Research Programme for Telecommunication Electronics II 2001-2003
EVALUATION REPORT

ACADEMY OF FINLAND

Research Programme for Telecommunication Electronics II 2001-2003

EVALUATION REPORT

Academy of Finland in brief

The Academy's mission is to finance high-quality scientific research, act as a science and science policy expert and strengthen the position of science and research. The Academy's operations cover all scientific disciplines.

The main focus of the Academy's development activities is on improving opportunities for professional careers in research, providing resources and facilities for high-profile research environments and making the best possible use of international opportunities in all fields of research, research funding, and science policy.

The Academy has a number of funding instruments for various purposes.

The Academy's annual research funding amounts to about 200 million euros, which represents some 13 per cent of the Finnish government's total R&D spending.

Each year Academy-funded projects account for some 3,000 researcher-years at universities and research institutes.

The wide range of high-level basic research funded by the Academy generates new knowledge. The Academy of Finland operates within the administrative sector of the Ministry of Education and is funded through the state budget.

For more information on the Academy of Finland, go to www.aka.fi/eng

Kuvailulehti

Tiivistelmä

Suomen Akatemian hallitus päätti kokouksessaan 21.3.2000 käynnistää Tietoliikenne-elektroniikka II -tutkimusohjelman (Telectronics II). Ohjelma ajoittui vuosille 2001-2003 ja se jatkoi tavoitteissaan aiemman tietoliikenne-elektroniikkaohjelman (Telectronics, 1998-2000) viitoittamaa tietä. Telectronics II -ohjelman tarkoituksena oli osaltaan varmistaa Suomen elektroniikan ja tietoliikenteen tutkimuksen taso maailman kärjessä.

Vuonna 2004, kun tutkimusohjelma oli lopuillaan, Suomen Akatemia nimitti kansainvälisen loppuarviointipaneelin arvioimaan Telectronics II -tutkimusohjelman tavoitteiden saavuttamista. Erityisesti paneelia pyydettiin keskittymään seuraaviin asioihin: tutkimusohjelman suunnittelu, tutkimusohjelman toiminta ja saavutukset sekä suositukset Suomen Akatemialle tulevien tutkimusohjelmien suhteen. Tämä raportti sisältää ohjelman loppuarviointipaneelin työn tulokset.

Raportissa tutkimusohjelman suunnittelu todetaan hyväksi. Ohjelmaryhmän kokoonpano oli erinomainen ja sen määrittelemät ohjelman tavoitteet sekä hakemusten arviointi hyvin onnistuneita. Ohjelman tieteelliset tuotokset olivat erinomaisia, mutta ne olisivat saaneet vielä suuremman kansainvälisen näkyvyyden mikäli tutkimusohjelma itse olisi ollut näkyvämpi. Tutkijankoulutus oli menestyksekästä ja sama todetaan innovaatioiden luomisen osalta, vaikka samalla mainitaan tutkijoiden passiivisuus patenttien hakemisen ja teollisen potentiaalin hyödyntämisen suhteen. Kansainvälinen verkottuminen hankkeiden osalta oli hyvää, mutta ohjelman sisäinen verkottuminen vähäistä. Ohjelman koordinaatiotoiminta mainitaan liian vähäiseksi. Kunkin tutkimushankkeen toiminta ja tulokset arvioidaan raportissa erikseen.

Arviointipaneelin keskeisissä suosituksissa toivotaan tutkimusohjelmilta kohdennetumpaa teema-alueiden valintaa, ohjelmaryhmän ja koordinaation roolin korostamista, tutkimustulosten hyödyntämisen edistämistä ja ohjelmien oman identiteetin ja roolin korostamista sekä tämän tutkimusalueen ohjelmilta perustutkimuksellisempaa luonnetta. Telectronics II -tutkimusohjelmalle suositellaan jatkoa aihealueen kansallisen strategisen tärkeyden vuoksi.

Description

Publisher		Date
	Academy of Finland	1 Oct. 2004

Author(s)	Final evaluation panel

Title	Telectronics II programme evaluation report

Abstract	The Board of the Academy of Finland decided on March 21, 2000 to launch a Research Programme for Telecommunications Electronics II (Telectronics II). The programme was carried out during 2001-2003 and was a continuation programme for earlier Telectronics research programme (1998-2000). The goal of Teletronics II was for its part to ensure the high level of the Finnish electronics and telecommunications research among the world's leaders in the field.
	In 2004 when the programme was coming to an end, the Academy of Finland appointed an international evaluation panel to assess the attainment of the objectives set for the programme. The panel was asked to assess the programme as a whole with a special focus on the following issues: planning of the research programme, activities and results of the programme as well as recommendations to the Academy of Finland for future programmes. This publication includes the report of the evaluation panel.
	The panel found the programme planning good and acceptable. The composition of the programme steering group was successful and the programme objectives and project evaluation criteria well defined. The overall quality of the programme research output was impressive, but the panel stressed that the research output would have gained much greater international visibility if the research programme itself would have been more visibile. The programme was successful in supporting research education and training of post-graduates as well as in creating innovations; however, the panel noted a degree of passivity on the part of the programme research community to progress this knowledge generation to patent applications and commercial value. The groups networked effectively with international groups in their respective fields, but the level of networking amongst the projects nationally within the overall programme was disappointingly low. The panel noted that coordination of the programme lacked adequate resources and was insufficient. The activities and research results of each individual project within the programme are commented in this report.
	The key recommendations of the panel stressed the following: a more coherent and synergistic set of research themes, a more well defined mandate and role for the steering group, additional effort and resources to coordination, a distinct identity and role for future programmes, and a stronger basic research base for future programmes in this field. The panel also recommended that because of the strategic importance of the area to Finland, a follow-on project to the Telectronics II programme should be considered.

Key words	telecommunication electronics, basic research, research programmes, evaluation, research funding

Name and number of series	Academy of Finland publication series 2/04

Distributed by	Academy of Finland, POB 99, FI-00501 Helsinki

Published by	Academy of Finland

Place and date of printing	Helsinki 2004

Other information	

Contents

Preface

The Board of the Academy of Finland decided on March 21, 2000 to launch a Research Programme for Telecommunication Electronics II (Telectronics II). The programme was planned to have a budget of 1.68 million euros, on budgetary conditions, and to run during the years 2001-2003. Together with the earlier Telectronics programme, a six-year period of targeted basic research funding for telecommunication electronics area was covered.

In 2004 the programme was drawing to an end and an international evaluation panel was appointed by the Academy of Finland to review the programme. Members of this panel were Professor Gabriel Crean, NMRC – Irelands ICT Research Institute, Cork, Ireland (Chairman of the evaluation panel); Professor Dieter Hogrefe, Institute for Informatics, Georg-August-Universität Göttingen, Göttingen, Germany; and Professor Hannu Tenhunen, Laboratory of Electronics and Computer Systems, Royal Institute of Technology (KTH), Kista, Sweden.

The evaluation panel was asked to address the following aspects:
- Planning of the research programme
- Activities and results of the research programme
- Recommendations for the future

This publication includes the report of the evaluation panel. Documentation of the programme and projects is available on the programme's website at http://www.aka.fi/eng >Research Programmes.

Gabriel Crean, Professor (Chair)
Dieter Hogrefe, Professor
Hannu Tenhunen, Professor

Introduction

Background

The Academy of Finland carried out the first telecommunication electronics research programme (Telectronics I) during the years 1998-2000. The objective of the Telectronics I was to create and support highlevel basic research on scientifically essential and rapidly developing areas of telecommunications and electronics research, by combining research and expertise on different areas. The programme was coordinated together with ETX and TLX technology programmes funded by the National Technology Agency (Tekes) to ensure co-operation between basic and applied research.

"The Finnish electronics and electrical industry, which includes the telecommunication industry, has grown strongly and steadily since the 1970's. Growth during the last ten years has been more than ten percent a year, and during 1999 there was a 25 percent increase over the previous year. In 1999 the production value of the Finnish electronics and electrical industry was already 100 billion marks; the export value of the products of the branch was 65 billion marks. This sum makes up 29 percent of the whole industrial export of our country and surpasses the export of both the paper and metal industries.

Intensive research is characteristic of the electronics and electrical industry. This is reflected in the fact that the research and development costs of the branch were 8.5 billion marks in 1999, 65% of the whole R&D input of Finnish industry. On the average, the R&D costs are about 20% of the refining value in the branch, since rapid development and short life cycles are typical for the products of this area. Ensuring the sufficiency of highlevel research, researchers and other highly educated personnel will be one of the main activities necessary in order to guarantee the positive development of the branch in the future."

The above citation from the Programme Memorandum stated one aim of the Telectronics II programme to ensure high-level research in Finland in the field of electronics and telecommunication with a support to the electronics and electrical industry. Also the evaluation of the Telectronics I research programme – evaluated together with ETX, TLX, and INWITE technology programmes – had indicated the need to set resources to basic research in the area.

EXSITE technology programme funded by Tekes was launched in parallel to the Telectronics II research programme and these two programmes were planned to be carried out in co-operation.

Objectives

The activity of the earlier Telectronics I programme was continued by Telectronics II research programme. Telectronics II was carried out during the years 2001-2003, some of the funding continuing still in 2004. The programme was launched to ensure the high level of the Finnish electronics and telecommunications research among the leaders in the field. The fundamental issue in the national activity of the branch is co-operation between universities, research institutes, and industry.

The international contacts of the Finnish scientific community and the networking of researchers and research groups with specialist centres are ways to create suitably large and efficient research communities. This Academy of Finland research programme concentrated on basic research, but one key target was the applicability of the knowledge obtained.

Organization

The Telectronics II research programme was run and managed by a programme group nominated by the Academy of Finland. The programme group included members from two of Academy's research councils and representatives from Tekes, industry and academia. The programme group was chaired by Director Kari-Pekka Estola from Nokia Research Center (year 2000) and Professor Kari-Jouko Räihä from the University of Tampere (2001-2004). The programme group was partly changed after 2000 and 2003, when the Academy's new research councils were nominated.

The coordination of Telectronics II was carried out during 2001-2002 by Programme Director Dr. Jukka Rantala from Nokia Group, based on a contract between him and the Academy of Finland.

The total funding applied for by 20 research projects proposals submitted in the Telectronics II call in September, 2000 amounted to 7.02 million euros. The applications were evaluated and rated by an international review panel. The selection of the funded projects was done by a subcommittee consisting of members of the Academy of Finland research councils and nominated by the Academy's Board. The total funding granted on January 16, 2001 for six research projects totalled 1.90 million euros. Of these selected six projects four were consortia and two were single projects.

Evaluation Procedure

The evaluation of the Research Programme for Telecommunication Electronics II took place in the meeting of the scientific international evaluation panel held at the Academy of Finland in Helsinki on June 8-9, 2004. In advance of the review, the evaluation panel received the following documentation:

- Programme memorandum
- Original abstracts and granted funding of the research projects (See Appendix 1)
- Scientific final reports of the projects, including publications lists
- Self-evaluation reports by the project directors

In the review meeting the panel heard oral presentations from and interviewed representatives of each of the six research projects. Additionally, the panel met two members, including the chairman, of the steering committee.

The evaluation was based on the above information along-with an additional summary report requested from the Steering Committee (Appendix 2).

The evaluators were asked to consider the questions provided in correspondence from the Academy on May 5, 2004 (Appendix 3).

A programme manager from the Academy of Finland participated in the meeting and supplied additional information and assistance.

Evaluation Report

Background and Programme Planning

The Telectronics II programme was created as a result of international evaluations organised by the Academy of Finland in 1997, 1999 and most recently 2002, which identified the importance of basic research in electronics to Finland and the potential of the Finnish research base. These reports stressed the need for resources to support basic research in the areas of telecommunications and electronics. The Telectronics II programme, which commenced in 2001, built on a successful telecommunications electronics research programme (Telectronics) launched in 1998.

The programme was targeted to increase the knowledge in the main technologies of broadband data transfer and to produce new information to apply for general use. Six research themes were identified and defined by exploratory working groups comprising both academic and industry participants. These were:

- RF circuits used in telecommunications, especially linear amplifiers, RF circuit architectures and broadband interfaces to digital signal processors
- Digital platforms in telecommunications, especially HW architectures, HW-SW codesign and subsystems, and inter and intra chip communication and control issues for IP integration
- System architecture analysis, design and verification
- Security and encryption technologies for telecommunications
- Telecommunication protocols and access techniques
- Demands and possibilities for telecommunications-based business activity chains, which are a result of new telecommunication techniques (e- and m-commerce, for example).

This list represented clearly the national competence and industrial base in Finland. However, it was noted that this list of research themes was very broad in scope making it difficult to have a coherent coordinated programme.

An impressive programme steering committee was formed and it organised the project selection with the assistance of external scientific reviewers. The programme objectives and project evaluation criteria were well defined. The response of the Finnish research community to this opportunity reflected the need for the programme and, from twenty applications received, six excellent projects were selected. These projects mapped to the above themes with the exception of no funded project in security & encryption technologies and e-business. In addition, two of the six projects were strongly related on the topic of signal processing for radio applications. The review panel found this planning process acceptable.

Results and Outcomes

The overall quality of the programme research output was impressive. The research results from the individual projects have been disseminated widely in journals and at international meetings. However, the opportunity to make an even larger

international impact was missed due to the absence of coordination at programme level. Based on the review material, it was evident that the Telectronics II programme was both a strategic and important source of funding for all participating groups.

The consortia pursued the research objectives set forth in their original proposals, demonstrating at the same time flexibility to integrate new ideas into ongoing activities. The review panel view this as positive and suitable for a basic research driven Academy programme. In addition, a key objective of the programme was to foster multidisciplinary high-level basic research. It was noted that each consortium achieved this objective to some degree.

The quality of the publications reported was impressive and judged to be of international calibre. We recognised good interactions within the research groups; however, between research groups there was almost no joint publication activity. This can be attributed to the absence of coordination at programme level. However, it was also noted that research groups received funding from several sources for closely related research activities and that it was difficult to determine the added value provided by the funding of the Telectronics II programme. As a result it was difficult to compare the research output and efficiency from large, well-funded groups and smaller groups. No ranking for individual projects has therefore been given.

The programme has been successful in supporting the research education and training of many postgraduates. The total number of graduates reflects the level of investment in the programme. In addition, a number of new graduate courses and workshops have been created in research themes and specific topics addressed within the projects. It is noted that a number of Master's theses have been funded. The review panel feels that the Academy's goals would be better served by an increased emphasis on doctoral and post-doctoral research.

Significant intellectual property has been generated within the programme and could lead to patent applications. However, the panel noted a degree of passivity on the part of the programme research community to progress this knowledge generation to patent applications and commercial value. In future programmes it is recommended that the Academy should encourage researchers to systematically identify and explore exploitation opportunities. It is further recommended that for future programmes a mechanism be established to enable patenting of the most valuable intellectual property generated, perhaps in collaboration with other funding agencies.

It is the opinion of the panel that the overall result of the programme has been very positive with key programme objectives and selection criteria delivered. However, an increased emphasis on coordination and networking should be encouraged in future programmes.

Networking

The Telectronics II programme has stimulated and strengthened interactions between research groups across Finland, as evidenced by the fact that four of the six

projects funded involved consortia of partners, whilst a fifth involved partners from different institutes within a university. It is also evident that the research groups interact effectively with international groups in their respective fields.

However, the level of networking amongst the projects within the overall programme was disappointingly low. Indeed, only one meeting of the entire programme research community took place, the initial kick-off meeting in 2001. The review panel noted the comment made in a self-assessment form by one of the research project coordinators that the programme structure did not provide any added-value beyond funding.

Coordination

The Telectronics II programme was established with a programme coordinator, a programme steering committee, clear objectives and a robust programme structure. Unfortunately, the programme coordinator, Dr. Jukka Rantala, had to withdraw from this role due to other responsibilities. This post was not subsequently filled. In addition, the programme steering committee has only met a few times, at the kick-off of the programme and again in December 2003 to organise this review. This situation has had an impact on the level of joint activities and networking within the programme. Continuous monitoring of progress within the programme was not evident from the review. The programme as a whole had a low visibility within and external to the Finnish research community. The programme did not develop a distinct identity, and unlike other Academy programmes no dedicated programme website was developed and, project partners did not have a strong association to the programme. Despite the lack of programme level coordination the individual projects produced impressive research results.

Project comments

Future Internet – Traffic Handling and Performance Analysis

Jorma Virtamo (coordinator), Helsinki University of Technology (HUT)
Ilkka Norros, Technical Research Centre of Finland/University of Helsinki (VTT/UH)
Funding: 300,130 euros

> "The project has addressed a number of problems arising in controlling the traffic and providing quality of service in the Internet and in analyzing the performance of the system", cited from the final report abstract.

Evaluators' comments:

- The project had a slow start with activities focused over the last two-year period
- Original project plan not fully followed, based on the needs of the research groups and, as a result, the work was more theoretical than originally planned.
- The new research topic, balanced fairness, appears promising.
- Some of the activities originally planned were performed in other projects with other sources of national funding.

- Within this project it was evident that the networking aspects were directed outward with successful participation in European COST (257 and 279) and EU IST (Euro-NGI-NoE) actions.
- Within the project there were no joint publications between HUT and VTT. There was no clear demonstration of value-added from working together in the same project in the research report or review presentation.
- There was no interaction with other projects within the programme.
- Within the project two Master's thesis were completed and one Ph.D. thesis will be completed this year.
- The reported publication output from this project is not impressive, perhaps due to the slow start of the project research activities.

Blind Signal Separation in Communications Receivers and Antenna Array Systems

Erkki Oja (coordinator), Helsinki University of Technology (HUT) Jyrki Joutsensalo, University of Jyväskylä
Visa Koivunen, Helsinki University of Technology
Funding: 380,697 euros

"In this project blind source separation (BSS) is proposed as an advanced add-on tool in DS-SS communication systems and antenna arrays."

Evaluators' comments:

- The combination of developing new mathematical tools and applied to real world engineering problems (antenna arrays) was appreciated and is a suitable use of Academy funding.
- The publication output is impressive.
- It was clearly evident that an interdisciplinary collaboration was present within the consortium.
- Within this project it was also evident that the researchers networked internationally with successful participation in an EU IST *BLISS* project.
- Arising from the project one Ph.D. thesis has been completed with three Ph.D. theses to be defended next year.
- The project has inspired a number of graduate courses within the project area.
- There was no interaction with other projects within the programme.

Concurrent Design and Fabrication of Integrated Module Board

Jorma Kivilahti (coordinator), Helsinki University of Technology (HUT)
Ilkka Suni, Technical Research Centre of Finland (VTT)
Funding: 360,850 euros

"The project had two major objectives. To interconnect reliably bare Cu-metallised chips and integrated passive components into multilayer flexible and rigid substrates with IMB technology, and to develop new concurrent design and manufacturing approach for producing reliable solderless electronic products."

Evaluators' comments:

- One of the key reported achievements of the project was the study of interfacial stability of multilayer interconnect materials. The review panel note a strong overlap of this topic with a similar project funded within the Research programme for Electronic Materials and Microsystems (1999-2002) involving the same principal investigator (Jorma Kivilahti, HUT).
- The integration of commercial software packages (ANSYS, MATLAB, FLOWTHERM etc.) in an integrated software tool, whilst of considerable interest to industry, perhaps lacks the academic innovation content required for an Academy-funded project.
- The panel note that a follow-on project has been funded with industry participation on the topic of "concurrent design and simulation of power electronic boards" based on the output from this project.
- One Ph.D. thesis has been completed, one will be defended this year with another three Ph.D. theses to be defended next year.
- There are no joint publications between the project consortium partners.
- There was no interaction with other projects within the programme.
- However, it was noted that the researchers networked internationally with successful participation in an EU IST network of excellence project (ELFNET) along-with research collaborations in Japan.

Advanced Radio Channel Identification and Equalization

Timo Laakso (coordinator), Helsinki University of Technology (HUT)
Visa Koivunen, Helsinki University of Technology
Aarne Mämmelä, Technical Research Centre of Finland (VTT)
Funding: 366,803 euros

> "The goal of the project was to develop advanced channel identification and equalization methods for future mobile communication systems and wireless local area networks, and their future extensions."

Evaluators' comments:

- For the research work led by Prof. Koivunen, the panel observed a certain degree of overlap with the work reported in the project "Blind signal separation in communication receivers and antenna array systems".
- The publication output appears impressive. However, we note the absence of any scientific output from the project leader.
- There were no joint papers between the research partners, HUT and VTT.
- It is noted that several of the publications listed in the publication output arising from the project were published in 2001, the year the project commenced.
- Two Ph.D. theses have been produced, one will be defended later this year with a Master's thesis in progress.
- There was no evidence of added value from a research perspective, arising from the project consortium. However, the partners demonstrated good collaboration in jointly organising graduate training courses.

- There was no formal interaction with other project consortia.
- It is noted a new joint follow-up project, AWICS, which has been funded by the Academy.

Development of the Second Generation Delta-sigma Frequency Synthesis Techniques

Juha Kostamovaara, University of Oulu
Funding: 283,532 euros

> "This project has produced knowledge on the improvement of the performance of delta-sigma frequency synthesizers with emphasis on the development of speed-up techniques and reduction of the in-band phase noise and output spur level."

Evaluators' comments:

- The research and publication output is impressive and will have a major impact on the topic area.
- The project has resulted in one Ph.D. thesis and two others will be completed in 2004/05. In addition, two other Ph.D. students have commenced work in the project area.
- A graduate course specifically on this topic has been developed.
- There was no evidence of national or international networking presented in the final project report or review presentation.
- There was no formal interaction with other project consortia within the programme.

On-Chip Communication Architecture for HW/SW Co-design

Jarmo Takala (originally Jukka Saarinen), Tampere University of Technology
Funding: 208,405 euros

> "In this project, future SoC designs are considered; chip interconnection architectures, formal design methodology, and spectral testing methods are developed."

Evaluators' comments:

- The publication output is good. However, there were no joint publications between the two institute partners within the project.
- One Ph.D. thesis has been produced, one is to be defended later and two Master's theses have been completed.
- The research output resulted in two invention notifications but these were not further progressed by the university.
- The researchers networked internationally with successful participation in an Exsite programme and research exchanges with University of California, Berkeley, Boston University, University of Nis in Serbia and KTH, Sweden, which all resulted in joint publications.
- There was no interaction with other projects within the programme.

Recommendations

- It is recommended that in any future programme, a more coherent and synergistic set of research themes and projects should be selected in order to generate added-value from the programme structure.
- It is recommended that a more well defined mandate and role for the steering committee be established in future programmes.
- It is further recommended that in future programmes a programme coordinator be appointed who has the appropriate resources and time available.
- It is recommended that in future programmes additional effort and resources be devoted to coordination and enhancing networking.
- Appropriate review of the research output efficiency will require increased transparency of funding sources.
- In future programmes it is recommended that the Academy should encourage researchers to systematically identify and explore exploitation opportunities.
- It is further recommended that for future programmes a mechanism be established to enable patenting of the most valuable intellectual property generated, perhaps in collaboration with other funding agencies.
- It is recommended that future programmes be designed in such a way that they can build a distinct and international identity.
- It is recommended that any future programme in this area should be more upstream of industry needs or indeed orthogonal to conventional industry needs with scientifically challenging objectives.
- It is recommended that because of the strategic importance of the area to Finland a follow-on project to the Telectronics II programme be considered. This should take into account the renewal of the basic research base reflecting the long-term global industry restructuring in this sector.

APPENDIX 1:
List of projects with granted funding and original abstracts

Future Internet - Traffic Handling and Performance Analysis

Jorma Virtamo (coordinator), Helsinki University of Technology, 194,374 euros
Ilkka Norros, Technical Research Centre of Finland/University of Helsinki, 105,756 euros

The project deals with a thorough study of Internet congestion and ways to ease it. Mathematical models will be utilized to analyze common mechanisms used in data transmission and congestion control. The aim is to gain understanding on the complex dynamics of the system and to improve current congestion control algorithms.

The quality of service in the Internet is based on priorities and different service classes. Mathematical models will be employed to evaluate, from the users' and service providers' point of view, various methods of differentiated services and how they function with different traffic profiles. Also, an algorithm will be developed for an agent that performs the traffic differentiation based on traffic and service class data. In addition, congestion pricing will be studied in the project as it is expected to be an efficient method to influence user behavior.

In some cases, using more efficient transmission methods such as IP multicast can alleviate Internet congestion. In transmission one task will be to establish an end-to-end resource reservation in the network. The main question is to calculate or estimate the probability that such reservation fails. The research focuses on how to calculate the so called blocking probability in the Internet traffic setting.

Blind Signal Separation in Communications Receivers and Antenna Array Systems

Erkki Oja (coordinator), Helsinki University of Technology, 126,899 euros
Jyrki Joutsensalo, University of Jyväskylä, 126,899 euros
Visa Koivunen, Helsinki University of Technology, 126,899 euros

The topic of the proposal is in developing blind signal separation algorithms for communication receivers and antenna array systems. These algorithms stem from the theoretical work on Independent Component Analysis (ICA) and blind MIMO (Multi-Input Multi-Output) deconvolution by the participating groups. The applications include interference cancellation and multi-user detection in spread spectrum communications, blind equalization in EDGE and GSM systems, and space-time receiver structures employing antenna arrays. In general, these techniques allow for improved spectral efficiency and higher capacity with relaxed assumptions. Similar techniques may be applied to biomedical signal processing, image coding, and speech enhancement using microphone arrays.

The research problem has become highly popular in the signal processing, communications and neural networks research communities. Blind methods do not require that the distorting or mixing system, the input signal, or the structure of the sensor array are known in advance. The mixing system can be modelled as Multi-Input Multi-Output communication channel where the mixing can be instantaneous (I-MIMO) or convolutive (FIR-MIMO). Moreover, the MIMO channel may be time varying. Consequently, blind adaptive methods developed in this project are needed for fast and power efficient computational solutions that are feasible in real mobile communication systems.

Concurrent Design and Fabrication of Integrated Module Board

Jorma Kivilahti (coordinator), Helsinki University of Technology, 209,933 euros
Ilkka Suni, Technical Research Centre of Finland, 150,917 euros

Increasing employment of portable electronics will require the most advanced materials and manufacturing technologies; higher performance and reliability at lower cost are becoming ever more crucial. Further, while striving for higher performance we will also encounter more fundamental difficulties, which have to be solved before the integration of microcircuit production technologies and board-level assembly technologies can be combined successfully. Especially, more concurrent design and simulation of electrical, thermal, and mechanical behavior of multilayer structures in various environments are becoming extremely important for the reliability of future portable electronics. Moreover, the IMB technology being developed in the Laboratory of Electronics Production Technology at HUT, requires new procedures for designing and manufacturing of HDI substrates containing embedded IC's and passives. Hence, the first objective of this research proposal is to interconnect reliably bare copper metallized chips with multilayer flexible and rigid substrates with integrated passive components utilizing the IMB technology. This requires comprehensive design and modeling of electrical, thermal, and mechanical performance as well as interfacial compatibility – all at the chip and the module board levels. This can be achieved only by combining all aspects of design and modeling from the very beginning. Consequently, the second objective is to develop new concurrent approach to manufacture reliable solderless electronic products by combining electrical, thermal, and mechanical design and simulation tools and aspects into a one coherent approach.

Advanced Radio Channel Identification and Equalization (ARCHIE)

Timo Laakso (coordinator), Helsinki University of Technology, 244,530 euros
Aarne Mämmelä, Technical Research Centre of Finland, 122,273 euros

The goal of the project is to develop advanced channel identification and equalization methods for future mobile communication systems such as UMTS (WCDMA) and EDGE (8-PSK), and wireless local area networks (WLANs) such as HIPERLAN/2 (ODFM), and their future extensions.

Availability of versatile data services capable of high bit rates is a fundamental requirement in upcoming mobile communication and WLAN systems. Novel receiver algorithms that are robust, efficient to implement, and have close to optimal performance, are crucial in reaching the design goals of the systems. In particular, channel estimation or equalization plays a key role in achieving high data rates and reliable performance. In this project, new channel estimation algorithms are derived. Special attention is paid to finding low-complexity, adaptive and efficient computational structures for channel identification and equalization. One family of algorithms is based on the idea of set membership filtering. Semi-blind receiver algorithms for improving the spectral efficiency by reducing training signals and pilot energy are considered as well. These methods exploit statistical and structural properties of communication signals in identifying both the amplitude and the phase response of the channel. Another important class of algorithms is based on the matched filter bank by which novel linear channel estimator algorithms can be derived for fast fading channels that can be applied in the receiver for example in the form of per-survivor processing (PSP) to improve the performance of the conventional Viterbi equalization algorithm.

Development of the Second Generation Delta-sigma Frequency Synthesis Techniques

Juha Kostamovaara, University of Oulu, 283,532 euros

Frequency synthesizers are used in all modern wireless communications. They form a fundamental part of both transmitters and receivers of radio waves. As new wireless standards develop, they have placed ever-greater demands on the frequency synthesizer component of a radio in order to achieve more information throughput in a given small frequency allocation. This is true of both emerging narrow band transmission schemes such as EDGE, and broadband schemes such as WCDMA or 3GPP, and will likely continue as new standards are set.

One type of advanced frequency synthesizer, a delta-sigma fractional-N synthesizer (1st generation) has been shown to have an outstanding ability to meet the otherwise conflicting requirements for rapid acquisition time, low noise, and extremely fine tunability. These have been investigated and used by various companies. This has resulted in delivering the full promise of delta-sigma fractional-N synthesizers but at some cost. To keep power consumption under control, and advanced BiCMOS process seems to be necessary. This tends to make stand alone chips rather expensive and integration with other CMOS base-band or IF chips less likely.

Another delta-sigma fractional-N synthesizer architecture (2nd generation) has been less widely investigated. It relies on a delta-sigma frequency discriminator. Recently at the University of Oulu, a new delta-sigma frequency discriminator concept has been developed. Analyses shows that a delta-sigma fractional-N synthesizer architecture based on the use of this delta-sigma frequency discriminator has the potential to achieve the same or better performance as the commercial 1.st generation delta-sigma frequency synthesizer chips but at lower power and in a CMOS process. This research project will attempt to verify that potential.

Delta-sigma fractional-N synthesizers of either type also offer an excellent training ground for mixed signal and RF IC design because they combine digital and analogue base band with RF design techniques in the same chip. This can produce graduates intimately familiar with the effects of interactions between the three areas.

On-Chip Communication Architecture for HW/SW Codesign

Jarmo Takala (originally Jukka Saarinen), Tampere University of Technology, 208,405 euros

Currently, the system design of computer architectures is heavily based on the premise that the communication structure between blocks can be described in a very imprecise fashion. However, this can cause severe errors in predicting the performance of the system. In this project, the accumulated knowledge is generalized and applied to the architecture analysis and co-design phases of the design flow.

The enabling technology is the HIBI (Heterogeneous Intellectual Property Block Interconnection) architecture, developed at TUT/DIG. The further development of the HIBI architecture is intended to allow the construction of near-arbitrary interconnection networks and their detailed performance analysis form the architecture level. This, in turn, facilitates the design, analysis, verification, and testing of intellectual property blocks. TH proposed formal approach to HW/SW co-design confirms the usability of this scheme also in the foreseeable future. The results of the project can be considered to alleviate the system-on-chip (SoC) design problem to a noticeable degree.

The objective of this research is to develop on-chip interconnection architectures and methods for future SoC designs. This facilitates the whole SoC design flow. The research project contains three tasks:

Communication Architecture: The objective of this task is to develop modular interconnection architecture, which allows different network topologies in a SoC environment. In addition, the performance of the architecture is to be analyzed.
Formal Design Methodology: The objective of this task is to develop a formal specification and design methodology, which allows an efficient path towards implementation. The emphasis is on library and intellectual property based solutions.

Spectral Testing Methods: The objective of this task is to make libraries consisting of fully testable IPs using spectral testing methods. These methods will be extended and generalized for testing of the produced complete HIBI designs.

APPENDIX 2:
Steering Committee's comments

The Telectronics II programme (2001-2004) was a continuation programme for the Telectronics I programme (1998-2001). It was launched after the successful evaluation of Telectronics I, partly based on the recommendation of the evaluators that investment of research resources in this area should be continued. A goal of Telectronics II was to increase the knowledge in the main technologies of broadband data transfer and to produce new information applicable for general use. Six broad themes were selected as the scope of the programme.

This starting point had a profound effect on how the programme was shaped. Being a follow-up programme, it was natural that Teletronics II was smaller in scale than Telectronics I. One motivation for the programme was that in parallel to Telectronics I, there were two large technology programmes organized by Tekes: TLX and ETX. This was a very large investment in research in this field, and the consequences of the high level of funding being suddenly stopped would have been undesirable.

Thus Telectronics II was very small compared to most other research programmes. Nevertheless, it needed to cover several research themes and produce high-quality basic research. As a consequence the steering group decided to select only a small number of projects (six) but to fund them as fully as possible. Another consequence was that these six projects dealt with very different research themes. There really were not very natural opportunities for co-operation between the projects. This was a deliberate choice by the steering committee.

The selection of projects also reflected the continuation nature of the programme: four of the six projects had, in one form or another, a predecessor in Telectronics I. The fact that most of the projects had already established working modes during Telectronics I led to the decision that no new coordinator was considered necessary after the original coordinator could not continue. It also influenced the very light monitoring of the projects by the steering committee.

In retrospect, the evaluation panel appreciates the high standard of research done in the projects, which seems to indicate that the goals set in choosing the projects were achieved. The lack of co-operation between the projects is not surprising but rather a consequence of the circumstances. Current research programmes and their coordination are very different in size and character, addressing many of the issues raised by the panel.

Our biggest concern is the observation by the panel that in many consortia, there was very little co-operation within the partners forming the consortia (e.g., no joint publications). Here the goals of multidisciplinary research were clearly not reached. Such co-operation takes a long time to establish, but again, since Telectronics II was a follow-up to Telectronics I, it was reasonable to assume that by this time the intra-project co-operation would have worked better. Multidisciplinary research

programmes are now common, and clearly there is a need to develop methods for fostering real co-operation in such projects.

The panel points out the difficulty of evaluating the exact impact of Telectronics II, when research initiatives are supported through several funding instruments. This is a more and more common situation – it probably is more useful to evaluate research groups (considering all funding they receive) on various occasions, and research programmes as a whole but not on a project level.

Finally, it was a pleasure to note that many of the projects were successful in networking internationally.

APPENDIX 3:
Evaluation Panel assignment

Letter from the Academy of Finland to International Evaluation Panel, May 5 2004.

The evaluation of the Research Programme for Telecommunication Electronics II (Telectronics II, 2001-2003)

The international evaluation is conducted by Professor Gabriel Crean (Chair) from NMRC - Irelands ICT Research Institute, Cork, Ireland, Professor Dieter Hogrefe from Institute for Informatics, Georg-August-Universität Göttingen, Göttingen, Germany, and Professor Hannu Tenhunen from Laboratory of Electronics and Computer Systems, Royal Institute of Technology (KTH), Kista, Sweden.

The objective of the evaluation is to estimate to which degree Telectronics II has succeeded I fulfilling the objectives that have been listed in the Programme Memorandum. Of specific interest are the programmatic approach, added value and programme impacts, interdisciplinarity, applicability of research, networking, and dissemination of results.

In the evaluation report, the panel is expected to assess the programme as a whole and reflect especially on the following issues:

1. Planning of the research programme
   a. Preparation of the programme and planning of the contents of the programme ?
   b. Research projects funded and funding decisions in creating the necessary preconditions for the programme ?

2. Activities and results of the research programme
   a. Scientific quality and results ?
   b. How the programme objectives are achieved ?
   c. Added value of the programme ?
   d. Coordination activities and results in relation to resources available ?

3. Recommendations for the future (including the justification for the recommendations)

The Telectronics II programme was created as a result of international evaluations organised by the Academy of Finland in 1997, 1999 and most recently in 2002, which identified the importance of basic research in electronics to Finland and the potential of the Finnish research base. The programme was targeted to increase knowledge in the main technologies of broadband data transfer and to produce new information to apply for general use.

This report of the international evaluation panel addresses aspects such as the planning of Telectronics II as well as the activities and results of the programme. It also includes recommendations for the future.