COST Technical Committee

Telecommunications, Information Science and Technology (TIST)

COST Action 254

Intelligent Processing and Facilities for Communication Terminals

FINAL EVALUATION REPORT
1. OVERVIEW: ACTION IDENTIFICATION DATA
COST ACTION 254: INTELLIGENT PROCESSING AND FACILITIES FOR COMMUNICATION TERMINALS

TCT Recommendation 21 March 1995
CSO Approval
Start date: 17 April 1996
Duration: 4 Years
Extension: -
End date: 16 April 2000

First MC meeting 30 September 1996
Last MC meeting 24 March 2000
Final Report September 2000
Evaluation Report 12 October 2000
TC-TIST Evaluation 19 October 2000

Number of signatories: 15

Signatories and date of signature

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<td>Austria</td>
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<td>United Kingdom</td>
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Institutes of non-COST countries: None

Area: Software and Terminals

Web site: http://cost254.tsc.uc3m.es

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2. TECHNICAL DESCRIPTION AND IMPLEMENTATION

In order to achieve the presented project objectives, project participants have created basic milestones that have been followed throughout the project duration. These basic research steps have included terminal classification, an overview of integration & systems aspects for the terminals, studies on integrated global terminal design, terminal and system modules-related experiments, that all had to be made available to other project participants through scientific and technical publications.

In order to enable efficient work on different topics covered by the COST254 Action Project participants, initially 3 working groups have been established, namely WG.1G dealing with emerging techniques for terminal hardware and software, WG.2G oriented on intelligent aspects of networking and terminals and WG.3A considering the integration of transmission, computing and processing facilities plus user needs at terminals for specific applications. The first mentioned working groups (WG.1G and WG.2G) have represented general objective project activities. The third mentioned working group (WG.3A) was application-oriented.

The activities on the project, as well as common trends in the area have shown strong convergence between working groups WG.1G and WG.2G. After the meeting in Neuchatel, the project organisation has changed towards 2 working groups:

- WG.1G: Emerging Techniques for Terminal Hardware and Software and Distributed Intelligence (Terminal to Terminal, Terminal to Network)
- WG.2A: Integrating Transmission, Computing, Processing and User Needs at Terminals for Specific Applications)

This work has served to develop general guidelines for the conception, design, implementation, and exploitation of terminals to be deployed in future networks, paying attention to the fact that complexity and intelligence have been the main subjects to address in order to achieve useful results.

The cooperation among project participants has based on exchange of scientific results at the workshops, which have regularly been organised by members of the project. The workshops that have been organised at several locations in Europe (see report item 6.2) have again proven to be the most appropriate way of information sharing and exchange. Each organiser of a particular Workshop has organised preparation and publishing of Workshop Proceedings that accumulate the knowledge gained during the project research. The technical value of the meetings and publications is high, however also the social impact of meeting in-person is not to be underestimated.

The Workshops have been opened to non-COST participants covering the topics related to COST254 Action. This way, the workshop organisers have constantly provided an additional source of knowledge to project participants. Additionally, the open policy of project management has led to participant extension throughout the duration of the project.
In addition to proceedings that have been published following the workshops, presenting the main research achievements, some of the results are still planned to be integrated and presented:

• Selected papers will be published in special issue of the journal SIGNAL PROCESSING-EURASIP (see Appendix 2).
• Preparation of a special publication of most important topics in the area of “Intelligent processing and facilities for communication terminals” at Kluwer or AP.

During the duration of the project many prominent researchers and young scientists have met not only to evaluate their work at the meeting but also to continue joined research and prompt information exchange. Such informal exchange of knowledge and materials between project participants working topics of common interest also helped building new communication approaches and technologies. In many cases bilateral agreements have been signed among research institutions and universities that promote common research and study activities. Specific projects that appeared from these lines of work have been coordinated by a Committee for New Projects and a Committee for External Relations.

3. PARTICIPATION AND COORDINATION

3.1 Management Committee

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  Signal Processing Laboratory (LTS)
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  Switzerland

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  Hungary

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  TU Budapest
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  University College Dublin
  Ireland

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  Norway

- Prof. J.D. Legat
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  Belgium

- Prof. M. Moonen
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  Belgium

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  Univ. di Trieste
  Italy

- Prof. K. Skala
  Rudjer Boskovic Institute
  Hypermedia Systems Laboratory
  Croatia

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  Slovac Republic

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  Swiss Federal Institute of Technology Lausanne (EPFL)
  Switzerland
3.2 Participating Institutions

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- Université Catholique de Louvain (Belgium)
- Rudjer Boskovic Institute (Croatia)
- École Nationale Superieure des Telecommunications (France)
- École Polytechnique Fédérale de Lausanne (Switzerland)
- Université de Bordeaux (France)
- National Technical University of Athens (Greece)
- University of Thessaloniki (Greece)
- Technical University of Budapest (Hungary)
- KFKI Research Institute (Hungary)
- University College Dublin (Ireland)
- Università di Firenze (Italy)
- Università di Trieste (Italy)
- SINTEF (Norway)
- Universidade de Algarve (Portugal)
- Universidade de Madeira (Portugal)
- Technical Univ. of Clvj-Napoca (Romania)
- Technical University Kosice (Slovakia)
- University of Ljubljana (Slovenia)
- Universidad Carlos III de Madrid (Spain)
- Universidad de Vigo (Spain)
- Université de Neuchâtel (Switzerland)
3.3 *Meetings of the Management Committee*

- 1\textsuperscript{st} MC meeting, Spain, 1996
- 2\textsuperscript{nd} MC meeting, Budapest, February 6, 1997
- 3\textsuperscript{rd} MC meeting, Toulouse, July 8, 1997
- 4\textsuperscript{th} MC Meeting, L'Aquila, Italy, 5 June 1998
- 5\textsuperscript{th} MC Meeting, Ljubljana, 20 November 1998
- 6\textsuperscript{th} MC Meeting, Neuchâtel, May, 1999
- 7\textsuperscript{th} MC Meeting Bayona – Vigo, September, 1999
- 8\textsuperscript{th} MC Meeting, Neuchâtel, December 1999
- 9\textsuperscript{th} MC Meeting, Bordeaux, March 2000

3.4 *Meetings of the Working Groups*

- Bayona-Vigo, Spain, June 24-26, 1996, (Pre-COST)
- Budapest, Hungary, Feb. 6-7, 1997
- Toulouse, France, July 7-9, 1997
- L'Aquila, Italy, June 5-6, 1998
- Ljubljana, Slovenia, Nov. 18-20, 1998
- Neuchâtel, May 06, 1999
- Bayona – Vigo, September, 1999
- Closing Meeting, Bordeaux, March 2000
3.5 **Short-term scientific missions**

Video compression algorithms for microsystems devices and telesurveillance
- beneficiary: Roberto Costantini, University of Trieste, Italy
- host institution: University of Neuchâtel, Switzerland, contacts: Mr. Michael Ansorge, Prof. Fausto Pellandini

Personalised model for remote education applications
- period: 01. 09. 1998 – 31. 08. 1999, 12 months
- beneficiary: Jasminka Pavasovic, University of Split, Croatia
- host institution: University of Ljubljana, Slovenia, contact: Prof. Jurij F. Tasic

4. **RESULTS**

The goals of the COST254 actions require the very state-of-the-art knowledge from many research areas. The need for efficiency in transmission and access take the communication problem to challenging new approaches in signal processing, network and service management. There exists a need to apply sophisticated, intelligent methods to solve such enormous, multi-sided task.

Although part of the functionality must be distributed along the networks elsewhere than the terminals, as well as in planning and management, many functions inevitably have to be carried out at the user site, requiring both local intelligence, computational power and interaction with the network intelligence.

The main activities were devoted to:

- Intelligent communication technologies and applications, with emphasis on mobile communications;
- Emerging technologies in telecommunications;
- Friendly exchanging through the Net.

The mentioned activities form only a very basic framework, within which several research areas have fulfil each other’s needs and even, potentially, overlap in order to provide best possible results.

Mobile communications present the future of how we will communicate. Modern communication systems are expected to be intelligent. The developments in wireless systems are also crucial for further integration of multimedia applications with mobile systems. Therefore applications and technologies for mobile multimedia communication terminals present an interesting research field. Due to specifics of portable communication terminals new approaches have to be considered. Powerful signal processing methods not only provide high-speed data transfer over wireless, copper or other user access media. The majority of activities have been oriented also to advanced processing of voice, image and video signals.

The research results led to more efficient algorithms and applications for voice recognition, very-low-bit rate voice coding and voice synthesis during the recent years already. In this year, a noticeable advance has been noticed in the area of improved image coding mechanisms, that either enhance standardised transform-based
compression methods or even go further in the direction of object recognition, shape
coding and other bit rate efficient systems.
From image processing point of view new coding and compression techniques are
needed. A part of the research effort was devoted to these problems. Applications of
multimedia approaches in various fields were also investigated. Typical examples are
telemedicine, tele-education, new technologies in security systems, etc.
In addition to image processing sound processing is also of vital importance.
Therefore a special attention was devoted to voice and audio processing. Voice is an
important issue in multimedia applications, development of user-friendly devices, etc.
In the future developments of multimedia systems a major role will also present
speech synthesis and recognition. The communication with the system should not be
limited to a keyboard. Even more, the elimination of the keyboard would result in a
wide variety of different multimedia systems that would truly become mobile.
Some of the most important fields of research in the action were noise reduction,
efficient coding for particular applications, speech recognition and synthesis, etc.
Result of man-machine voice communication for interactive voice servers and robots
were presented.
Network provision and management activities have included both wired and wireless
standards. Since the main communication media still present wireline systems, new
approaches to fast and reliable communications were investigated. With the increased
speeds of communication, new network techniques must be investigated. Research
was devoted to various problems met on a communication channels as well as new
approaches and results were presented. New coming multimedia applications require
transmission rates in gigabits per second. Therefore new approaches must be
developed for efficient utilisation of existing communication links such as twisted
pair and at the same time new technologies were also investigated. Besides to the
transmission problems, efficient techniques for traffic control were also investigated
and results for different xDSL technologies were presented.
Applications for wireline and wireless systems are based on digital signal processing
techniques and algorithms. Research in the areas of synchronisation, noise reduction,
linearisation were also part of research efforts.
An important part of each advanced media terminal certainly represent processing
hardware. To enable real-time multimedia signal processing combined with signal
processing required to provide the network connection, efficient hardware structures
are to be implemented. As part of the presented results, new hardware accelerators for
image processing applications were proposed. Special attention was also devoted to
low-power design, which is an essential attribute for mobile platforms.
For example, digital cameras implemented on a single chip were developed. In
addition, other hardware for mobile and conventional communication systems were
presented. The research has also extensively covered the issues connected with
friendly and secure exchange through the Net. Internet is gaining the importance in
our lives, i.e. work and leisure as a global communication medium, it is becoming the
way of access to materials, goods, services, etc.
One of the main issues connected with Internet is copyright of materials that became
easily accessible. Digital watermarking is a viable solution to the increasing demand
for copyright protection mechanisms for a particular segment of materials that are
copyright protected.
The Net can be also efficiently used for many multimedia applications. New ideas and
approaches in distance learning, information systems were presented all gaining the
advantage of utilization of the Net. One of the important factors in the future
multimedia applications is personalization of devices and services, i.e. matching user needs. Since Internet is becoming a part of our lives it is crucial that handicapped persons could also benefit from this technology. Therefore activities were also oriented to blind and visually impaired users that could benefit from the use of a computer. Services for intelligent media terminals are the most important part of the research; the not only demonstrate the usability of the terminals but also represent a major research challenge. Significant activities have been performed on how to use Intelligent Terminals and Communication Agents for Teleeducation. It is universally recognized that the deployment of the information superhighways will produce drastic changes in the life of advanced societies. In particular, there are electronic commerce, teleworking and teleeducation, as well as a dramatic increase in the volumes and types of entertainment products. While some of the above elements deserve a lot of studies and experiments, the attention for teleeducation is relatively reduced. The above mentioned activities in multimedia and its applications have been the main orientation of the research in the COST project. The participating organizations have recognized the importance and benefits of such friendly cooperation, where new ideas and knowledge are shared between the parties. The results can be studied more in detail referring to the reports and publications listed in the following sections.

5. DISSEMINATION OF RESULTS

5.1 Publications and Reports

- Proceedings of Bayona-Vigo Workshop, Spain, June 24-26, 1996
- Proceedings of Budapest Workshop, Hungary, February, 1997
- Proceedings of Toulouse Workshop, France, July, 1997
- Proceedings of L'Aquila Workshop, Italy, June, 1998
- Proceedings of Ljubljana Workshop, Slovenia, November, 1998
- Proceedings of Neuchâtel Workshop, May, 1999
- Proceedings of Bayona – Vigo Workshop, September, 1999
- Proceedings of Bordeaux Workshop, March, 2000
- Special issue of the journal SIGNAL PROCESSING-EURASIP, in preparation.
- Special publication covering most important topics in the area of “Intelligent processing and facilities for communication terminals” at Kluwer or AP, in preparation.
5.2 Conferences and Workshops

- Bayona-Vigo, Spain, June 24-26, 1996, (Pre-COST)
- Budapest, Hungary, Feb. 6-7, 1997
- Toulouse, France, July 7-9, 1997
- L'Aquila, Italy, June 5-6, 1998
- Ljubljana, Slovenia, Nov. 18-20, 1998
- Neuchâtel, May 06, 1999
- Bayona – Vigo, September, 1999
- Bordeaux, March, 2000

5.3 Web site

URL: http://cost254.tsc.uc3m.es

The main dimensions of the COST 254 action are provided:

- general information about the MoU and guidelines about how to join the action
- list of signatory institutions with a contact e-mail addresses
- objectives and working groups
- links to web sites of COST 254 Workshops
- some links to related sites
- last report presented at the join TCT and MC meeting and other issues
- Chairperson and secretary's addresses

5.4 Scientific and Technical Cooperation

COST 254 participants are actively connected to research and industrial partners on other common European projects (ACTS etc.)

5.5 Transfer of results

First need to be mentioned is the immediate transfer of knowledge to students working at the participating Universities. Other dissemination of results lead to active of COST 254 participants with research and industrial partners on other common European projects (ACTS etc.) The results have been published in internal Workshop Proceedings, as well as at the special session at the EUSIPCO 2000 Conference.
6. **ECONOMIC DIMENSION**

Participating entities per country was estimated as:

* 1 scientist ...................... 60,000 €
* 1/2 technician ................... 20,000 €
* 2 Ph.D. students ............... 50,000 €
* 1/5 secretary ..................... 5,000 €

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135,000 €

The amount for (1995) full costs of all countries together was estimated to 14 x 150,000 = 2,100,000 €/year; i.e. 8,400,000 € for the entire four years that are covered by the action. This was the overall estimated resource requirement of the participating institutions.

The funding received from the EU COST funds were the following:

- 1997 € 45,000
- 1998 € 84,000
- 1999 - 2000 € 30,000 (to start) + € 26,400

In total € 185,400

7. **SELF EVALUATION**

In the opinion of MC, the work on COST254 enables active co-operation between several research groups on different subjects that make a new dimension in the area of modern communication systems. These joint activities lead both to improvement of existing methods in particular research areas as well as to gaining new level of service and knowledge by combining results from several areas of research.

The activities during COST project have, based on active exchange of knowledge, generated some new and challenging aspects of the existing results. The application of new technologies in the rapidly developing communication systems and terminals do not depend only on technologically advanced system fragments but also on efficient system integration. The exchange of knowledge that has been promoted by the COST project has led not only to improvement of the communication subsystems but also helped the contribution partners to be more aware of the technology that complements their research activities.

The knowledge and ideas were successfully exchanged through the workshops that were organised during the project duration. Furthermore, many new contacts were
established leading past, present and future cooperation. The parties that participated in COST 254 project are interested in further joint research activities under a similar project. Even more, new institutions are prepared to join the group.

The participating partners have actively deployed the new knowledge through cooperation with their industrial partners and some more implementation-oriented projects arose based on contacts and knowledge gained throughout the duration of the COST254 project. Despite of these results we feel more partners from the industry should be directly involved in the project for a more active and rapid implementation of challenging theoretical results.

The main difficulties presented the available resources. It is a belief of the MC board that the budget should also provide resources for grants, which would enable researchers to visit other institutions. Participating institutions would greatly benefit from knowledge distributed from distinguished visiting lecturers. It would be of a great benefit if resources for such visits would be available.

8. EVALUATION

8.1 Evaluation panel and evaluation procedures

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- Peter Wintlev-Jensen, European Commission, International Cooperation, IST Programme, DG INF SO F4, Rue de la Loi 200, B-1000 Brussels, Belgium. Tel: + 32 2 299 9320, Fax: + 32 2296 9131, peter.wintlev.jensen@cec.eu.int

Documents made available

MoU (sent to all Evaluation Panel Members in advance)

Final Progress Report (sent to all Evaluation Panel Members in advance)

Minutes of MC Meetings (made available at the meeting):
- 8th MC Meeting, Neuchâtel, December 1999
- 9th MC Meeting, Bordeaux, March 2000

Workshop Proceedings (made available at the meeting):
- Ljubljana, Nov. 18-20, 1998
- Bayona–Vigo, September 6-8, 1999
- Bordeaux, March 23-24, 2000

The Evaluation Panel met in Brussels on 5th October. The Panel Members examined the available documentation, exchanged their views on individual sub-points of point 9, and formulated a draft text for each of the sub-points. The text was then finalised using e-mail communications between Panel Members.
8.2 Results versus objectives

The participants went beyond the original objectives stated in the MoU in order to take into account the advances which were taking place during the implementation of the COST 254 Action. Four years is a long time for this kind of Action without updating the original objectives and putting them in line with new developments in pertinent technologies.

The results achieved by this Action match the objectives at least in their importance and value, if not directly in one-to-one comparison with those defined in the MoU.

8.3 Outcome and achievements

The main outcome of the Action is the creation of a truly heterogeneous community of research groups throughout Europe covering complementary technologies required to conceive and develop new types of multimedia communications terminal equipment and services. The research community has succeeded in accumulating in-depth knowledge and expertise in the areas of:

- Image and video enhancement techniques;
- Efficient, scalable coding of visual information;
- Advanced speech and high-quality audio coding;
- Wired and wireless access technologies;
- Advanced approaches to network and service management;
- User friendly interfacing, including agent-based customised service support;
- Efficient real-time processing platforms

The individual organisations have been involved primarily in basic research in their respective areas, looking for appropriate technologies which may be applied to the terminals of the future. Their achievements are many and well reported at the workshops organised during the Action. The organisations were not oriented to the delivery of specific products within the Action’s timeframe. Nevertheless, there were a few exceptions, such as the development of the micro-cameras.

8.4 Impact of the Action

As already mentioned, the COST254 Action has set up a community of research groups, where each individual partner is a leading expert in its own specific area applicable to new advanced communications terminal technologies. Excellent professional as well as personal relations among group members led to the free exchange of ideas, the use of communications technologies, active participation during workshops and other unofficial contacts. Furthermore, new product-oriented proposals were initiated, for example:

- a combination of advanced multidimensional signal processing methods for image enhancement and compression
• new low-power real time VLSI processing structures and agent-based user access technologies for new personal and professional mobile communication devices.

New initiatives for joint product-oriented activities are expected to follow, not only within the COST framework, but also in other EU-funded programmes or between interested organisations.

### 8.5 European added-value

The bottom-up approach, as encouraged throughout the duration of the Action, has stimulated the partners involved in the Action to open up their research activities and to show that they are really experts at what they have done. The combination of international and national funding created synergies among large research groups across COST as well as opportunities for smart people with no projects to get involved through a common channel. The Action stimulated contacts among leading experts in specific research areas in Europe, not by creating competition among partners, but rather by stimulating joint interdisciplinary research by adding value to their individual efforts.

The official co-operation within the Action was established in two ways, either by regular exchange of knowledge and active participation at Workshops organised by project participants, or by staff mobility, sponsored by COST 254 funding. Beneficiaries of the so-called short-term scientific missions were not only the young researchers themselves, but also the participating research groups, because such co-operation made long lasting contacts among the partners involved. This has the potential to lead to new joint research and development activities among partners in the future.

The project initiated extremely valuable co-operation among leading researchers in the area of modern communications terminal technologies in Europe. Concrete results include the design of specialised real-time architectures for products in the area of multimedia communications terminals and services, and video sensors with embedded processing and compression modules.

### 8.6 Co-ordination and management

Although a change of the Action Chairman took place when the Action was already well under way, the co-ordination and management of the Action was not adversely affected and remained effective until the end of the Action.

The experience gained while running the Action and the development trends in the relevant research domains required certain organisational changes. The Action started with three working groups and later (beginning of 1999) switched to only two. These organisational changes did not create any serious problems.

The main issues which influenced the normal progress of the Action, especially in the last year, were due to uncertain funding of the Action on the part of the Commission. This has lead to delays in reimbursements.
8.7 Dissemination of results

The Action produced a large body of results. The dissemination of results and achievements within the Action groups has been very good, mainly through conferences and workshops. The same cannot be said for the dissemination of results and achievements to the outside world.

To improve the dissemination of results to the outside world it is planned that, in addition to the proceedings published following the workshops, the most important achievements will be integrated and published in:

- Special issue of the journal Signal Processing-EURASIP
- Special publication of the most important topics under the title “Intelligent processing and facilities for communication terminals” by Kluwer or AP.

It should be noted that publishing results a year or more after the completion of the Action might result in a very poor impact on the outside world. Timely publishing is extremely important.

The Action has a web site which should have been used more actively and creatively. For example, a selection of the best papers could have been published on the web site after each workshop. This opportunity was missed by the Action.

The proceedings of the individual workshops are a very valuable source of information on the results and achievements of the Action. Nevertheless, the content of the proceedings should be better organised and papers properly categorised.

The Action should have encouraged participants to prepare some of the more serious workshop/conference papers to be sent for peer review to international primary journals for possible publication. This would have afforded the members of the Action a greater opportunity to promote their ideas and results to a more international audience.

8.8 Strengths and weaknesses

Key Strengths:

- Very large and strong research group in this area in Europe;
- High proportion of involved young researchers;
- Good distribution of specialised knowledge between individual institutions;
- Established mechanism of know-how exchange
- Good technical management of the Action;
- Openness of the Action;

Key Weaknesses:

- Efficiency of dissemination of results to the outside world
• Administrative project management of the Action, problems with on time reporting;
• Unclear transfer of results;
• Different reporting format of individual institutions taking part in the Action;
• Active participation in contributing results to international standards setting bodies;

8.9 Recommendations

The evaluation recommendations are to:

• Continue support for this type of COST action;
• Improve overall dissemination of results and achievements.
• Use web technology more creatively and actively.
• Unify the reporting style and presentation by partners within the action.
• Introduce and foster submission of scientific and technical papers for peer review and their possible publication in international primary journals.
• Ensure results are disseminated to industry through suitable demonstrations, workshops, media events and publicity, etc. (industry showcases, one-day lunch invitations etc.).
• Encourage new actions involving standardisation institutions, service providers, operators, and manufacturers of terminals. Make Europe globally competitive in this area.
• Monitor closely the development of the Internet IPv6 set of protocols, and encourage direct contribution to the further development of IPv6 in order to add some real European advantage in their evolution.
• Connect this kind of Action to the Internet Engineering Task Force (IETF). All big companies are behind the IETF with their research and academic potential. The competitiveness of Europe is at stake and such involvement with the IETF should be sought.

9. TC REMARKS

The project initiated extremely valuable co-operation among leading researchers in the area of modern communications terminal technologies in Europe. Concrete results include the design of specialised real-time architectures for products in the area of multimedia communications terminals and services, and video sensors with embedded processing and compression modules.