ISTAG Recommendations for FP6, December 2000

Executive summary: *boosting the future of IST in Europe by FP6 can be shaped most effectively when proper measures are taken to focus relentlessly on certain key enabling technologies and technology research initiatives (TRI's), with an open mind to and investigation of possible technology bifurcations, with an emphasis on long range research that will help invent the future, and supported by an FP6 architecture that is simple, flexible, open to world-wide co-operation, and fosters entrepreneurship.*

The IST Advisory Group (ISTAG) to the European Commission has put considerable effort into getting more focus in the programs within the current framework programme FP5. This has been successful in that the FP5 work packages have been focussed under the notion of "Ambient Intelligence" i.e.:

> *"Start creating an ambient intelligence landscape (for seamless delivery of services and applications) in Europe relying also upon test-beds and open source software, develop user-friendliness, and develop and converge the networking infrastructure in Europe to world-class".* [1]

Earlier this year ISTAG has taken an endeavour to try and get to a higher level of focus and a higher pace in the estimation of the future of Europe in the ICT landscape. The tool used is scenario planning. This paper describes preliminary results and recommendations that follow from this study. ISTAG offers this as relevant input for the definition of the Sixth Framework Programme, FP6.

Planning via scenarios goes beyond more traditional extrapolation from the past in that it offers a provocative glimpse on a set of scenarios for the future that can (but need not) be realised. Each scenario has a script that is being used to work out the key developments in technologies, society, economy, and markets necessary to arrive at the scenario. Once we realise that the time-scale of significant changes in the ICT industry has become shorter than one year, scenario planning is one of the few structured ways to get an impression of the future. To put it otherwise, rather than extrapolating from the past, scenario planning helps invent the future. Even qualitative changes and breaks (e.g. technology bifurcations) can be accounted for in the modelling of the future.

Scenario planning starts from key drivers that can be found in technology, economy, and society. The most important driver used is the widespread acceptance of the notion that in our technological society the user, both "mass consumer" and "business employee", should move in the foreground, the centre of our attention, and such people will optimally benefit from all the services and applications that the new technology can offer in the background. This was also the underlying driver that has brought ISTAG to the notion of "Ambient Intelligence".

In a study conducted by IPTS and with the help of several expert groups from all layers of society and from across Europe, four scenarios have been worked out that all serve to underscore once more the vision of "Ambient Intelligence". The main structuring differentials between the scenarios are: efficiency versus sociability/ humanistic criteria as the demand driver, and community versus individual as the type of user driver; see picture. In all four scenarios a personalised ambient plays a serving role to the human being.

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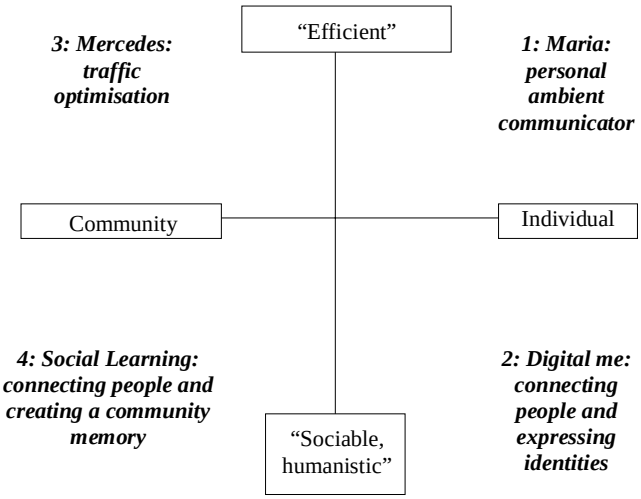
[1] ISTAG Orientations for WP2000 document ftp://ftp.cordis.lu/pub/ist/docs/istag-99-final.pdf (July 1999)



The four scenarios can be described as follows:

'Maria": is a scenario where a business woman is *individually and highly efficiently* supported by a personal communicator that goes way beyond the current GSM and PDA like devices in that it takes care in an intelligent way that the world around Maria (like car rental, parking, hotel, presentations) is organised automatically and intelligently. The technological and socio-economic changes are relatively incremental build outs of existing approaches. The key barriers appear to be the establishment of interoperating hierarchies of agents. The lead here is business sector demand (which tends to be more efficiency orientated and less price-sensitive). No large changes in behaviour of people are assumed.

"Digital me" is a scenario in which a person is supported by a Digital Me personal assistant to *individually but sociably* build and maintain relations. In fact this offers an alternative mode of use of personalised ambience. The emphasis is on play and social interaction rather than efficiency. Lead markets may emerge first amongst "alternative or youth cultures." The changes in behaviour relate mainly to the willingness to reveal (or disguise) personality on-line. Price could be a barrier to a break through to a mass market.

"Mercedes" is a scenario in which a person *individually* is supported by an intelligent personal digital assistant and a *community* infrastructure such that in travelling ridesharing is an accepted and normal practise, and rerouting through public services is an effective way of travelling. This scenario is further out on the time horizon than the two 'individual' scenarios, not so much due to technological barriers as because it implies major infra-structural developments (i.e. highly developed networks of inter-operating sensor systems and dynamic database management systems). It also makes significant assumptions about public behaviour changes such as accepting ride shares or traffic management systems.

"Social learning" is probably the furthest out in terms of time as it has high demands both from a technological and socio-economic viewpoint. In this scenario ambient support systems should be capable of creating challenging and interacting learning environments that underscore that learning is essentially a social, cultural, and lifelong process. "Social learning" implies significant technical developments such as high 'emotional bandwidth' for shared presence and visualisation technologies, or breakthroughs in computer supported pedagogic techniques. In addition, the scenario presents a challenging social vision in the service of fostering community life through shared interests.

All four scenarios may in fact in time happen after each other, "Maria" perhaps first, then "Digital Me", next "Mercedes", and finally "Social learning". However, from a point of view of

desirability one may also push for “Maria” first and then move on to the challenging and exciting “Social Learning”, fitting very much in a European cultural tradition. Such, however, is a choice to be made by Europe, or European entities, not by ISTAG.

The scenarios must be seen as a tool of learning. None of the scenarios may in fact be realised although to some extent that is very much up to us, the European society. So what do we learn from the scenarios.

First of all scenarios help us identify needed key enabling technologies (in arbitrary order):

Key enabling technologies

- mobile, wireless and IP technology
- ultrafast optical processing
- networked embedded intelligence
- adaptive network management and control
- converging core and access broadband networks
- seamless and dynamic multidomain network interoperability, management, control, service access, cashing, and use
- new computer and communications architectures
- self-testing and self-organising software
- distributed databases management/datamining and warehousing
- intelligent agents and real time middleware
- information filtering and presentation
- trust and confidence enabling tools, e.g. secure ID authentication / smart-SIMs
- micro-payment systems
- I/O devices like displays, sensors/ actuators, and smart materials
- storage
- multimodal and adaptive user interfaces e.g. speech, gesture, and pattern recognition
- multilingual and cross-media content
- nano-and micro solid state and optical technologies

Two points are to be stressed here 1. a top and high performant network infrastructure is a condition sine qua non for any scenario that one may envision, and 2. the user-interface technologies are necessary both for scenarios fostering professional productivity of the business employee as well as for those fostering leisure and social functioning of humans. Other scenarios that one could envisage focussing more on business to business instead of on the user would also need these user-interface technologies. The key enabling technologies are thus to some extent independent of the particular scenario one favours. A further focussing of technologies might be possible when the business side of the scenarios is analysed in more depth; this is work in progress.

Secondly scenarios help us identify possible points of technology bifurcation. Such bifurcations can give rise to the development of totally new businesses, and could offer totally new services to humans. Examples are the invention of the compact disc, and the microprocessor. Some possible bifurcations that follow from our work are:

Potential technology bifurcations/breakpoints to 2010:

Devices live off ambient power sources (sunlight, body-heat, natural motion, bursts of radio-waves): *radical breakthrough to mobile and wearable devices.*

Self-organising/self repair software systems are generalised and in use: *radical breakthrough to software dominated applications.*

Sentient networking: the network resources automatically provide the bandwidth needed to perform the task: *radical breakthrough to emotional service on demand.*

Achievement of distributed real time middleware and a common intelligent agent technology: *breakthrough to fully intelligent networks and devices*

Fully optical broadband networks are in place: *breakthrough to ultra high speed low cost/bit networking*

Thirdly they help us to identify key focus areas for technological research initiatives. Some illustrative examples suggested by the scenario work are

Schematic TRIs:

The all optical/photonic network initiative: High performant (throughput and quality of service) fully packet based networks like the Internet are key to any scenario and have electrical routers replaced by optical elements like optical cross connects and optical packet switches.

Intelligent Networks and Devices Initiative (INDI): *One major enabler* will be a 'service control plane/platform' that provides seamless access to the different services, the policies to use them and the environment to allow a transparent provisioning. A successful service control plane/platform depends on advances in information processing technologies (e.g. intelligent agents, information filtering and presentation, active nodes, distributed processing, policy-based management, encryption, middleware, intelligent data mining, multimedia high level coding, content information processing, voice synthesis, deep language understanding, and so on). *Another major enabler* is intelligent objects/devices, which are on one side aware of the physical environment in order to seamlessly interact with the user (e.g. voice and mood detection), but on the other side must be connected to the ambient connectivity infrastructure, supporting ubiquity and mobility. Some key technologies to be developed in this respect are: wireless connectivity at nano-cell level, P2P (peer to peer) connectivity to support Application to Application interoperability, bursty mode and transaction mode connectivity, distributed intelligence also supporting dynamic addressing, self routing, self resource negotiating, wireless routing and self assembling networks, optical communications, database distribution.

A) INDI in Motion - Services for people: Personal access networks and profiles are accessed automatically, supporting the connection from home/work to leisure sites, inclusive cultural, sports, and tourism. Business oriented use in the workplace and on the move. Beyond UMTS the evolution of fourth generation mobile systems and enabling techniques is of interest. Basic issues of investigation could be: innovative planning/management approaches to fully deploy the capability of new solutions with reference to a bandwidth ranging from 5 to 18 GHz, management of radio resources in a multi-system environment, new radio access techniques (e.g., Time Modulation Ultra Wide-band), new development in intelligent antennas, high performance real-time compression and decompression of multimedia signals;

B) INDI for electronic commerce: digital content will take an abstract form called "Digital Item" on which Users (all players on the value network) will execute actions giving rise to other digital items with a value added that becomes the object of a transaction. Such items can for example be goods finding their way from supply to demand. Vehicles can become network nodes.

C) INDI at Home: homes will have to become powerful and low cost platforms characterised by high bandwidth all optical access and local area networks. Key additional issues are the availability of low cost multi-wavelength optical sources and frequency selective devices as well as suitable optical interfaces with the core network. Unified home environment where PC, TV, phone, games, books may all merge into a single environment and/or device utilising high speed connectivity.

D) INDI privacy and security initiative: create the technology that will help and guide privacy and security. Some examples are: advanced identification/authentication techniques (e.g. based on combining biometrics, digital signature and perhaps genetic/biological methods); technology to preserve anonymity/privacy against the "big brother" infrastructure, and so on.

The information factory initiative: Identification and modelling of the required structural and behavioural elements for building information factories: Framework for data mining and decision support services. Enable processes of gathering, transferring, aggregating, disseminating, and mining of data in order to help corporations and large organisations management to take quick and adequate and reliable decisions.

The Tangible User Interface Initiative: Creating smartifacts such as *Interactive Surfaces:* transformation of each surface within architectural space (e.g., walls, desktops, ceilings, doors, windows) into an active interface between the physical and virtual worlds; the *Coupling of Bits and Atoms*: seamless coupling of everyday graspable objects (e.g., cards, books, models) with the digital information that pertains to them; and *Ambient Media*: use of ambient media such as sound, light, airflow, and water movement for background interfaces with cyberspace at the periphery rather than the centre of human perception.

Safe and dependable systems initiative: aim to develop reliable/robust/dependable large-scale or complex systems. Will aim to achieve breakthroughs such as self-assembling and self-testing software, component based techniques, hardware that has high levels of redundancy (fault tolerance), support for a massive jump in the requirement for scalability as we move towards ubiquity of computing, building in graceful failure, context based content search tools.

The Community Memory/ Sharing of Knowledge: aim to create shared knowledge space for organisations, social groups, across cultures and even across time for individuals; Build eCulture to shift cultural content to communities beyond museums, eLearning for lifelong learning. A development of knowledge management techniques and organisational performance enhancement tools. Projects to create shared knowledge spaces, telepresence tools.

The key focus areas for technological research initiatives as well as the importance of technology bifurcations underscore once again the importance of well focussed long range world-class research in Europe to open up an ever increasing reservoir of new ideas and creativity to help invent the future.

Fourthly both the current pace of the ICT industry and the scenarios indicate a high sense of urgency in the business of ICT and the necessary global character of them. This implies that whatever measures are being taken in FP6 to support Europe's ICT, they should support fast responses, flexibility, and world-wide co-operation, as well as entrepreneurship.

Fifthly all the scenarios emphasize the social dimension of innovation, the ability as well as the willingness of the society to absorb or to react to technological developments. Issues such as energy, environment, social sustainability, privacy, social robustness and fault tolerance may at the long term determine the success or failure of specific technologies.

The final clear result from the scenario exercise is that a host of new business models will be emerging from whatever direction is taken by Europe. It is not the task of ISTAG to develop the new business models. But the continuation of the exercise will give ample consideration to the economic feasibility of the scenarios and organisational implications in the public and private domain. Such work is the focus of expert workshops in December.

Finally, ISTAG's efforts will continue to determine the most important competitive technologies that are needed to be developed for the future of Europe from roadmapping for the various scenarios. Such information will be of great value to FP6.