Multimedia telematics: R&TD to shape the global information and knowledge society

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El reto derivado de la transformación de la sociedad industrial hacia una sociedad de la información y el conocimiento, junto con la globalización de la economía es la dependencia cada vez mayor de todas las actividades económicas e industriales de las tecnologías de la información y la comunicación. La I+D de la UE en este ámbito trata de aportar una dimensión europea a los distintos aspectos implicados: desde las tecnologías e infraestructuras de base hasta las aplicaciones para los ciudadanos y las empresas. El objetivo es la articulación con otras políticas de la Unión que posibiliten satisfacer de manera integrada a nivel europeo, las necesidades de los ciudadanos de servicios de interés general avanzados y de alta calidad; de empresas, consumidores y trabajadores, para innovar los métodos de comercio y producción. Las acciones previstas posibilitarán igualmente un liderazgo europeo en la producción de contenidos y servicios basados en las nuevas tecnologías multimedia, mediante la realización del potencial inmenso de creatividad basado en nuestros recursos humanos y culturales.

Palabras Clave: Investigación. Telemática. Multimedia. Redes. Educación. Formación. Conocimiento.

Ekonomiaren globalizazioarekin batean gertatzen ari den industria gizartea izenekoa informazio eta ezagupenaren gizarte bilakatzeko prozesuak bai ekonomia eta bai industria jarduera guztiak gero eta gehiago informazio eta komunikaziorako teknologien mende izatea ekarri du. Alor honetako EBko I+G delakoa inplikaturiko alderdi guztiei europar dimentsioa ematen saiatzen ari da: oinarrizko teknologia eta azpiegituretatik hiritarrei eta enpresei zuzenduriko aplikazioetaraino. Helburua Batasunaren beste politika batzuekin artikulatzea da, Europako mailan hiritarrek interes orokorreko zerbitzu aurreratu eta kalitate handikoen alorrean dituzten premiak modu integratuan asetzearren; bai eta enpresa, kontsumitzaile eta langileek merkataritza eta produkzio metodoak berritzeari begira dituztenak ere. Aurrikusitako ekintzek europar buruzagitza bideratuko dute, orobat, multimedia teknologia berrietan oinarrituriko eduki eta zerbitzuen produkzioari dagokionez, gure giza eta kultura baliabideetan oinarrituriko sormenezko ahalmen eskerga gauzatzearen bidez.

Giltz-Hitzak: Ikerketa. Telematika. Multimedia. Sareak. Hezkuntza. Prestakuntza. Ezagupena.

Le défi découlant de la transformation de la société industrielle en une société de l'information et de la connaissance, lié à la globalisation de l'économie est la dépendance toujours plus grande de toutes les activités économiques et industrielles des technologies de l'information et de la communication. Le I+D de l'Union Européenne dans ce domaine tente d'apporter une dimention européenne aux différents aspects impliqués: depuis les technologies et les infraestructures de base jusqu'aux applications pour les citoyens et les entreprises. Le but en est l'articulation avec d'autres politiques de l'Union qui puissent satisfaire, de façon intégrée au niveau européen, les nécessités des citoyens de services d'intérêt général avancés et de haute qualité; d'entreprises, de consommateurs et de travailleurs, pour innover les méthodes de commerce et production. Les actions prévues faciliteraient également un leadership européen dans la production de contenus et de services basés sur les nouvelles technologies multimédia, au moyen de la réalisation du potentiel immense de créativité basé sur nos ressources humaines et culturelles.

Mots Clés: Recherche. Télématique. Multimédia. Réseaux. Education. Formation. Connaissance.

Introduction

The European Commission sees multimedia information and telecommunications networks as key ingredients for the competitiveness and welfare of society, and as a means for creating a future space of knowledge that will be accessible and bring benefits to all citizens and businesses. In particular, information, research and knowledge networks are a vital element in sustaining scientific and technical progress. It is very encouraging to see that there is such a high level of commitment to this topic all over the world, and the high level of interest shown to participate into the global knowledge and research village much beyond pure commercial interests.

The strategic importance attached by the European Commission to this topic is mirrored by the increasing R&D funding devoted to the applications of the Information and Communication Technologies to all fields of general interest. This was the rationale underpinning the creation of the Directorate within DG-XIII (Telecommunications, Information Market and Exploitation of Research) to deal with Telematics applications, networks and services, to which I belong as Head of Division responsible for applications in the areas of Education, Training and Research.

I will start by saying that there has been too much excitement, very often some hype and inflated expectations surrounding the so-called Information Infrastructure. Although undoubtedly the new information and telecommunication technologies are a driving force for innovation, and represent a boost for productivity, they are still far from meeting many of the high expectations forecast some years ago. Still an overwhelming majority of teaching, medicine and transport systems, to indicate a few examples, are only using these technologies to a very limited extent, and in applications which are not situated at the core of their businesses.

It is said that technology was not ripe enough, and that now with the advent of multimedia and broadband communications, the advantages are so obvious that an endless plethora of applications and services will thrive everywhere. An oversimplification of the issues entailed would lead us to consider that it would suffice to roll out the so called "information superhighway" to make this happen, and no doubt the Internet experience seems to endorse such an assumption. Nevertheless, it is worthwhile to answer a key question: what do we mean by Information Society? My standpoint is that it is much more than superhighways, which in effect refer to the means rather than to the overall essence of the concept. "Minor highways" are also essential, reaching ultimately to the individual user. Only if well understood, mastered and placed within a broader context of general policies, can information and research networks be the motive forces which will take us to a future common space for innovation: a real knowledge infrastructure supporting the future Information Society.

The latter reflections are particularly applicable in the European context, in which a number of constraints and specific political, socio-economic and cultural challenges are raised. The European position and plans in this respect, in the light of recent developments and in relation to more general policies, will be one the main themes of my speech. Thus, I will attempt to approach the topic within the broader context of the internal market, research and technology development, and telecommunication policies. There are a number of difficulties related to the very nature of these policies and programmes; such as the variety of regulatory frameworks, the different administrations involved in the Member States, and the conflicts between user demand and technology push.

The Internal Market as the driving force for the new policies

The building of the Internal Market in the European Union has been a twofold process. Firstly, it represented a "creative destruction" of previous obstacles hindering European development, that is to say trade barriers, subsidised economies, and what was called in the past the "Fortress Europe". It was as well a process to tackle new challenges, a process of "positive construction" to build European networks, institutions, and, what is of course even more important, a European societal consciousness.

These two processes are underpinning any industrial and research policies. In particular telecommunications policy because of the importance it acquires in the building of a Europe without frontiers, open to the entire world in the upcoming information age. All of these ingredients need to be combined in a coherent manner to create a compelling vision of a pan-European service infrastructure for a Europe united by the new technologies of the information society, capable of playing a pioneering role in meeting the global competitive challenges ahead.

European policy on R&D

I must first ask the question: why does the Commission support research? The answer is simple. A basic duty of government is to create conditions under which citizens may prosper. In today's world, prosperity is maintained by those industries which add the greatest value per worker, in other words the skill intensive, high technology industries. But the high technology of today is the commonplace of tomorrow. Only through continuous advance can industry maintain its place at the leading edge of the market. If high technology is the engine of prosperity, research is its fuel. Research is vital to push forward the frontier of innovation.

As an abstract principle, this is fine, but it does not yet answer the question - why is the Commission involved? To answer that, we must look back to the 1970's, a decade of spectacular technological development, especially in information technology and telecommunications. In what we then referred to as Western Europe there was considerable concern that our economies would be overtaken by the high tech industries of our main competitors. The response, it was agreed, should be to boost our efforts to support research, to build the basis for the new industrial revolution that was foreseen.

However, research today is not only expensive, but it also requires specialised skills, and wide combinations of skills. Research efforts fragmented by national boundaries could not hope to keep pace with those supported by the far larger economies of the USA and Japan. For this reason, the European Commission launched collaborative research programmes, bringing together partners from across the Community to pool knowledge and expertise in leading edge research. Now if I can stretch my metaphor almost to breaking point, fuel requires oxygen to burn, and information is oxygen to the fuel of research. Research, and especially international collaborative research, demands access to, and exchange of, large quantities of complex information.

European Research so far has been facing three main problems. The first and most obvious one deals with financial constraints (only approximately 2% of the GDP is currently devoted to R&D, lower than other advanced world regions); the second one is specific to the situation in Europe, where

there is not a single policy but a number of policies and actions leading to fragmentation and lack of co-ordination (less than 10% of research is conducted within a trans-European framework, including ESA, CERN, etc.) in spite of the dramatic improvements stemming from European research initiatives; and finally the self-acknowledged lack of success in converting scientific breakthroughs and technological achievements into industrial and commercial successes.

Anyhow, European collaborative research has experienced good progress: past Framework Programmes for R&D have brought about a wealth of results and have resulted in co-operation between researchers who consider Europe as their natural working place. The fourth Framework Programme defined a new set of Programmes for the years 1994 till 1998 (13 BECUs have been allotted to it). As with previous Programmes, this is again only a small percentage of the total R&D budget of the European Union, which is largely made up from national endeavours, but is nevertheless an essential element bearing in mind the broad effect on the co-ordination of Member States' policies.

It is worth highlighting the evolution followed by the R&D policy of the Union as a consequence of the approval of the new Treaty on European Union. Indeed, in the chapter devoted to Research and Technology Development, the new Treaty highlights the closer ties of R&TD with society's needs and other Community policies. Thus Article 130f states: "The Community shall have the objective of strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other chapters of the Treaty". In other words, R&D should explicitly support other policies of the Union: industrial policy, cohesion, single market, education and training policies, and should further support society's needs.

Four main activities have been undertaken: basic research (including technological development and demonstration programmes); co-operation with third countries, for example on world-wide strategic projects (in areas such as the human genome or global climate change and environment); dissemination and transfer of R&D results, and finally stimulation of the training and mobility of researchers.

Telecommunications in the European scene

Let us examine the current policies, the status and future plans in European telecommunications. It is broadly understood that telecommunications nowadays underpins the activities of most industrial sectors and it is central to the performance of the service sector in Europe. A good communication infrastructure is a key asset for industrial competitiveness and will lead to productivity improvements. A wide range of companies now depend on advanced services to integrate dispersed activities, to manage their manufacturing and market operations or to train their staff, that is to say to gain competitive advantage in an era of rapid product innovation. Advanced telecommunications and telematics services infrastructures are now considered a key factor for innovation in manufacturing, management and in the provision of efficient services. They are thus equally essential for meeting society's needs.

At the same time the Telecommunications sector itself is underpinning a growth of more than 6% a year in real terms over the last years, twice as fast as growth in total economic output, with an even faster growth last year due to the bur-geoning of mobile communications. By the year 2000, telecommunications will be the third largest market after the food and drink and chemicals sectors. Therefore it clearly deserves equal attention in its own right. The creation of the Single Market has had a strong influence in Telecommunications policy since the mid 1980's. Nowadays as new technological and political developments occur and change the European scene, some adjustments and changes in emphasis are being considered.

The well known recent political developments in Europe have obvious implications. For example the Community is reinforcing the efforts towards the implementation of the Union Treaty, which recognises explicitly a more important role for Telecommunications as a key element for the implementation of the Union objectives; or changes in Eastern Europe which broaden the scene as they affect the strategies and enter the markets of the EU. Underlying these changes is the globalisation of markets, which is leading to the opening of Community markets to European and international competition, whilst Japan's and USA's interest in European markets continues to grow.

Other more specific developments to be considered are the re-regulation of Public Network Operators, the restructuring that the European Telecommunications industry is experiencing whilst consolidating its position in the world market. At the same time information technology continues to weaken, by-pass operators enter the scene, the sector of value-added service providers is growing in importance, mobile operators are emerging as a new force and the multiplicity of value-added services are increasingly diversifying the choice that users have. All of these request further targeting of investments by the network operators.

Growth in core telecommunications infrastructures and services will not be enough, traffic will be increasingly driven by other market sectors, such as education and entertainment, teleworking and financial services, multimedia communications, and customised services which are implementing the concept of pay-per-use. This is a challenge for a sector which has been dominated by Public Network Operators, facing nowadays the dilemma of competition versus the required co-operation that the high investments involved, and the shifts of value towards the services are demanding. Co-operation is the only way for entering into these new service markets and to cater for quality. Digitalisation and deployment plans for ISDN or the future Broadband are very demanding in terms of investments, and especially for the latter, the pay-back period needs to be shortened by economies of scale. This forces to co-operation in the large scale. However, services have most of the value of the chain, but they are scattered and focused on customer niches as our experience in Telematics Applications Programme has shown. This forces to co-operation in the micro scale. This scenario, in which cost reduction comes from the economics of scale but benefits come from the specialisation of services, will make the telecommunication sector a very challenging and moving sector.

Indeed, although high-speed services for businesses are already available in major urban centres in Europe and in all major towns, the enormous potential domestic market for image-based services (whether HDTV or other video-services) makes consideration of economies of scale very important. The economies associated with the provision of many services over broad band infrastructures will generate strong pressures for effective inter-operation of different networks. The blurring of distinctions between business and domestic services, asso-

ciated with a growth in teleworking, electronic commerce and telelearning will mean that comparable telecommunications capabilities both in terms of bandwidth and intelligence will need to be provided in business and residential areas.

Services on high-speed connections (increasingly on optical fibre) will dominate telecommunication revenues by 2010. A harmonious European implementation of new services will shorten the payback period on investment in new infrastructures and equipment by about 7 years compared with separate national initiatives. The total investment needed for a European approach would be no greater than that required if any one country proceeded independently.

Our objective is to ensure that users get the maximum benefits in terms of costs and performances from the services made possible by the technological advances. This would increase the confidence of both individual users and business in the services provided Europe-wide. On the other hand, the objective is to foster the creation of the appropriate regulatory environment able to increase the confidence of investors. In that respect inter-operability of the various networks and services and definition of the appropriate standards are the key issues. It is essential that the process to define standards, and therefore the agenda of the standardisation bodies, is streamlined by priority. The setting of priorities should be based on market trends, which are not only to create a much more open environment for services world-wide but are likely to open up larger markets to European firms. A precondition to the latter is, of course, reciprocity to get external markets opened to European businesses. European industrial actors have proved that cooperation in the above sense pays. This has been the case of the success of GSM and the joint trials on ATM and it is follolling the same approach towards the new generation of mobile communications as the new directive on UMTS shows.

The new Treaty: the means to create Trans-European Networks

The new Treaty on European Union bears several important implications which are influencing the telecommunications' area. On top of the political commitment involving a further step towards a European Union, it represents a pragmatic development of policy instruments and an action plan in crucial areas.

Thus, there is an explicit recognition of the role of telecommunications as being instrumental for the realisation of Union objectives. The new concept of citizenship of the Union and the so called four freedoms (movement of people, goods, capitals and services) involve the development of trans-European infrastructures enabling the conveyance of services throughout Europe. Accordingly a new mandate has been laid down in the Treaty aiming at the development of Trans-European Networks.

Specifically it states the following guidelines: "To achieve the objectives stated in Articles 8a (freedom of movement and residence) and 130a (economic and social cohesion), the Community shall contribute to the establishment and development of trans-European networks in the areas of transport, telecommunications and energy infrastructures"; whilst it further makes provision to ensure equity of access as the cohesion policy obliges. "Action by the Community shall aim at promoting the interconnection and inter-operability of national networks... and shall take account in particular of the need to link island, landlocked and peripheral regions with central regions". Some concrete mechanisms are envisaged in order to achieve the above objectives. "The Community shall establish guidelines, priorities and projects of common interest; implementation measures necessary for the inter-operation of networks; may support the financial efforts of Member States for projects of common interest".

Trans-European Information Networks: towards the Global Information Society

Nowadays it is admitted world-wide that information networks are a key to economic development as much as other 'traditional' infrastructures (pipelines, railways, highways, etc.). As we have already seen, the articles in the Treaty on European Union lay down legal provisions to overcome the fragmentation and lack of inter-operability of Trans-European Networks. As a further development, the *White Paper on growth, competitiveness and employment: the challenges and ways forward into the 21st century,* spurred by the initiatives in other regions of the world, and particularly the USA on the so called information superhighways, is proposing an action plan which is placing information networks at the top of the political agenda.

The "White Paper" represents a boost to align the Member States and European Union efforts towards overcoming the obstacles to deploying new information infrastructures and services. It has highlighted the need to mobilise resources and channel endeavours at a European level in a partnership between public and private sectors so as to get a seamless common information space by deploying infrastructures (High Speed Communication Networks) on the basis of ATM (Asynchronous Transfer Mode) technologies, generic services (interactive video, electronic mail, access to information.....), and applications. This represents a kind of a common information and communication space, which is moving to all-digital and multimedia based services.

A high level task force convened following a Council discussion on the "White Paper" reaffirmed the need for those actions, together with a number of policy recommendations deemed as necessary for the emergence of an information society. They concern issues such as de-regulation of telecommunications, regulation of IPR protection for access to knowledge, privacy and security, together with a number of proposed actions for generic services and application areas to start with so as to boost the latent demand for services: teleworking, distance learning, research and university networks, health care, transport, environment, administration networks, among others.

What is worth highlighting is the acknowledgement of the decisive role of market forces in the building of this infrastructure, and in particular, the role that is to be played by the private sector as an enabler of the emergence of the new information and knowledge based economy, which in turn will generate more innovative and dynamic services. The key is not lack of money or technologies, they do exist, but human knowledge and initiative.

I started by asking a major question that I will try to answer here: what do we mean by the information society? It means much more than "superhighways". It will underpin the move from a mass economy to a "niche" economy, it has to bring more flexibility and choice to the individual, and correspondingly, more individual responsibility. This will boost productivity in both manufacturing and services, and in the long run new solutions to old problems, by bringing together demand and supply, problems with solutions, and by doing so,

improve cost-effectiveness, performance and outreach of basic services such as health care, education and training, or transport.

The role of R&D in the development of telecommunications infrastructures and services

Co-operation between industry, telecommunications' organisations and users of new services is essential for the cost-effective development of telecommunications in Europe. One of the best ways of stimulating this co-operation has been through the European Union´s support for research and technology development in multi-annual Framework Programmes.

There was already 10 years ago in the 2nd Framework Programme a chapter devoted to the so called 'enabling technologies' and, in particular, addressing Information and Telecommunications Technologies and their applications. I will analyse their interrelations and their contribution to the development of services, although being aware of the risk of oversimplification of the rich environments created around these actions.

The approach was manifold: whilst ESPRIT (Europe Strategic Programme for Research on Information Technologies) was addressing more basic technologies with a scope ranging from basic research to technology demonstration and technology integration, RACE (Research on Advanced Communications for Europe) was addressing mainly the communication and service infrastructure. The applications programmes such as AIM (Advanced Informatics in Medicine), DELTA (Developing European Learning through Technological Advance) and DRIVE took as their point of departure these technologies in order to build experimental services and to assess the actual feasibility, acceptance and exploitability in the various sectors targeted (health care, education and training, road transport, etc.). From technological feasibility to socio-political feasibility, the various Programmes were designed to complement each other in the future deployment of services and infrastructures.

In the third and fourth Framework Programmes (1990-1998), three programmes are of primary importance for the multimedia and telecommunications field: ESPRIT, RACE and its follow-up ACTS (Advanced Communications Technologies and Services) and the one addressing their application areas (TAP).

The programme of R&D on communications technologies was built on the co-operation started in 1988 under the first phase of the RACE programme, and addressed new avenues of technology development. It is now coming to the completion of its research on Integrated Broadband Communications. This has laid the foundations, both in terms of technology development and standardisation, for the first generation of integrated digital services to evolve in a consistent way throughout the Union. The programme included collaborative research on switching systems, optical communications, network and service management, mobile communications and information security. It also carried out a wide range of experiments and trials of advanced services in real business and commercial environments.

The important role that RACE and ACTS have played in paving the way for the future implementation of broadband communications has been recognised. Nevertheless it is generally agreed that the actual deployment of IBC networks and services will greatly depend on the creation of a consistent, stable and appropriate regulatory environment in which the major investments can be made with confidence. Current developments in the ATM (Asynchronous Transfer Mode) technology environment, such as the ATM trial set up by most European Network Operators, indicate a willingness to keep pre-competitive co-operation until the phase of actual deployment of trans-European commercial services.

ATM pilot map

The Telematics Applications Programme: meeting users' needs

The programme of R&D on Telematic Systems in Areas of General Interest represented a boost for the demand-pull side by addressing applications areas. Based on previous work in various key application domains and some brand-new ones, this programme aimed at ensuring that a common understanding emerges about how new information and communication technologies can best contribute to key economic and social needs of the next century.

New needs for exchanges of information have emerged with the completion of the Single Market in 1992, and a harmonised approach had to be taken to applications of telematics in key areas of social and economic importance in Europe if we were to see a strengthening of socio-economic cohesion in the European Union.

According to the policies discussed earlier, in the new Telematics Programme there is an increase in effort and a broadening of the application areas to be tackled. In this case the use of technologies for meeting essential needs of society is quite in line with the current political agenda of the European Union. This is mirrored by the nearly 900 MECUs budget which was earmarked (1995 - 1998) for research activities in this area.

The new focus of R&D is on the use of the emerging information and communication infrastructure, to convey services particularly in those applications which are going to shape the information society of the future, with the twofold objective of improving competitiveness of industry and employment situation and enhancing the quality of life for citizens, particularly by facilitating equal and universal access to citizens to the information infrastructure. Thus, a wide range of basic policies of the Union are considered, from industrial policy and cohesion, to the more specific ones, such as education and training, research, health care, transport and environment.

RTD in telematics applications is making it possible to establish a closer link between technological progress and the users' needs. It is concentrating efforts on cost-effective solutions driven by the requirements of the users, whose representatives are associated to each stage of the projects, from the needs' assessment up to validation. It addresses primarily advanced applications involving multimedia technologies. The Programme is devoting important resources to the technical validation proposed with a view to define standards and utilisation guidelines enabling intercommunication and interoperation while striving for maximising the generic content of the solutions provided for the various areas. All that is beneficial for the users who are able to get access to a broad variety of services throughout the EU, and for industry and business who benefit from the broadened market outreach. The user focus ensures that users can express their latent demands for services while industry will ensure that services and applications developed are to find a market beyond this research. Thus, exploitation of results comes at the forefront as a key issue in this research.

The impact of this research is considerable, since a successful introduction of telematics services throughout Europe is going to lead to an improvement of the quality of life and working conditions, a new impetus to economic growth which will boost employment - being based on new products and services, consolidation of the Internal Market and, what is more important, strengthening of the economic and social cohesion of the European Union. These considerations have been reinforced by the "White Paper" and in the report which the high level group on the Information Society has produced following the Council mandate.

The application areas tackled encompass most of public interest services, which are essential for the smooth running of the Internal Market and to meeting the new obligations of the Treaty. The fields addressed are all of major political, economic and social importance, such as services for administrations and transport systems, services for improving the quality of life, such as health care, or those for elderly and disabled, urban and rural teleservices and environment. A final cluster of applications defines the future knowledge infrastructure which will enable all Europeans to have at their disposal a repository of available knowledge and information, in the form of a network to access the knowledge pool stocked in libraries, in a common research space, and to lifelong learning facilities whenever and wherever learners will need them, regardless of their location, language or time constraints. In all these areas a new generation of advanced services will be developed and validated with users. All these enable new methods of access, sharing and updating the knowledge.

Research on Networks and Networks for Researchers: *Networking Europe's Brain Power*

Let me examine first the initiatives taken so far to set up networks for researchers in Europe. Integrated within the above programmes, a number of actions were undertaken in order to build up specific network solutions for researchers. The most visible result of this activity was the EuropaNET service, a European multi-protocol backbone operated as a fee based service, which was established as a result of co-operation with the National Research Networks. Now the Commission has placed research networking firmly in the mainstream of its activities. What was once seen as a measure employed to enable research in other areas is now recognised as an action which produces valuable results in its own right.

Programmes such as Human Capital and Mobility contributed, by means of schemes of exchange of researchers and the creation of scientific networks, to the creation of a pan-European research space. But, in our context, the key issue is: what about the networks supporting the daily work of the European researcher? I mean telematics networks making possible the exchange of data, images and access to distributed common facilities, for example. In the information and communications age, the intended European space has to be substantiated as well by telematics networks, as the European research community is called to play a pioneering role as leading-edge users, whilst contributing to move forward the frontier of innovation.
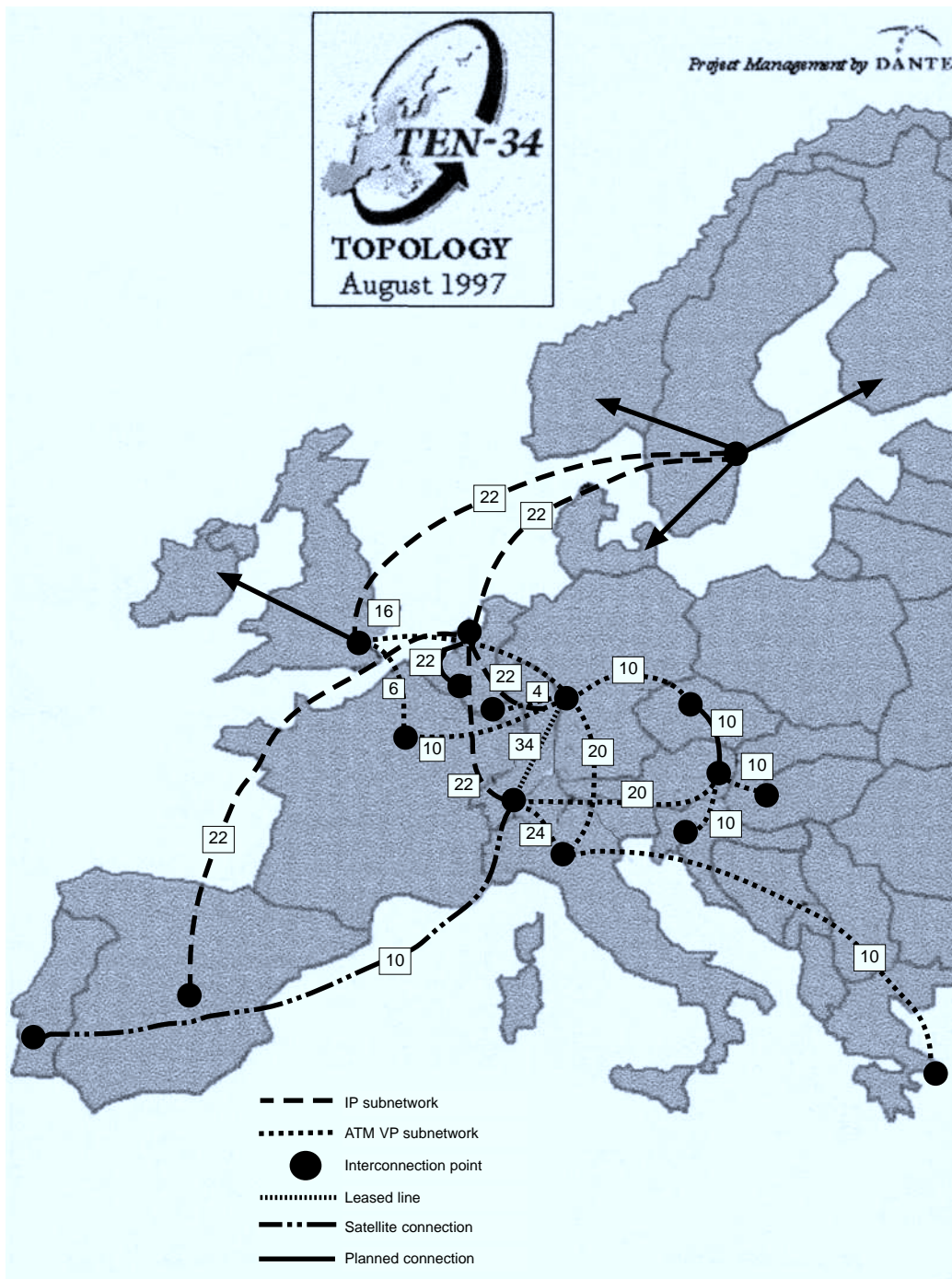
The establishment of telematics networks and services for researchers, undoubtedly increases efficiency, and thus the competitiveness of European research. They reduce the lead-time to the market at a moment when this is extremely critical due to the shortening of the period of obsolescence of any scientific and technological innovation.

In the first place there was a need to enhance the capacity of the current European research networks, which were suffering an increasing traffic demand blocking the development of new advanced services. There are various factors in confluence in this accruing pressure: the move towards multimedia services, for example in synchronous and asynchronous computer mediated communication (multi-media electronic mail, video-conferences and asynchronous group communication); the fast growth of information processing performance; and the global shift to distributed applications stemming from the latter.

The European Union has successfully deployed high speed trans-European networks operating at speeds of 34, to be updated stepwise to 155 megabits per second, to give our researchers the services and platforms planned for or available to their counterparts in other continents. This is making possible the emergence of a plethora of new generic applications. At the same time, we are integrating our research networks into the global information community, by increasing the links which connect the current European networks to the rest of the world, and improving the efficiency with which we use available resources.

In parallel, we are supporting research activities to develop the building blocks of the future "image based" networks. The move toward image and multimedia based networking is increasing enormously the demands on networks. As part of our research programme we are investigating the application of advanced technology in operational conditions. We recognise the great gulf between technology in the laboratory and dependable operational services - services which can support the pilot projects necessary to demonstrate to industry the market potential of technologies.

The Commission, with all these initiatives aims to increase the weight of the participation of European Research in worldwide networks, such as those within Internet. This will increase the influence of the European industry in the definition of strategies and standards for future of research networking. Industry understands, because of previous experience, that leading-edge users as researchers are to play a major role in the testing of advanced networking technologies which will be common place in the near future. Therefore, we need to involve further the industry and counteract the views that telematics networks and applications for researchers have just an academic interest and not an industrial one.

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- - - - IP subnetwork
.... ATM VP subnetwork
● Interconnection point
.... Leased line
-·-·- Satellite connection
——— Planned connection

But this is not done for the sake of having fancy technologies, but to provide services to the researchers' community. Therefore, we are developing advanced applications and validating them with real users, such as the advanced distributed multimedia services that support co-operative research, as much academic as industrial. This involves particularly the development and validation of applications to permit, on the one hand, access to knowledge on the large scientific networks; and on the other hand, co-operative work at a distance, particularly through remote monitoring of experiments, teleworking or video-conferencing in scientific circles. Finally work addresses ways of selecting, searching and presenting scientific information on results of research in progress to make them easily accessible through telematics means to those users who wish to exploit them, so as to cater for the rapid pace needed nowadays for diffusing scientific and technological innovations.

The Educational Multimedia Task Force: towards the Learning Society

Another key element of this knowledge society is education and training. It is broadly admitted that this success of the IS will be heavily based on the skills of the population to be able to benefit from the new opportunities. In fact, the growth of knowledge underpinning the explosive technological development is putting a big challenge to the current education and training systems: people require nowadays lifelong learning, in contrast with the previous once-in-a-life education for the full professional career, whilst changes of job profiles increase further the need to adapt the current on-the-job training systems. There is not only a dramatic increase in the size of the learning demand, but also an important qualitative change: a more flexible approach is required, further adaptation to the learners' needs be they in terms of capacities, previous knowledge, diversity of paces or simply access to quality learning

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regardless of time and distance. This was the rationale to tackle this basic area of the Telematics Applications Programme (Telematics for Knowledge: Education and Training): to ascertain the ways by which the use of new technologies was able to optimise learning benefits in terms of efficiency, lower costs and increasing the supply meeting the above mentioned demand for learning whenever and wherever required and catering for a diversity of learning styles and paces.

A number of experiments were launched so as to cater for the needs of on-the-job training in industry, SME's, home learners, universities, open and distance learning institutions, specialised professionals, etc. Those experiments involved quite a diversity of users, from mobile learners, such as children of fairground or circus workers, to the most sophisticated needs of professionals in microelectronics or metereology. New technological developments enabled innovative applications, such as those based on simulations for virtual science laboratories, multicasting systems based on M-Bone, multimedia conferencing systems for virtual distributed classrooms, etc.

There was a need beyond the above research to co-ordinate with policies and programmes of the EU related to this sector: ESPRIT dealing with developments of new multimedia generic tools, deployment of Trans European Telecommunications Networks (TEN-TELECOM), educational and socio-economic research and what is even more important, the two main Education and Training Programmes of the EU (SOCRATES and Leonardo da Vinci). Combining budgets and, what is more important, constituencies, enabled to put all the above research activities within the mainstream EU policies. A joint workplan was designed and the answer of the actors was extremely encouraging, more han 10000 organisations took part in submitted proposals. There was a clear lesson learnt: many education and training institutions are aware of the need to cooperate Europe-wide to cope with the trend towards specialisation and growing demand. The action is resulting in a number of new networks linking schools, teacher training institutions, educational multimedia designers and producers, industrial training in a diversity of areas. The resulting partnerships involved in the new 46 projecst are to be the forerunners in the implementation of the European learning society.

The future research: integration within the IST Programme

The previous research has contributed to a great extent to a big number of infrastructures, systems and applications which are being exploited Europe-wide. Now looking into the future, there is a clear need to shift emphasis and continue progress towards the IS, taking stock of previous research and bearing on the changing technology and societal environments. The current advances on technologies (information capture, storage and access, processing and transmission) are bringing about a shift from stand alone to networked information and processing. Digitalisation is resulting in the convergence of both technology and media, industries and markets. Stemming from this, a single and integrated programme is about to be launched, what will enable tackling all the issues from an integrated viewpoint: from the essential technologies and infrastructures and the main application areas, such as new services for the citizens, new methods of work and trade, the multimedia contents and tools, to the socio-economic research involved in the effective deployment of those services at large scale. All these topics are to define the key actions of this integrated endeavour.

The above actions will be complemented by "Visionary Research" on future and emerging technologies of a longer term nature, involving particularly high risks, but potentially rewarding by the promise of major breakthroughs; and the support to broadband-based research infrastructures. They will contribute to configure an all encompassing strategic effort which will aggregate endeavours of industry, researchers and users towards the fulfilment of a user-friendly Information Society.

Multimedia Content and Tools: Technologies for Knowledge Access and Transfer

As I am dealing with the knowledge society, I will emphasise the research foreseen in the area of technologies for knowledge access and transfer. Indeed, content is increasingly recognised as a key asset in the global Information Society. Beyond the technical infrastructure and the telecommunications costs, the actual contents populating the infrastructure will be the key acceptance factor by citizens and industry as much as one of the most rapidly growing markets. Europe has an important cultural heritage and patrimony which should bear fruit if properly diffused and harnessed for the Information Society. These are the main reasons to tackle this domain as part of the integrated plan as a key action.

There is still a need to improve the functionality, usability and user-acceptability of digital content, to establish its value for international business and social applications, particularly to promote innovative education and training systems and to enable cultural and language diversity. There is a need to develop and apply new models, methods, technologies, and systems for creating, processing, managing, networking, accessing and exploiting digital content, in its different forms, whether as knowledge, publications or digital objects.

It should be an interdisciplinary endeavour, aiming to exploit the effects of media convergence bringing together traditional content providers like publishers, libraries, museums, educational and cultural institutions, with IST and media industries, SMEs and emerging players from the public and private sector. Some research topics include the development and management of large-scale multimedia resources, systems for IPR and business transactions, and content infrastructures in cross-disciplinary areas, such as statistical databases, geographic information and all kinds of knowledge repositories. New systems based on language technologies able to cater for a multilingual information society are equally an important element at the core of the European requirements for the acceptance and take up.

I will address in further detail the research dealing with the field of education and training because of its crucial role in the knowledge society. The aim is providing the EU with a blueprint for a seamless and cost-effective implementation of advanced technologies for enhancing educational and training systems. Visionary concepts such as virtual universities, the school of the future or the learning organisation providing just-in-time training will come to fruition by experimenting innovative ways of integrating multimedia pedagogic material, and on new approaches to lifelong learning. On the basis of the previous achievements of the TAP and Educational Multimedia Task Force, the actions are to tackle all the issues required for the improvement of learning: the learning processes, the content and services and the access infrastructure.

On the improvement of the learning process: sustainable learning gains will be achieved by better supporting more autonomous and more individualised learning, addressing all the components of a modular instructional management sys-

tem (local learner support, peer learning, remote tutoring, course/curriculum design systems, accreditation systems, knowledge assets management and easy access to learning resources together with new delivery models).

For the development of higher quality learning material three different perspectives are to be considered: the content itself; the embedded pedagogical or didactic approaches; and the adaptability to the learner needs. That means research on new instructional design tools, learner modelling techniques, knowledge modelling and learning ergonomics. The material will range from simple distributed hypermedia to advanced simulation environments such as virtual laboratories.

Providing access to learning resources and services to all learners (e.g. in institutions, on-the-job or at home, including those in remote areas, nomadic or disabled persons) is a key requirement. The development of common platforms will allow full access to services across heterogeneous networks, addressing harmonised identification and retrieval of learning and of other knowledge resources.

From basis research to large scale trials, all the above actions will lead to seamless advanced learning services which will harness the technologies in order to be more efficient and accessible to all learners regardless of their location, language and catering for a broad diversity of needs.

Support to Research Infrastructure

The current implementation of trans-European research networks will be continued in a twofold way:

It will address the *Broadband Interconnection of National Research and Education Networks,* with the objective to facilitate the supply of trans-European broadband interconnections between national research and education networks at capacities and of a quality matching the aggregated need of Europe's academic and industrial researchers and to keep the resulting network at the forefront of the state of the art. This would imply an upgrading of the existing capacity of 34 Mbits/s via 622 Mbits/s to gigabits/s, including the necessary connectivity to third countries. This would allow effective European collaborative research and education activities (including the creation of "virtual laboratories" and "virtual institutes"), enabled by the deployment of state of the art Internet-based applications within the academic and industrial research communities.

It will create *Advanced European Experimental Testbeds* with the objective of integration of leading-edge collaborative research and development, demonstration and take-up activities, from the entire IST Programme, addressing future generations of communication technologies, protocols, services and distributed applications. This experimental interconnection of the testbeds of individual operators, industries, universities and research facilities in Europe (together with necessary connections to third countries) would provide a practical basis for collaborative research efforts (e.g. in photonic networks, service configuration protocols or mobile broadband services). It would also lead to the early availability of the most advanced infrastructure, which would in turn allow for early experiments with advanced applications (e.g. remote high-volume data visualisation, meta-computing or networked immersive virtual reality) requiring very high bandwidth or new services. It would also enable Europe to play a leading role in defining, standardising and validating the next generations of

network protocols (including those for the Internet) and other emerging broadband services. It would contribute to the long-term interoperability and seamlessness of advanced network infrastructures, services and applications.

If at the end of the day there are high speed European links to research centers, they will have to be paid for by the users, by Member States research programmes, European Commission R&TD programmes themselves, and by private leading edge industries dealing with research. We have to show evidence to industry that this is a key sector. Industry will contribute only if there is a clear perception of longer term profits. That is to say that this community represents a wealth of leading-edge users, and a way to penetrate in high technology world markets which have been beyond their reach so far.

Concluding Remarks

Telecommunications are being considered as a key factor to innovation and productivity. Infrastructures based on networks spreading information and knowledge are nowadays well understood as being just as essential as other more "traditional" networks (such as transport or energy). This has been recognised throughout the work of the EU, and even in the new Treaty, with the explicit articles on Trans-European Networks. They address key requirements for the development of the Union, representing substantial market sectors, and provide the potential for a leading-edge market in Telecommunications and Telematics.

Indeed, these technologies cannot be considered in isolation from other policies, they are essential to promote a harmonious development of all the European regions, and in so doing contribute to the implementation of the essential political pillar that cohesion represents. They are at the core of innovation, and hence affect industrial development and competitiveness. They are the life blood of research and education policies, whose benefits are to reach by capillarity to all the European regions and spread beyond the current borders of the Union, because the responsibility of the EU goes beyond them, after the new challenges raised by Eastern Countries, which have transformed radically the European scene.

The dilemma between competition and co-operation should be streamlined. The regulatory framework must be subsidiary to the above principle of universal access. De-regulation of Telecommunications should mean in parallel a re-regulation in standards, accessibility etc. capable to ensure the creation of a supporting infrastructure available Europe-wide, able to convey services which should be accessible to all users whenever and wherever required and in the language they want. This is the real challenge for the accomplishment of the European citizenship we are now targeting. New telecommunications do not respect frontiers and therefore are going to contribute substantially to the building of a Europe based on equal opportunities to access services essential to society. Since information services are to enhance the quality of life of citizens, it should be, in particular, by facilitating equal, universal access to them.

Standards, privacy, copyright protection, trustworthiness of the information provided and security are some of the issues requiring a world-wide dimension. In this global information market place, European industry has a vested interest in ensuring the appropriate IPR protection, the end-to-end compatibility enabling an appropriate access to services provided world-wide which will facilitate the uptake of the information market. Equally, perception of the users of lack of privacy

could be a deterrent to market development. Furthermore, Europe has to play an active role in the deployment of world-wide services, from the standardisation process up to the development of interlinkages to world-wide networks. In this respect, we need to take a more proactive role in these world-wide services, because they contribute as well to open up large markets to European businesses.

There are good reasons for a global co-operation for the setting up of these infrastructures. Firstly because the research challenges are not any longer of a single region of the world, current research is in many fields rather a world-wide effort.

Secondly, because the Knowledge Society is equally a global undertaking. The interlinking of education and research networks at a global scale creates the basis for cooperation on world-wide endeavours, such as the human genome, within what is already coined as the global research village; and to cross-fertilise learning systems by increasing the supply of the highest quality learning. Thirdly, because this information infrastructure represents a major opportunity to industry world-wide as it opens up a world market that is continuously expanding, and undoubtedly the European Union will be one of the forerunners in this undertaking. In the spirit of the new Information Society we should foster and encourage world-wide links.