etc., for greater robustness and better discrimination via sensor fusion.

Interfaces

- Very Advanced ('*Ambient*') Driver Assistance Systems including:
    - cognitive driver models
    - 'deep' physiological interfaces
    - automotive grade precision positioning and mapping
    - enhanced situation-awareness via instant Real-time Reality Reconstruction and Augmentation
    - integrating e-cocoons and dynamic multi-resolution look-ahead (maps, road, micro-weather, traffic ...).

- Ambient 'all senses' interfaces; including speech, 3D-displays, force feedback ...

Knowledge and content

- For the garage management: manufacturer car logbook, maintenance vehicle record.

- For the driver infotainment: car user guide, driving assistance messages, positioning and mapping data …

- For the passengers entertainment: in-car games, movies, books …

Trust and security

- Trusted , secure controlled 'keyless' access (vehicle, services ...)

- like the home environment, car must, in the future, provide more sophisticated security than access control — specifically all the *AmI Space* security capabilities of authentication, accountability and audit.

Micro-electronics

- Mass storage: fast access, automotive grade packaging

    2006: 40 - 50 GB ; 2010:   > 100 GB

- Displays:

    - high luminescence OLED; by 2010: *free-form?*
    - holographic projection

- Power consumption: *for always-on capability*; not such a big deal in the automotive space with the transition to 42V, fuel cells, etc.

Annex 4: AMBIENT INTELLIGENCE IN THE PERSONAL ENVIRONMENT

EUROPEAN COMPETITIVE POSITION

Strengths, weaknesses, opportunities and threats	Recommended response
Strengths Large and demanding European home market Practically 100 % wireless coverage in Europe, every European can communicate wherever she or he is — people are used to using both fixed and mobile telecommunications European manufacturers are in the globally leading position for infrastructure supply for 2 and 3 G systems, based on the early development of Europe wide standards Good understanding of the European political and regulatory bodies of mobile issues Bluetooth technology becoming well established globally as a standard for local area communications European research in wireless systems in is the globally leading position	'Exploit'. The challenge is to sustain leadership in a changing market Strategic Initiative to further develop wide and local area network technologies and to develop the context-aware services and applications that will use them Seek synergy with the E-Europe plan to ensure continued uptake of personal communications technology in Europe
Weaknesses Internet, GRID and office application technology mostly not sourced from within Europe Increasing proportion of consumer products and components, such as displays and sensors, largely Asian dominated In Europe, the mobile sector is still technology driven rather than being based on an understanding of users' needs	Trade-off: Careful evaluation of where European leadership is still possible and desirable. Special consideration for wireless specific applications and services "Trade-off": This is a wide field and it should be investigated in which particular areas European industry might be able to compete "Recover": Scope for actions to increase uptake of services and applications and to simulate the development of new services and applications related to societal challenges

Opportunities	
The coming boom in communications between devices, and in the interpretation of the information they generate for human use, will generate a mass market for new services and systems	"Exploit" These opportunities should be exploited by the European industry to become world-leader in ambient intelligence systems for the personal environment
A multidisciplinary approach to the R & D is made possible by the representation of many different sectors in the IST programme	A special effort should be made to further develop strengths in wireless communications beyond 3G, for both local and wide area use, and in personal communications management systems
Europe's strength in embedded systems could be developed into a strength in the high value added control and management systems for mobile ambient intelligence	A special effort should be made to develop strength in low power embedded devices
The success of the i-Mode services demonstrates a large scale latent demand for mobile services and applications when the business models allow all participants to generate profit – this latent demand could be tapped globally, with the appropriate services, applications and business models, by European actors	A special effort should be made to encourage the development of applications and services based on incorporation of wireless technology into existing and new systems
Threats	
Market fragmentation and a lack of open standards would decrease the value of services for the user, leading to the absence of economies of scale and scope in the development and operation of services for European actors	Ensure that this does not happen through a large-scale initiative to sustain leadership in the development of global standards
Fragmentation of efforts within the IST Programme could lead to the absence of synergy between application and technology sectors limiting the effectiveness of the R&D	Ensure that technology development for networks, services and applications is undertaken in one integrated project on personal communications with strong links to initiatives focusing on other environments such as the car and home
Lack of a European-wide framework for the regulation and licensing of future systems could result in uncertainty in the investment environment and a reduction in the capital available to develop and roll-out mobile ambient intelligence systems and services	The European Commission should assess the possibilities for a European regulatory body coving the scope of ambient intelligence systems

2010 Updated vision

"It's amazing really, when you look back on it, just what a change the introduction of communication between intelligent devices made to our lives in recent years! Now, in 2010, we are connected to the real world, to the enhanced real world, and to cyberspace through a range of both wireless devices we carry with us and both wireless and wired devices embedded in the home, car, enterprise and other environments.

The wireless devices we carry around are light, small in size and work using low energy technology, enabling the devices to run for months without recharging. We have sensors sewn into our sports and leisure clothes helping us to optimise our fitness, reduce our stress levels and relax. Other sensors help those of us with known medical conditions to have mobility and lead normal lives while knowing that our medical condition is being continuously monitored and controlled through optimally released medication.

We are always connected to our personalised communication spaces now that we have developed the advanced functionality of the Cyberspace assistance system. It's introduction in 2006 really made a difference to the way we live and work. The Cyberspace assistance system recognises our voices and gestures and can usually tune our environment to our preferences by connecting to the Cyberspace assistance systems of our cars, work places and homes. It's constantly being extended and soon it will even work in public transport systems — it has taken a long time to get it adopted everywhere as there were so many different and incompatible systems on the market when people first started to use Cyberspace assistance. Everything got a lot easier to use since the Cyberspace standard started to gain widespread support.

We don't use keyboards so often these days as speech driven systems are so much more convenient to use while you walk around. I feel so much safer knowing that I can always call help over my wireless device. Using it's built-in camera, I can show the emergency services what's happening as I'm calling them. I worry less these days since I only have to touch a button, to find out if my family and friends are OK. As terrorism still reappears in new forms every few years, we all want to be sure that we are well prepared, should anything happen.

Societal and economical challenges

Economic challenges

Personal communications and services based on the widespread adoption of wireless and Internet technology have been major driving forces behind the growth of the European economy in the nineties. In order for Europe to reach the goal of becoming *"the world's most competitive economy in 2010"*, we will need to build on these successes. New market opportunities will open up as wireless

technology becomes as pervasive as microprocessors are today and new services and applications are enabled by the interconnection of the personal space with the surrounding environment through sensors, actuators, multi-modal interfaces and new management and control systems.

Socialisation

The support of socialisation is a critical function of the *AmI* world, ensuring that individuals are aware of potential opportunities, with proximity alerts for friends, family and work colleagues — or even potential friends — and creating a meeting space for friends and family. These meetings can take on a physical presence but also, in the *AmI* vision, a virtual presence. Individuals will need support to understand their roles and the negotiation and renegotiation of them. This will involve games, proposals and experiments, the acceptance or rejection of precedents and the establishment of new patterns of interaction as they are experienced.

These issues are challenging for an *AmI* environment, as such an explicit expression of role and negotiation is not the norm. Complex socialisation such as this will need to be understood otherwise the individual will suffer chaotic switches of focus or cognitive overload when more than one person is in the virtual room or at the virtual door.

Communication support

A key part of socialisation is the act of communication between individuals or across broader communities of practice, being sensitive to the environment and the situation (e.g. meeting, train). Access — with appropriate privacy — must be available when needed and where acceptable, utilising appropriate media and appropriate synchronous or asynchronous modes.

Avatar

Having more than one space to live in creates problems for people. An avatar, or virtual projection of physical form, will act on their behalf when it is not possible for them to focus on the virtual world or it will give them a recognisable presence when they are focussed on the virtual world.

Safety and security

Communicating sensor and personal communications systems will enable systems to detect alarming situations, such as an accident, and automatically get assistance, without requiring actions from the person needing assistance. Track of movements and warning of insecure neighbourhoods will be done dynamically

using police reports. Dependants such as children and those in care can be tracked and guardians alerted to alarming situations and reassured of safety (e.g. they just got home).

Position and navigation

Positioning in physical space and virtual space is a critical function to enable the person to navigate and, where privacy is not required, to publish their whereabouts. Apart from navigation, positioning will enable the alerting of 'interests' (possibly general; possibly specified for that environment on that day) proximity and directions.

Transportation sourcing

While mobile, transport proposals can be offered based on distance to destination, available time, scheduling, physical location of the transport options, and wellness (e.g. tiredness) of the person or companion.

Environment personalisation

Everyone has preferences on environmental conditions — temperature, humidity, background noise, privacy etc. Personalising the environment is possible where the number of people is low or microclimates are possible — and a complex negotiation of needs must be supported otherwise.

E-wallet

Most people carry a wallet or purse containing money, credit cards and identification. In the *AmI* world these e-items are likely to be carried in a device using biometric security.

Entertainment

In a laid back mode, either as an individual or in a group, potentially including those at a distance, entertainment can be proposed, negotiated and brokered. This entertainment can take many forms and media and can fulfil the need for fun or learning or both. It may, for instance take the form of a personal dream world, since many environments are deprived and boring to the person and a focus in a personal virtual dream world may be welcome. Of course, there must be alerts so as to shift attention to the physical world when appropriate (e.g. train arrival or someone talking to you at a meeting).

Health

Access to learning and reference material in many environments within specific contexts (e.g. "Find me a smoke free health food restaurant") will help remove barriers to healthy living. Personal health-related facilities such as support of disease management, personal health reminders (e.g. medication, immunisations), record keeping and sensor monitoring could help improve the known difficulties for individuals in often complex and confusing situations in supporting self care. Virtual communities of others with the same health status, in a pseudoanonymous persona, will help reduce isolation and change behaviours. Virtual links to our health care providers will help minimise our travel and life disruption and help our providers be supportive in the many environments we navigate.

E-Learning

As a species we learn in social contexts and accessibility within a specific context to a virtual library and to virtual communities will enable event-based learning and continual life-long learning. Different learning styles can be supported through personalisation and tailoring of available learning material at appropriate times.

E-Work

Mobile computers and phones have brought work into many environments for many people. Linking a workforce together virtually and to work resources (e.g. files) is part of today, although still needs enhancing. The future must improve virtual realities to enhance communication as well as to provide resources in a distributed way so as to support tasks that local devices cannot support.

Requirements to realise the vision

Communications and networking

People on the move become networks on the move as the devices they carry network together and connect with the networks around them. Some of the networks will be moving at high speed in cars, trains and planes. This requires:

- new network architectures
- multi-access and re-configuration capabilities in the networks, services and devices so that the transitions are seamless from the user's perspective
- new self-configuring wireless network capabilities will be needed to support communication between the multitude of sensors and communicating devices

- 'always reachable' personal preferences and information through whatever networks and devices happen to be available

- high bandwidth capabilities so that people use applications usually used over fixed networks and local area wireless networks from wherever they happen to be over wide area wireless networks. This will entail:
  - a new scalable, air interface family for beyond-3G systems
  - the allocation of new spectrum
  - the flexible reuse of already allocated spectrum.

Software technologies

All people will have 'permanent residence in cyberspace'. They will expect consistency between the actions of their avatar and their own actions in their professional and private lives as they answer phone calls, organise meetings and organise events. This will require:

- new interfaces definitions and standards

- new types of middleware and management products to support and organise the greatly increased volume of communication between people and between personal environment tuning systems and devices such as sensors and actuators

- support for the many new demands which will be made on interfaces by augmented reality and semantic and context-aware services.

Microsystems

- New portable communications devices to implement personal communications networks and services needing:
  - modes permitting very high data rates with real-time communication and low delays while supporting
  - low power devices, and especially
  - low power displays.

Interfaces

- Multi-modal interfaces that include gesture recognition and input from sensors to support speech and sound driven systems for people moving around.

- 'Personal interface management systems' to enable personal devices to interact with and use the interface devices available in different environments, such as the head-up display on the car windscreen or the office wall.

Knowledge and content

Cyberspace content, including information publicly available on the Internet, and private and corporate information not intended to be publicly available, will have to be accessible through many different devices effectively communicated on whatever type of device is available, whether it is a large screen or a portable headphone set with no display. This will require:

- real-time content preparation, translation and editing.

Much of the content accessed will have been developed on an amateur, rather than a professional, basis and much of this could be used for exchange of information between community interest groups. This will require:

- new software and systems to support amateur group communications for private and pubic access
- GRID facilities for the storage and processing of the vast amounts of data collected by sensors and other devices and amassed by both professional and amateur groups.

Trust and confidence

Security concepts will have to become one of the first considerations in any new system design, rather than something to be added at a late stage in the design, and trust and confidence will require:

- new security concepts, applications, services, networks and devices so that people trust the applications, services and underlying networks. A balance between personal privacy and public security will be needed in these new concepts
- it is likely that the personal environment will play a key role in the management of security for the individual in AmI Space
- new policies for privacy so that the data collected from sensors on the body and in the personal environment is not misused and trust in the system lost.

Annex 5: THE ENTERPRISE ENVIRONMENT

EUROPEAN COMPETITIVE POSITION

Strengths, weaknesses, opportunities and threats	Recommended response
Strengths Europe has a long and strong tradition in manufacturing and service industries Active research and development in collaborative, distributed engineering leading to creative design capability, including European products and systems, like CAD (e.g. CATIA), ERP (e.g. SAP, Baan) and process automation Substantial and world class effort in research in tools for Virtual and Smart Enterprises with a critical mass of collaborative work. This provides early, and systematic entry into the area	Support research with industry leaders and encourage their further involvement in European programmes; This includes large industries such as SAP but also emerging SMEs that provide alternative solutions
Weaknesses Lack of investment and awareness of the benefits of IST, especially in small European companies Fragmentation of the European markets which is a major hurdle for small suppliers Lack of generic interoperable infrastructure and lack of common reference models and of common vocabulary Weak or non existing IT supply industry in critical fields including databases, operating systems and their extension to generic office and business solutions Fragmentation of the Community research effort between programmes (IST and Growth) and even within the programmes No clear methodology for management of networked enterprises	Research should complement and not replace policy initiatives such as eEurope that promote the wider adoption of IST. The development of solutions that are sector — based across Europe can help overcome market fragmentation Support for the development of architectures that ensure the interoperability of enterprise applications at all levels Support more integrated approaches encompassing all business processes including manufacturing and design and engineering processes The research effort should be more co-ordinated to ensure critical coverage and learning from best practices Research should not only address technology issues but also help emerge a better understanding and control of the overall context including the global management issues

Opportunities	
The new 'networking' paradigm as an alternative to compete with existing highly efficient monolithic manufacturers outside Europe	Initiative to develop interoperable tools for networked enterprises. The effort should aim at generic solutions for all businesses. It could be supported by some sector-based developments (e.g. Textile, construction, automotive, aerospace, food industry …)
EU can maintain leadership in Virtual Enterprise (VEs) models and in developing a comprehensive methodology for VEs	
New businesses in tools to support Knowledge management and knowledge sharing in networked environments	Facilitate the emergence of new SMEs in the field to provide interoperable knowledge solutions that cover the whole products life cycle
European industry can be in a more competitive position to address the cultural diversity in Europe given the current trend towards mass customisation by non European suppliers	
Threats	
Speed of change — especially to adapt/provoke pan-European changes	Develop coherent approaches to RTD with the right balance between medium term solutions responding to today's problems and more visionary research for the longer term
Extension of US dominance of office and business environments to interoperable tools for virtual enterprises (e.g. emergence .Net etc.)	Support in the medium term open standards such as for Web services including the contribution to the further development of current concepts and their deployment
Continued fragmentation of research because of the lack of standards in modelling, methodologies and platforms, lack of common vocabulary, etc.	
Fragmentation of the development effort leading to divergent and non-interoperable solutions	Developing a longer term vision for tools that support more efficiently cross enterprises co-operative processes and new methods of work taken account of Europe's diversity
Decreasing innovative breakthrough-oriented research. Innovative solutions, products and services are increasingly from outside Europe	
Failure to recognise early enough, and use, relevant developments in other areas	Research to be better articulated with policy initiatives

2010 vision

The vision of Ambient Intelligence and the 'societal challenges' are primarily focused on the needs and desires of the individual person, as indicated by the Ambient Intelligence Scenarios. However, the working life is an important part of an individual's life and industry and manufacturing are important for Europe: we all need goods, buildings, energy, etc. Manufacturing (and other forms of business) will in the future be based on the fluid combination and re-combination of business processes and the seamless inter-operation of their supporting information systems.

Business is already today working in networks of interdependent organisations, rather than stand-alone companies. This trend is increasing. In these networks, business partners will quickly and easily come together to benefit from a business opportunity, fulfil the need and then disclose the collaboration. In addition to manufacturing, this way of working will in the future increasingly apply also to innovative early stages of product life like engineering and design, and to customer collaboration and logistics.

Companies will be able to co-operate in this way despite their different infrastructures, business cultures, organisational forms, languages, and legal and fiscal systems. Moreover, the business networks themselves will be constantly changing.

The incorporation of communicating sensors and actuators in every aspect of work processes of service delivery and production, distribution and use will continue to change value-chain relationships. Logistics has been revolutionised by the introduction of GPS systems in recent years. Another revolution will take place as 'thinking tags' (or agent tags) relay status information on goods obtained using sensors in real-time to logistics management centres. A similar revolution will enable the 'smart factory' of self-configuring products built from autonomous components and assemblies.

While the focus here is on industry, many of these trends will also be seen in public and non-profit organisations in the future.

European companies and other enterprises can, through working together in networks, open up new markets by providing new products and services via new processes.

Social and economical challenges

To achieve this vision requires more than new technology. Significant development of models and methodology for collaborative business are needed. To solve the management problems we need to understand the behaviour of networked organizations. A virtual enterprise cannot be managed like a single company. However, we want to have it work like a company.

The virtual enterprise

There is a lot of research already in the areas of 'virtual enterprises', 'extended enterprises', etc. More is needed. From where, for instance, will come the methodologies to manage virtual enterprises? The virtual enterprise is not a legal entity; its partners may have their own 'hidden' agendas; partner specific objectives may in some specific matters be contradictory to the need of the virtual enterprise; the ownership of IP is more difficult to decide; etc). What kind of

boundary conditions, restrictions, incentives (rules, contracts, information disclosure, etc.) would lead to a wanted 'global' result in a distributed environment, where partners locally 'optimise' their operations. How do these change from partner to partner and from case to case? This research should take inputs from separate fields, such as:

- Organisation and social research
- Economic research
- Cognitive sciences
- Operations Research (OR)
- Process modelling and simulation.

Research should also address the potential for:

- new forms of contracts
- new legislative frameworks covering contracts, liability, IP, etc.
- new taxation regimes to avoid unnecessary corporate barriers
- new business practices.

Business processes and ICT

There are many interpretations of terms like 'virtual enterprise', but a common base is the utilisation of advances in ICT for efficient operations over enterprise borders. The ICT should support efficient set-up, operation and dissolution of virtual enterprises. This also includes issues like partner search and pre-qualification.

The utilisation of ICT is crucial to the fluid configuration of business processes. Today, though, interoperability is a real problem. Companies have different business processes and company cultures. Their IT systems may differ radically (CAD, PDM, ERP, MES, etc.). If collaboration is based around a strong company, this company today usually dictates the systems and practices to be used by its collaborative partners. However, the vision also contains the fact that a company simultaneously can belong to several networks. Investments in different systems for different collaborative partners is not a solution, especially for SME's.

ICT platforms for collaboration in specific cases have been developed in FP5, but the interoperability between different solutions has not been addressed adequately yet.

For realisation of the management of business and knowledge, solutions might be based on distributed computing, agent technology, artificial intelligence, neural networks, etc.

- new collaborative and management models

- methods and tools in order to monitor and control process across companies. Today's business process management tools only support processes in one company but not activities which cross company borders or activities in several concurrent networks
- definitions of standards to exchange data and perform transactions across company borders. These standards have to support the integration on semantic level and on business process level
- simulation to enable the evaluation of approaches.

Engineering and design

The 'global office' is becoming a reality. People work together world-wide on the same projects or development tasks as if they were in the same office. Great advances in team-work support systems support this trend. However, interoperability between different tools is a problem. As design and engineering are dealing with much sensitive information and knowledge, trust is also a major issue.

Downstream manufacturing services (after sales support, operations support, maintenance, training ...)

Sustainability requires life long management of products and processes. Life cycle product and process knowledge management is crucial for environmental concerns and re-cycling of products. The term 'extended products' understands the product mainly as a service and covers all phases of its life cycle. A production facility can also be considered as a product from the view of the process developer.

The lifecycle support of products and growing producer's responsibility for disposal of products increase the importance of flexible organisation. The fast set-up, operation and disclosure of a virtual enterprise in maintenance is a different challenge than for a virtual enterprise to deliver a process plant. The life-time of the maintenance virtual enterprise may be only hours or days, when a plant project may last for years.

Logistics

The growing similarity of products brings logistic services into a more important role. The preciseness, exactness and quality of a delivery will in future decide the market success of products.

Also logistics service providing in virtual enterprise plays a major role, e.g. the operation and optimisation of multi-user-warehouses.

There are needs for:

- methods and algorithms for an improved and flexible use of existing material flow equipment
- standards in warehouse management systems for an improved interoperability
- tools, technologies and methods for quick commissioning of complex logistics systems, such as proven testing procedures and systems
- logistic operating systems with open structures and interfaces for high and low level systems (SCM/ERP … SPS).

However, logistics may change with increased standardisation of product and process presentation, and research should address:

- virtual logistics — the transfer of information describing products and production to replace physical logistics
- fourth party logistics (4PL)
- the application of the ASP concept to the production of commodity goods.

Requirements to realise the vision

Communication and networking

- Interoperability between different systems/companies (including new possibilities for multimedia, new measurement and sensing applications):
  - concepts and technology for interfaces between different systems on a semantic and knowledge level
  - approaches for utilisation of the web for collaboration (semantic web, other approaches?).

- Integration of business processes:
  - models & methodology to set-up/operate/maintain/disclose networks & virtual enterprises
  - methodology for management of distributed, networked collaboration
  - methodology for management of co-opetition — to achieve global optimisation given competitive local optimisation.

- Interoperability between different systems/companies (including new possibilities for multimedia, new measurement and sensing applications).

- Mobility:
  - in addition to ''pan European interoperability and multi-lingualism'', mobility can lead to a radical change in working practises and even in organisational solutions. Tools and methods to support mobile collaboration, team working and information access to manufacturing and product knowledge (also intangible) will be needed together multi-technology based interfaces

- for cost breakthroughs in delivering broadband content, to and from products and production facilities using several different media including satellite communication
- the data collection may include architecturally significant local mass storage capability and in addition methods for pattern recognition and classification of information (including images, video, voice, etc.) to provide relevant features for different kind of users
- standardisation: Open Source software as an approach for rapid and successful introduction of new standards
- Development of a Logistics Operating System: an open framework providing basic logistic functionality for warehousing and transportation, as well as standardised interfaces.

Software technologies

- Software supporting integration and interoperability on semantic and business process levels.

- European Resource Grid to provide:
  - hardware infrastructure
  - software applications
  - services and knowledge
  - new business models for software and services providers — and users too.

- Development of new methods and tools for the component-based development of distributed application are necessary for the support of collaborative business.

- Software management process and techniques for distributed, collaborative software development including:
  - process models
  - role concepts for human resources
  - software techniques for component-based development.

Microsystems

- New sensors and measurement systems:
  - low energy consumption (preferably taking energy from its local environment)
  - small size and integrated in the process or product
  - local intelligence (e.g. control of local behaviour)
  - large and flexible communication with environment
  - methodology for sophisticated testing of distributed software for shortening commissioning and ramp-up time.

Interfaces

- 'Intelligent" interfaces supporting operations of products and processes also taking into account cognitive aspects.
- Interfaces for different managerial and organisational levels:
    - intelligent
    - real time
    - remotely and wireless accessible.

Knowledge technologies

A fundamental basis for the collaboration is knowledge sharing and knowledge management over the whole network. Knowledge is created in all phases of a product life-cycle and in all levels of the network. Efficient utilisation of the network and interoperability require that the right knowledge is easily available for every partner in a form suitable for his or her needs:

- Life cycle knowledge integration:
    - support for maintaining and utilisation of product related knowledge over its life-cycle (models for information usage, access/use control)
    - means to collect knowledge and information from later phases of life cycles (operation use, disposal) and feed it back to design, planning and engineering phases.

- Life Cycle Networks implementation:
    - Support for Life Cycle Networks for the Material Recovery, especially for plastics, to produce a recycling plastic with defined material specifications and a guarantee of no hazardous materials in its recycling. (Models for process and quality management systems for the whole network with all actors of the production chain.)

Trust and security

- Technical network security is a must and developments are needed to enable secure ad-hoc interconnection of networks, in a way which is as transparent as possible.
- Collaborative forms to support personal and organisational trust:
    - team formation
    - methods for qualification and selection of partners
    - software and team-ware support for collaboration.
- Systems for support of legal and business collaboration.

Annex 6: THE SCIENCE AND ENGINEERING ENVIRONMENT

EUROPEAN COMPETITIVE POSITION

Strengths, weaknesses, opportunities and threats	Recommended response
Strengths Good involvement of many sections of the EU scientific user community in Grids Involvement of industry in the e-Science Programme shows potential for Europe Significant European industries that can benefit from Grid technology Good EU backbone network and high bandwidth global connections	Coordinated portfolio of special initiatives on Grid applications for Science and Engineering with emphasis on EU industry, including promotion of the vision of composable and interoperable Grid services to EU academia and industry *Comment: there is need to maintain high-bandwidth backbone network and to extend with improved access routes*
Weaknesses Very few significant European middleware companies and few SMEs developing/supporting Grid middleware/services Patchy availability of broad-band access (reason partly technical, partly regulatory and partly a consequence of tariffs) Only partial engagement of EU IT research community	As part of the portfolio of special initiatives (see above) coordinate so as to create environment to promote development of EU middleware companies and SME creation Remove regulatory barriers to broad-band access Engage EU academic IT community
Opportunities Competitive position in knowledge and content technologies, in agent technologies, and in other software engineering technologies Transform mainstream commercial enterprises through exploitation of new services, software and tools developed for science and engineering Integration of mobile devices/sensors into Grids for industrial/environmental applications Establish pan-European Grid production quality testbeds for use by academia and industry Create EU companies for Grid middleware, services and consultancy	Exploit these capabilities through their engagement in the portfolio of special initiatives (see above) Create ERA initiative to link national Grid activities (as part of the portfolio of special initiatives?) Develop first-class infrastructure for EU Grid services for both academia and industry As part of the portfolio of special initiatives (see above) include training and consultancy for industry

Threats	
'Open Grid Standards' may be hi-jacked by proprietary interests	Engage vigorously in Open Protocol activities for standards relevant to AmI plane middleware
European industry may not engage with Grid agenda	Develop education and research agenda for Grids
Web Services approach to distributed computing may fail to deliver on its promises	

2010 vision

The vision is of transparent interoperability between different systems and companies, enabling new possibilities for communication and sharing of multimedia information, and new measurement and sensing applications.

The Grid architecture is an extension and specialization of Web Services focused on the utilization of large-scale distributed computing, data resources and facilities in dynamic Virtual Enterprises. In this way, using secure single sign-on technologies for AAA (digital certificates are used at present) Grids can provide a solution to most if not all of the interoperability problems of large distributed organizations with multi-vendor platforms and operating systems. In particular these include both Unix systems (proprietary and Linux) as well as Windows XP and its successors. The Grid middleware envisioned here would provide the basis for new 'interactive B2B' applications.

Societal and economic challenges

E-Science/e-Engineering

- Collaborative e-Science to support global, distributed R&D.
- Dynamic distributed e-Engineering applications.

E-Health

- Grids to support e-Health applications including electronic patient records, medical data archives for diagnosis and epidemiology.
- Exchange of medical data, wide-area knowledge-based medical decision support systems.

E-Environment

- European Grid for environmental monitoring, sensor networks.

- Grid technologies for disaster prediction e.g. flooding.
- Integrate Earth Observation data for pollution monitoring.

E-Business

- Enable dynamic Virtual Enterprise creation.
- Assist in Enterprise Application Integration e.g. ERP, SCM, CRM.
- Interoperability and composability of e-Services.

E-Learning

- Grids providing computing, data and facilities for general public, schools, universities and business.

Requirements to realise the vision

Micro-electronics and opto-electronics/Micro-systems

- Distributed sensor networks and networks of MEMs with on-chip co-processing and communication capabilities.
- Low latency, high bandwidth communication technologies will be necessary for some applications.
- All optical 'lambda' networks for QoS, etc.

Communication and networking

Grids will typically link several/many organizations in more than one country. Scientific Grids are being built that link research institutions throughout Europe, the US and Japan. As e-Science applications proliferate and this type of cooperative working becomes a standard methodology of science, there will be a need for:

- Continued upgrading of the bandwidth and services offered by the GEANT pan-European network and national networks.
- Good links to the US, Japan and the rest of the world.
- Novel lambda networks using optical switching for applications with particularly demanding QoS requirements.

Industry will typically create intra-Grids and dynamic inter-company Virtual Enterprises using VPNs provided by the TelCos, for example.

Software technologies

Europe has strengths in several niche software applications but needs to develop novel Grid services. These services could form the basis for new ASPs, particularly in the area of tools. Grids will need:

- models for composing a complex set of services in a managed and error-free way
- software engineering techniques for Web and Grid Service applications that can deliver dependable, fault-tolerant services are also required
- agent technologies to realize the vision of a marketplace for e-utilities delivered over the Grid.

Knowledge and content

There could be a major opportunities for Europe in:

- provision of content
- data mining
- decision support
- knowledge discovery and management.
- ontologies for different communities and industries.

With the increasing importance of ontologies, together with the movement towards a semantic Web that supports intelligent 'M2M' interaction, there will be a parallel development towards the development of semantic Grids.

Interfaces

Grids that use a variety of technologies both for inputs and for interaction are likely to be components of mass-market Grid applications and will require:

- connectivity between Grids and PANs and 4G mobile devices with avatars and agents

This could become a whole new industry.

Trust and confidence

This is a vital area for Grids along with AAA and privacy concerns. These issues are likely to be especially acute for applications in the healthcare sector.

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