



Editorial Board:

Mats Aspñäs | Christel Donner | Monika Eklund
Ulrika Gustafsson | Timo Järvi | Nina Kivinen

Turku Centre for Computer Science Annual Report 2004

TURKU CENTRE *for* COMPUTER SCIENCE

TUCS General Publication
No 38, May 2005



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Annual Report 2004

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Foreword

TUCS was started in March 1994 and it has published annual reports since year 1996. The form of the report was changed last time to cope with the increasing amount of information. Although the volume is still extensive we want to record the achievements in TUCS for later recollection.

TUCS celebrated its 10th anniversary and year 2004 was successful also in its customary functions. During the year we have tried to find a solution to the future funding problem as the Ministry of Education has begun to discontinue the Information Industry program earlier than was supposed. TUCS cut down its budget for year 2004 and started to downsize some of its operations. As a whole this has not yet showed up in the results of TUCS but within a couple of years new decisions must be made.

I thank the present staff of TUCS, which form the editorial board of this report, for fast and professional work. Also the officers of the departments have gathered information for the publication, which is gratefully acknowledged.

Turku March 18, 2005

Timo Järvi

Acting director

1 TUCS in Brief

Turku Centre for Computer Science (TUCS) is a joint research and education centre between the University of Turku, Åbo Akademi University, and the Turku School of Economics and Business Administration.

TUCS coordinates research and education in the field of Information Technology. The activities are carried out in the TUCS Master's and Graduate schools, and in the centre's own research laboratories. The main areas of research are algorithmics, bio-informatics, communication systems, discrete mathematics, embedded systems, information systems, mathematical modelling, microelectronics and software engineering.

1.1 The Development of TUCS

TUCS was started in March 1994 in cooperation between the three universities mentioned above. The purpose was to combine the research, the advanced level teaching and the doctoral education of the participating departments into a joint research centre, with a Graduate School as a central component. TUCS Graduate School (TUCS GS) was the first one to start in Finland. The graduate school model was considered very successful by the Ministry of Education, and in the next two years altogether 93 graduate schools were formed in Finland, in all areas of science.

During the years 1995 – 1999 TUCS was selected as a Centre of Excellence in research by the Academy of Finland. This was recognition of the strong research carried out by the research groups at TUCS. Especially the research group of Prof. Arto Salomaa in formal languages and cryptology at the University of Turku and the research group of Prof. Ralph-Johan Back in programming methodology at the Åbo Akademi University were mentioned.

In 1998, TUCS assumed the role of the local coordinating organ for a large national expansion program, with the goal of increasing the intake to the education programmes in Computer Science and Electronic Engineering in the Finnish universities by 1000 students annually. For the departments taking part in the cooperation within TUCS, this meant that the total annual student intake increased from 180 to over 300 during the years 1998 – 2000. The main part of the expansion was directed to the programme in Computer Science and Engineering, leading to a Master's of Science in Technology. The expansion program also included a four-year programme for professional upgrading, with a student intake of over 200 per year. The expansion resulted in a considerable change in the organization of TUCS, since its responsibilities were extended also to cover coordination of basic education. The Ministry of Education, together with the cities and municipalities in the Turku region, financed the program.

In 2000, the discipline Electronics and Telecommunications Technology, which belonged to the Department of Applied Physics at the University of Turku, joined TUCS. Electronics and Telecommunication was actively involved in the education programme in Computer Science and Engineering, which was carried out in co-operation between Åbo Akademi University and the University of Turku.

The Department of Information Technology at the University of Turku was formed in the beginning of 2002 by combining the discipline Computer Science, which formerly belonged to the Department of Mathematical Sciences, and the discipline Electronics and Telecommunication Technology, which formerly was part of the Department of Applied Physics. The discipline mathematics, which belonged to the Department of Mathematical Sciences, formed an own department, the Department of Mathematics.

The Centre for Reliable Software Technology, CREST, was formed in 2002. CREST is a research centre within Åbo Akademi University and TUCS and consists of four research laboratories or groups: Distributed Systems, Embedded Systems, Mechanized Reasoning and Software Construction. CREST is a Centre of Excellence for Formal Methods in Programming, appointed by the Academy of Finland.

1.2 Premises

TUCS premises are presently in DataCity (5th floor), which is situated in the Turku Science Park area. The Department of Information Technology (University of Turku), the Department of Computer Science and the Department of Information Systems (Åbo Akademi) are all located in the same building. Also Turku School of Economics and Business Administration has a small research unit in the Datacity building. The Department of Mathematics (University of Turku) and Turku School of Economics and Business Administration are located at about 10 minutes walking distance.

TUCS takes part in coordinating and planning the new building in which most of the departments participating in TUCS will be located. The planning of the new ICT-building started in 2003 and it will be ready in the summer of 2006. The construction work on the new building begun in March 2004. TUCS, the Department of Information Technology (University of Turku), the Department of Computer Science (Åbo Akademi), the Department of Information Systems (Åbo Akademi), telecommunications and electronic commerce (Turku Polytechnic), and Turku Science Park will move to the new building.

2 Year 2004

This section gives a short overview of the most important events at TUCS in the year 2004.

2.1 Conferences

The departments belonging to TUCS have arranged the following conferences during the year 2004:

- The Joint Finnish-Italian Workshop on Information Systems (FIWIS 2004) was organized by the Turku School of Economics and Business Administration, June 13, 2004.
- The 12th European Conference on Information Systems (ECIS 2004) was organized by the Turku School of Economics and Business Administration June 14 – 16, 2004.
- The 31st International Colloquium on Automata, Languages and Programming (ICALP'04) was organized by the Department of Mathematics, University of Turku and Turku Centre for Computer Science July 12-16, 2004.
- The 19th Annual IEEE Symposium on Logic in Computer Science (LICS'04) was organized by the Department of Mathematics, University of Turku and TUCS July 13th - 17th, 2004.
- The 11th Nordic Workshop on Programming and Software Development Tools and Techniques (NWPER'2004) was organized by The Centre for Reliable Software Technology (CREST) August 17-19, 2004.
- The 2nd Nordic Workshop on UML, Modeling, Methods and Tools (NWUML'2004) organized by The Centre for Reliable Software Technology (CREST) August 19-20, 2004.

2.2 Thesis awards

Mika Hirvensalo from the Department of Mathematics at the University of Turku was awarded the Rolf Nevanlinna prize for best Mathematics thesis in Finland 2003 for his doctoral thesis “Studies on Boolean Functions Related to Quantum Computing”.

The same thesis also received the prize for the best doctoral thesis in Computer Science, by the Research Foundation of the Finnish Society for Computer Science (Tietotekniikan Tutkimussäätiö).

2.3 University of Turku obtained the right to grant degrees in technology

Starting from August 2004, the University of Turku obtained the right to grant Master of Science and Doctoral degrees in Technology. The first Ph.D. Tech. degree from the University of Turku was granted in October 2004 to TUCS student Seppo Virtanen for his thesis "A Framework for Rapid Design and Evaluation of Protocol Processors".

2.4 New visual expression

In the spring 2004, TUCS took into use a new visual expression, including a new logotype and a set of graphical recommendations for published material. The layouts of publications in TUCS' series as well as the layout of the web pages were renewed to conform to the new visual expression.

2.5 10th Anniversary celebration

Turku Centre for Computer Science celebrated its 10th anniversary on September 22 by arranging an anniversary seminar followed by a dinner for about 100 invited guests. As part of the celebrations, a Studia Generalia series with presentations by researchers in TUCS was also arranged during the autumn. The presentations were open for the public to attend and were grouped into the following four themes:

September 22: DNA computing

- Academician Arto Salomaa: *DNA computing: Used for 10 years*

October 20: Software Quality

- Academy Professor Ralph-Johan Back: *Incremental software construction*
- Professor Markku Nurminen: *Extracting benefit from the information system*

November 17: New Models of Computation

- Doctor Mika Hirvensalo, TY: *Comparing classical and quantum information*
- Doctor Ion Petre, ÅA: *Computing on a nano-scale*

December 15: Digital TV

- KTT Tarja Meristö, ÅA: *Digital Futures 2013 - alternative scenarios for digital television and mass communication in Finland*
- Director Ari Ikonen, Nokia NVO: *TV broadcasting to mobile phones*

3 Organization

The education and research activities at TUCS are carried out within the Master's and Graduate Schools and the Research Laboratories. Decisions are primarily made in the TUCS board, while planning and execution is carried out in the workgroups, the Graduate School Committee and the Advisory Committee. By the end of 2004 there were about 35 professors, 50 Ph.D. level researchers and 95 doctoral students at TUCS.

3.1 The Director, the Vice-director, and the TUCS Board

The board is the organ with the highest authority in TUCS. The director and the vice-director of TUCS are responsible to the board. They are also responsible for the activities carried out within TUCS. During 2004, Prof. Timo Järvi (University of Turku, Dept. of Information Technology) acted as director, and Prof. Kaisa Sere (Åbo Akademi University, Dept. of Computer Science) was the vice-director until November 18th, 2004. Prof. Jan Westerholm acted as the vice-director from November 30th, 2004.

TUCS board consists of professors from the participating departments, students and a representative from the local IT enterprises. The board has the following members (deputy members in brackets) for the period January 1st, 2003 – December 31st, 2005:

- Chairman: Prof. Ralph-Johan Back, Åbo Akademi University, Dept. of Computer Science (Prof. Jan Westerholm until November 18th, 2004)
- Vice-chairman: Prof. Reima Suomi, Turku School of Economics and Business Administration, Inst. of Information Systems Science (Prof. Hannu Salmela)
- Prof. Christer Carlsson, Åbo Akademi University, Inst. for Advanced Management Systems Research (Prof. Pirkko Walden)
- CEO Jaakko Kuosmanen, ICT Turku Oy (CEO Tarmo Hahto, Business to Business Mediat Oy)
- Prof. Jouni Isoaho, University of Turku, Dept. of Information Technology (Lecturer Risto Punkkinen)
- Prof. Juhani Karhumäki, University of Turku, Dept. of Mathematics (Prof. Mats Gyllenberg)
- Prof. Tapio Salakoski, University of Turku, Dept. of Information Technology (Prof. Markku Nurminen)
- Prof. Kaisa Sere until November 18th, 2004, Åbo Akademi University, Dept. of Computer Science (Prof. Johan Lilius)
- Prof. Jan Westerholm from November 19th, 2004, Åbo Akademi University, Dept. of Computer Science (Prof. Johan Lilius)

- Doctoral Student Paula Steinby, University of Turku (Doctoral Student Eugen Czeizler)
- Master's Student Henry Lönnbäck, Åbo Akademi University (Master's Student Jaana Nylund)
- Master's Student Niko Railo until March 16th, 2004, Turku School of Economics and Business Administration (Master's Student Tarja Viskari)
- Master's Student Hannu-Pekka Kulta from March 17th, 2004, Turku School of Economics and Business Administration (Master's Student Tarja Viskari)

3.2 Advisory Committee

TUCS advisory committee (TUCS AC) is an expert body consisting of representatives from the industrial and economic sectors within the field of Information Technology, the public sector and the universities. The advisory committee arranges four meetings per year, and its main task is to increase cooperation between TUCS and its external partners. At this moment, the advisory committee consists of 24 members appointed for the period 1.6.2003-31.5.2006. TUCS Board may appoint new members during the period. The members of the Advisory Committee are listed below:

- Tarmo Hahto, Business to Business Mediat Oy, Chairman of the Advisory Committee
- Teemu Hovi, TeliaSonera, Vice Chairman of the Advisory Committee
- Jaakko Astola, Tampere University of Technology
- Roger Broo, Åbo Akademi University
- Kari Bäckman, B & B Solutions Oy
- Osmo Eerola, Elcoteq Design Center
- Jouko Häyrynen, ICT Business Development
- Ari Ikonen, Nokia (NVO)
- Juha Immonen, Siemens Oy
- Jaakko Kuosmanen, ICT Turku Oy
- Reino Kurki-Suonio, Tampere University of Technology
- Riitta Lahesmaa, Centre of Biotechnology
- Armas Lahoniitty, The City of Turku
- Hannu Lehtinen, Ericsson
- Harri Lönnberg, The University of Turku
- Olli Mertanen, Turku Polytechnic
- Jukka Mäki, Tekes / V-S TE-keskus
- Jorma Nieminen, Benefon Oyj
- Tim Olin, Kuulalaakeri Oy
- Matti Rasila, The City of Salo
- Tapio Reponen, Turku School of Economics and Business Administration
- Ilkka Ritakallio, Teleste Oyj
- Arto Salomaa, University of Turku, Department of Mathematics, TUCS
- Juho Savo, Regional Council of Southwest Finland (Varsinais-Suomen Liitto)

3.3 Master's School Workgroup

The Master's School workgroup handles most of the questions related to the Master's School. The main responsibilities are the coordination and planning of the joint activities for the programmes, as well as the application procedure. The Master's School workgroup consists of representatives from the departments, faculties and other units involved with the Master's School activities. The workgroup is headed by Prof. Jan Westerholm.

3.4 Educational Workgroups

The administrative work at TUCS is partly organized through workgroups. There are three educational workgroups whose preliminary task is to coordinate the advanced level studies in their field: The Computer Engineering workgroup, the Computer Science workgroup and the Information Systems workgroup. The educational workgroups consist of teachers and professors from the participating departments, student representatives and administrative staff. The workgroups each arrange 2-4 meetings per year.

3.5 Graduate School Committee

The Graduate School committee handles most of the questions regarding TUCS GS. The main responsibilities are the handling of study reports, the evaluation of applicants and decision making about principles concerning the supervision of students. The members of the Graduate School committee are professors (and supervisors) from the participating departments. The Committee is headed by Prof. Juhani Karhumäki.

3.6 Research Laboratories

Research at TUCS is organized into research laboratories and centres, which may consist of several laboratories. There are currently 16 research laboratories and two centres within TUCS.

The research laboratories are independent and choose their own research topics. The laboratories are organized around one to three professors and, in addition to these, consist of senior researchers, postdoctoral researchers, doctoral students and Master students. A research laboratory may be shared between more than one university (or department).

3.7 Research Centres

3.7.1 Centre for Reliable Software (CREST)

The Centre for Reliable Software (CREST) is a research centre within Åbo Akademi University and TUCS, and it consists of four research groups: Distributed Systems, Embedded Systems, Mechanised Reasoning, and Software Construction. For the years 2002-2007 the CREST research groups have been nominated by the Academy of Finland as a Centre of Excellence for Formal Methods in Programming.

The mission of CREST is to develop, verify, and validate techniques to build and maintain reliable software systems. Typical research topics in CREST are software models and software development models to construct reliable software, theoretical frameworks to check and ensure correctness requirements of software, tools to support these frameworks, applications in which they test and develop these models and frameworks.

3.7.2 Institute for Advanced Management Systems Research (IAMSR)

The Institute for Advanced Management Systems Research (IAMSR) is a research institute within Åbo Akademi University and TUCS. IAMSR is carrying out theory-driven and applied research in approximate reasoning and fuzzy logic, real options, self-organizing maps and neural nets, interdependent multiple criteria optimization, software agents, mobile and electronic commerce methods and technology, industry foresight methods, scenario technologies, knowledge based support systems and hyper knowledge.

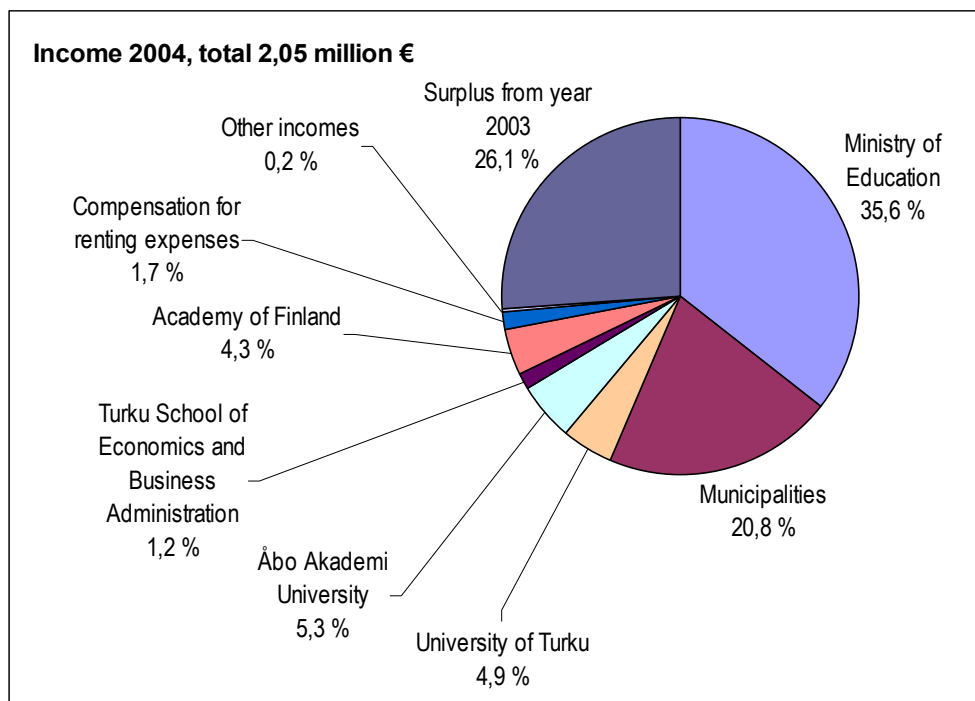
4 Financing

The activities of TUCS are mainly funded by the Ministry of Education, the Academy of Finland, the municipalities and the three universities of Turku: University of Turku, Åbo Akademi University and the Turku School of Economics and Business Administration.

The total income for year 2004 was 2.05 million euros (including the surplus from 2003). The Ministry of Education financed 28 Ph.D. student positions and the Academy of Finland financed two postdoctoral researcher positions. The Academy of Finland also supported TUCS with 21.000 euros for researcher training courses (TUCS short courses) and for Ph.D. students' conference trips. The appropriation from the Ministry of Education added up to 36 % of the total funding and the appropriation from the Academy of Finland up to 4 %.

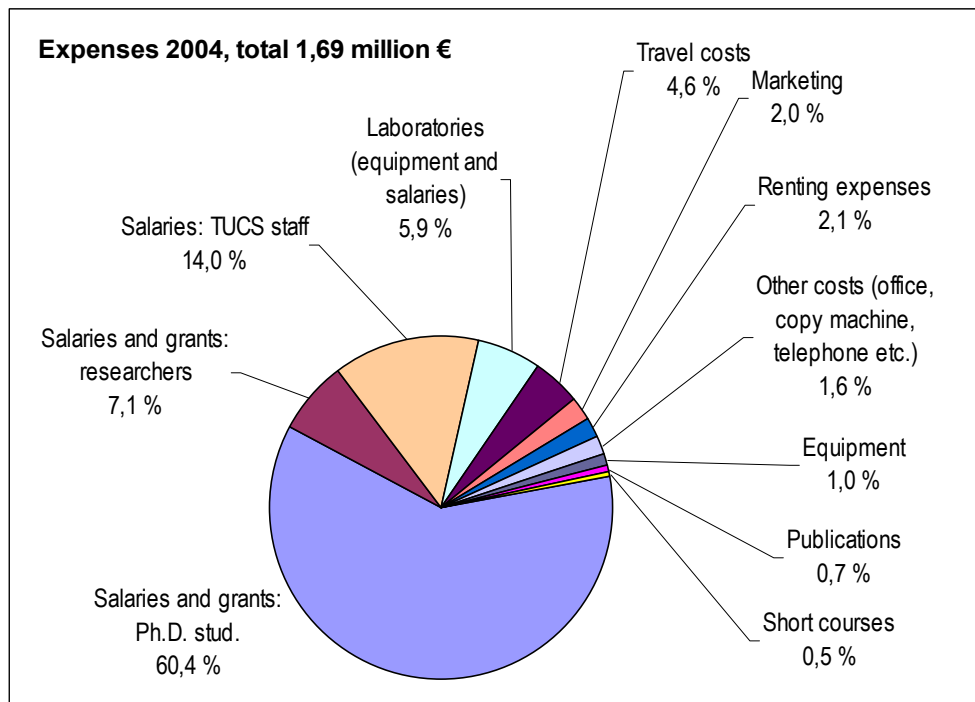
The appropriation from the municipalities was 425.000 euros or 21 % of the total funding. The participating municipalities were Turku, Salo, Raisio, Kaarina, Naantali, Lieto and Uusikaupunki. The universities (University of Turku, Åbo Akademi University and the Turku School of Economics and Business Administration) supported TUCS with a total of 232.600 euros, which added up to 11 % of the total income.

The surplus from year 2003 formed a substantial part of the total funding, a total of 26 %. The relative large surplus is planned to be used during 2005 and 2006.



Ph.D. students, Post Doc researchers and TUCS Staff) form a significant part, 81 %, of the total expenses. The TUCS laboratories used 6 % of the total, mostly for equipment and salary costs, and 5 % was used on conference participation and other travel costs. The rest of the expenses consist of marketing, renting expenses, publications, short courses and other office costs.

The surplus at the end of 2004 was around 356.000 euros.



5 Research

During 2004 there were 16 independent research laboratories and two centres within TUCS. The laboratories are involved in specific research projects, which are most often financed by the Academy of Finland (basic research), TEKES (industrial applied research), EU or directly by industry. The laboratories provide supervision for both doctoral and Master's students, they are responsible for teaching advanced level courses within their own specific research area and they may also offer post-doctoral positions.

5.1 Independent Laboratories

5.1.1 Algorithmics Laboratory

The Algorithmics Laboratory has 23 members: five professors, three senior researchers and 15 doctoral students. The laboratory is part of the department of Information Technology. In 2004 the laboratory received external funding for a total amount of 120.000 euros.

Laboratory Leaders:

Professor Risto Lahdelma (industrial algorithms, embedded systems)

Professor Olli Nevalainen (industrial algorithms, data analysis)

Professors:

Timo Knuutila (industrial algorithms, logic programming)

Ville Leppänen (programs, software)

Jukka Teuhola (data mining)

5.1.1.1 Background and Mission

The Algorithmics Laboratory has been organized to support the research on design and analysis of efficient algorithms. Our mission is to develop efficient algorithms for Finnish industry. Our research covers both theory and applications. While many of the interesting problems are hard to solve to optimality, practical solutions can often be found by novel problem solving techniques relying on combinatorial optimization, parallelization, and heuristic and approximative techniques.

The laboratory has been formed around the research activity of five senior researchers in the field. This increases the coverage of the broad topic. Recently, advanced programming and software techniques along with research on computer games have become active research topics besides core algorithmics.

5.1.1.2 Research

The research can be divided into the following areas:

Industrial Algorithmics

The laboratory works currently in co-operation with Valor Finland, Kone, Teleste and Process Vision. Production control problems of electronics industry have been solved during the last 16 years. The main goal is to develop efficient methods for the assembly of printed circuit boards with automated placement machines. The tools in use include the whole spectrum of algorithmic techniques ranging from 0/1-programming and constraint logic programming to heuristics.

A wide spectrum of industrial control, planning and decision-making problems can be solved using stochastic modelling, analysis and optimization techniques. Applications range from off-line systems for supporting strategic decision-making to on-line systems relying on embedded algorithms.

Data Analysis and Signal Processing

The group works in co-operation with numerous research laboratories, including the Turku Centre for Biotechnology, the Department of Pathology, the Department of Plant Physiology, and the Department of Medical Physiology, all at the University of Turku.

Methodologies for biological arrays have been developed, e.g. micro-array, and 2-D differential display and MS/MS- spectrometry. The group has participated in several research projects concerning the gene level data analysis of diseases (breast cancer, colon cancer, diabetes, asthma).

Data Mining

The group has developed algorithms for discovering frequent patterns from quantitative relational data sets and for solving the discretization of quantitative domains. The algorithms have been generalized to fuzzy intervals of attribute values.

Parallel Processing

During the year we have studied distributed shared memory implementation influenced routing problems. Focus has been on writing a survey on thinning protocols.

Software Techniques

The group has continued studying methods to improve software quality by introducing OO mechanisms that can be used to guarantee object integrity.

Computer Games and Graphics

The group has worked and published papers on the algorithmic and networking problems present in computer games. The two main foci have been reducing the effect of network limitations in multiplayer games and solving real-time decision-making problems. In computer graphics, the main results are related to fast computation of shadows and visibility in a 3D space.

String Algorithms

The group has developed fast algorithms for finding the longest common subsequence of strings, which is a fundamental task in many applications that need to measure the similarity of sequences.

5.1.1.3 Future goals

The research laboratory is following the modern trends in algorithmics. Previous research has concentrated on fast and powerful heuristics. Recent increase of computer power has enabled exact algorithms even for problems of practical size. Development of approximation algorithms for hard problems is also one of the new directions in the field. Among near future goals is also to study mobile and distributed software related issues, like game applications, security issues, and component techniques. The laboratory follows up-to-date programming and software techniques.

5.1.1.4 Selected Publications

During 2004 the laboratory published 43 publications (2 doctoral theses, 1 chapter in book, 7 articles in journals, 19 articles in conference proceedings, and 14 technical reports).

Attila Gyenesei. Discovering Frequent Fuzzy Patterns in Relations of Quantitative Attributes. PhD thesis, 2004.

Juha Kivijärvi. Optimization Methods for Clustering. PhD thesis, Feb 2004.

Juha Kivijärvi, Joonas Lehtinen and Olli Nevalainen. A Parallel Genetic Algorithm for Clustering. In Recent Advances in Simulated Evolution and Learning. Kay Chen Tan, Meng Hiot Lim, Xin Yao, Lipo Wang, editors. , Advances in Natural Computation - Vol. 2, World Scientific, Aug 2004.

Jukka Arvo, Mika Hirvikorpi and Joonas Tyystjärvi. Approximate Soft Shadows Using an Image-Space Flood-Fill Algorithm. Computer Graphics Forum, 23(3):271-280, 2004.

Marius C. Codrea, Esa Tyystjärvi, Martin vandeVen, Roland Valcke and Olli S. Nevalainen. Classifying Apples by the Means of Fluorescence Imaging. International Journal of Pattern Recognition and Artificial Intelligence (IJPRAI), 18(2):157-174, Mar 2004.

Timo Knuutila, Mika Hirvikorpi, Mika Johnsson and Olli Nevalainen. Grouping PCB Assembly Jobs with Feeders of Several Types. Journal of Flexible Manufacturing Systems, 16(2), Apr 2004.

Jukka Arvo and Jan Westerholm. Hardware-Accelerated Soft Shadows Using Penumbra Quads. Journal of WSCG, 12(1):11-18, 2004.

Attila Gyenesei and Jukka Teuhola. Multidimensional Fuzzy Partitioning of Attribute Ranges for Mining Quantitative Data. International Journal of Intelligent Systems, 19(11):1111-1126, Nov 2004.

Jukka Arvo and Timo Aila. Optimized Shadow Mapping Using the Stencil Buffer. Journal of Graphics Tools, 8(3):31-40, 2004.

5.1.2 Bioinformatics Laboratory

There are altogether some 15 members of the Bioinformatics Laboratory: one professor, four senior researchers and some ten doctoral students. The group is working at the department of Information Technology. In 2004 the laboratory got external funding from Tekes and industry in excess of 300.000 euros.

Laboratory Leader:

Professor Tapio Salakoski

5.1.2.1 Background and Mission

The laboratory was established in 2000 as a joint initiative of TUCS and the Turku Centre for Biotechnology. The laboratory conducts and organizes interdisciplinary research and education in the field of bioinformatics.

5.1.2.2 Research

Current research projects include the development of bioinformatics databases, tools, and analysis methods for gaining better insight into cellular signaling and metabolic networks; text mining of scientific literature for information extraction about protein-protein interactions; data modeling for the improvement of rule-based speech synthesis; and the design and implementation of mobile services based on existing bioinformatics resources on the Internet. The main collaborators include Turku Centre for Biotechnology; Department of Biochemistry and Pharmacy, Åbo Akademi University; Institute of Medical Technology, University of Tampere; and Karolinska Institutet, Stockholm. Recently, the laboratory has been active in establishing the Language Technology Cluster, a national initiative coordinated by the laboratory in collaboration with the TUCS Communication Systems laboratory and Phonetics laboratory at University of Turku. In addition to the academic collaborators, most of the current projects include several industrial partners, both software and pharmaceutical companies. A majority of the research is conducted on external funding.

5.1.2.3 Future Goals

A main goal is to establish the current bioinformatics education by launching a new Master's Degree programme in 2006. The current good level of external research funding is sustained and increased further. Collaboration with other academic and industrial parties will have a high priority also in the future.

5.1.2.4 Selected Publications

Filip Ginter, Jorma Boberg, Jouni Järvinen and Tapio Salakoski. New Techniques for Disambiguation in Natural Language and Their Application to Biological Text. *Journal of Machine Learning Research*, 5:605-621, 2004.

Filip Ginter, Tapio Pahikkala, Sampo Pyysalo, Jorma Boberg, Jouni Järvinen and Tapio Salakoski. Extracting Protein-Protein Interaction Sentences by Applying Rough Set Data Analysis. In *Proceedings of the Fourth International Conference on Rough Sets and Current Trends in Computing (RSCTC 2004)*, 2004.

Sampo Pyysalo, Filip Ginter, Tapio Pahikkala, Jeppe Koivula, Jorma Boberg, Jouni Järvinen and Tapio Salakoski. Analysis of Link Grammar on Biomedical Dependency Corpus Targeted at Protein-Protein Interactions. In *Proceedings of the International Workshop on Natural Language Processing in Biomedicine and its Applications (JNLPBA)*, 2004.

Filip Ginter, Sampo Pyysalo, Jorma Boberg, Jouni Järvinen and Tapio Salakoski. Ontology-Based Feature Transformations: A Data-Driven Approach. In *Advances in Natural Language Processing. Proceedings of the 4th International Conference EsTAL 2004*.

5.1.3 Biomathematics Laboratory

There are altogether 12 members of the Biomathematics Laboratory: one professor, five senior researchers and six doctoral students. The laboratory is part of the department of Mathematics.

Laboratory Leader:

Professor Mats Gyllenberg

5.1.3.1 Background and Mission

Mathematical modelling has become increasingly important in many branches of biology. The dynamical consequences of even quite simple ecological interactions or physiological mechanisms are impossible to understand without mathematical modelling and analysis. Evolutionary biology relies on modelling to study phenomena that may take too long time to be directly observable. The rapidly developing techniques of molecular biology and genetics produce a large amount of data, which need efficient computer algorithms to be handled. The classification and automatic identification of micro-organisms using molecular sequence data are tasks that need sophisticated mathematical models and computer algorithms to be successful.

5.1.3.2 Research Projects and Future Goals

Adaptive dynamics

The theory of adaptive dynamics provides a framework for modelling evolution by natural selection in complex ecological systems. Adaptive dynamics originated from integrating and extending concepts and techniques from evolutionary game theory are proved to be very successful in more than 50 applications to various ecological settings. Contrary to the essentially static view of evolutionary game theory, adaptive dynamics puts special emphasis on dynamical phenomena, such as the origin and divergence of new species (or within-species diversity) by evolutionary branching, or evolution to extinction. Currently, intense research is devoted to developing its mathematical foundation so that the range of applications significantly increases. Key foreign collaborators are Ulf Dieckmann (IIASA, Austria), Hans Metz (Leiden, the Netherlands) and Mikko Heino (Bergen, Norway).

Adaptive dynamics in metapopulations

In general, a metapopulation is a population of local populations living in discrete habitat patches. Metapopulation models have a great potential of application to many types of biological systems. We have focused on the evolution of dispersal and of ecological specialisation. There are many ecological mechanisms which make dispersal advantageous, such as kin competition, risk spreading and fluctuating environments. However, dispersal often requires extra energy, which cannot be used for reproduction. Dispersal can also increase mortality risks. Also for an individual, which has specialized to the local environment, dispersing to a different environment is not beneficial. For a generalist individual, who performs reasonably well in all local environments, the benefit of dispersing is quite different. It is clear that these two life-history traits have a strong effect on the benefit of the other. However, there is only a very limited amount of research done about the co-evolution of dispersal and local adaptation, which is one target of the project. This work is needed in order to understand the dispersal and adaptation behaviour of different species observed in the nature. Key foreign collaborators are Martijn Egas (Amsterdam, the Netherlands) and Geza Mesz ena (Budapest, Hungary).

Coexistence and evolution in plant-endophyte systems

Endophytes are fungi, which live in the tissues of agriculturally important grasses. By producing toxins, endophytes make the host plant inedible to cows and other vertebrate grazers, and therefore they appear to be symbionts. However, the occurrence of endophytes is strongly variable in natural populations, which hints at possible costs and disadvantages of the infection. In a joint project with Dr. Kari Saikkonen (MTT Agrifood Research Finland), we develop models to understand (i) the dynamics of endophyte infection within an individual plant and (ii) the dynamics of infection in structured plant populations.

Respiratory data analysis with applications to sleep-disordered breathing

The objective of the research is to combine experimental studies with mathematical modelling and data mining to analyze the operation of the human respiratory control system. A particular aim is to investigate the dynamic behaviour of the system during transition from wakefulness to sleep and the perturbations underlying the development of sleep-disordered breathing (SDB). Data mining tools are of clinical importance in patient monitoring and decision supporting systems. Mathematical modeling aims at describing the key mechanisms underlying the experimental observations both in healthy subjects and in patients with SDB. Such models provide, for instance, a test bench to predict the effective treatment for each patient. The key national collaborators are Prof. Olli Nevalainen (University of Turku), and Prof. Olli Polo (Tampere University Hospital). The project benefits from the data and expertise of Prof. Ramon Farr e and Josep M. Montserrat (University of Barcelona).

Computational molecular biology and bioinformatics

External Funding: Academy of Finland (52 850 €)

As the new high-throughput molecular assessment techniques produce large amounts of noisy data, both at the mRNA and protein level, efficient utilization of these techniques requires powerful computational data analysis. Our particular aim is to clarify T helper cell differentiation by identifying genes involved in early polarization of Th2 cells and by exploring their hierarchy, regulation and causal roles in this process. Bioinformatics protocols developed cover a wide range of laboratory technologies, including differential display, oligonucleotide and cDNA microarrays, two-dimensional electrophoresis, and isotope-coded affinity tag (ICAT) techniques. In computational molecular biology, modeling and simulation studies will provide basis for better strategies in developing diagnostics and therapies for diseases such as asthma and type I diabetes. This is a joint project with Prof. Riitta Lahesmaa (Turku Centre for Biotechnology), Prof. Timo Koski (Linköping University), and Dos. Matej Orešič (VTT Biotechnology).

Protein-ligand interactions: rules for molecular recognition from mathematical modelling of protein structural data

Protein molecules in living organisms function in their three-dimensional state by recognition of other molecules, called ligands. The specific recognition of ligands requires a rough geometrical match between the surfaces of the protein and ligand molecules. However, the chemical complementarity, or fit, between the binding site and the ligand is the most important factor enabling highly specific recognition of ligand molecules. The chemical fit involves many weak non-covalent interactions at the atomic level of the molecules, such as hydrogen bonding and hydrophobic interactions. Moreover, the protein atoms and the ligand atoms can form cohesive networks of interactions so that several atoms from several sites simultaneously contribute to a molecular interaction. Consequently, it is of major importance to characterize and predict molecular interactions with mathematical models. This is a joint project with ÅA Department of Biochemistry and Pharmacy and the Department of Mathematics of Linköping University.

5.1.3.3 Selected Publications

During 2004 the laboratory published 21 publications including 12 articles in journals, 3 chapters in international refereed compilation works, one Ph.D. thesis, one book and 4 technical reports.

- V. Ahola, T. Aittokallio, E. Uusipaikka and M. Vihinen. Statistical methods for identifying conserved residues in multiple sequence alignment *Statistical Applications in Genetics and Molecular Biology*, Vol. 3, pp. 1-28. (2004)
- S.A.H. Geritz and É. Kisdi. On the mechanistic underpinning of discrete-time population models with complex dynamics *J. theor. Biol.*, vol. 228, pp. 261-269. (2004)
- M. Gyllenberg and Yi Wang. Dynamics of the periodic type-K competitive Kolmogorov systems *J. Differential Equations*, vol. 205, pp. 50-76. (2004)

- É. Kisdi. Conditional dispersal under kin competition: Extension of the Hamilton-May model to brood size-dependent dispersal. *Theor. Pop. Biol.*, vol. 66, pp. 369-380. (2004)
- S. Liu, L. Chen and R. Agarwal. Harmless and profitless delays in the discrete Lotka-Volterra systems. *Applicable Analysis*, vol. 83(4), pp. 411-431. (2004)
- Kalle Parvinen and Martijn Egas. Dispersal and the Evolution of Specialisation in a Two-Habitat Type Metapopulation. *Theoretical Population Biology*, 66(3):233-248, Nov 2004.
- Kalle Parvinen. Adaptive Responses to Landscape Disturbances: Theory. In *Evolutionary Conservation Biology*. Regis Ferriere, Ulf Dieckmann, and Denis Couvet, editors. , Cambridge Studies in Adaptive Dynamics, chapter 14, pages 265-283. Cambridge University Press, 2004.
- Heikki Ruskeepää. *Mathematica Navigator: Mathematics, Statistics, and Graphics* (Second Edition) Elsevier, 844 pages, ISBN 0-12-603642-X (2004)
- Jori M. Soukka, Arho Virkki, Pekka E. Hänninen and Juhani T. Soini. Optimization of Multi-Photon Event Discrimination Levels Using Poisson Statistics. *Optics Express*, 12(1):84-89, Dec 2004.
- P. Yan and J. Jiang. Periodic solutions of general autonomous system of Lienard Type. *Applicable Analysis* 83(7), pp. 735-746. (2004)

5.1.4 Communication Systems Laboratory

There are altogether 25 members of the Communication Laboratory: 3 professors, 5 senior researchers (post doc) and 17 doctoral students. The laboratory is part of the department of Information Technology. In 2004 the laboratory got external funding from industry and Tekes (115.003 euros), the European Union (48.667 euros), Academy of Finland (34.000) and other external parties (56.183 euros).

Laboratory Leader:

Professor Jouni Isoaho

Professors:

Valery Ipatov

Juha Plosila

5.1.4.1 Background and Mission

The laboratory is responsible for teaching and research of communication systems and digital systems. The target is to develop key enabling technology and competence needed for designing and implementing broadband digital communication and computation systems today and in the future. This includes integration of wireless and wired communication infrastructures with dynamic system implementation techniques and platforms. System design methodologies cover both functional and physical design and modelling issues. Research and teaching activities are deeply integrated. Also, the laboratory has taken a active role in co-operation and network-

ing within its key areas. There the target is to create strong consortiums to provide long-term and fundamental co-operation with strongest ICT centres round the world within these key areas. Currently, key co-operation partners are Tampere University of Technology and the Royal Institute of Technology, Sweden.

5.1.4.2 Research

In research activities the laboratory has focused on three main issues:

Future communication concepts, systems and applications

- advanced techniques for air interface design for broadband communication
- interactive communication system techniques in hybrid networks, e.g. interaction and roaming between different network techniques
- main system applications: language technology and digital audio
- seamless applications in hybrid networks, e.g. all-IP and DVB related issues
- application sharing in complex networking systems, e.g. functional partition
- user interfaces: speech technology and multimodality in general

System implementation platforms and design methodologies for digital communication and computation systems

- asynchronous system and component techniques in communication platform design
- physical performance and noise modelling of communication platforms
- functional and physical systems specification techniques and refinement

Nano systems design and implementation techniques

- dynamically reconfigurable error-tolerant array based implementation platforms
- dynamic system design approach for cell array platforms
- concurrent reconfigurable modular communication systems

In topic 1 we are building our profile in communication systems covering the overall infrastructure from content provider to end-user in hybrid networks. In this work we integrate our multidisciplinary University and our partners within TUCS towards common goals to build up enablers needed for extensive use of digital media. In communication system concept studies we use several different perspectives in addition to technical aspects e.g. business models, regulation aspects and human behaviour. In topic 2 we are researching key issues needed to design and implement communication platforms using DSM VLSI technologies. These issues cover functional and physical design methodological issues needed to ensure correct functionality of very complex digital systems. In functional system design issues we are doing active co-operation with Distributed systems laboratory at Åbo Akademi University. In physical system design issues we are co-operating Electronics and computer systems at the Royal Institute of Technology. In Communication platform development we are co-operating actively with Tampere University of Technology. To solve problems relating to future NoC design research and education we are building strong European consortium (UTU, KTH, TUT, TTU, DTU, SLI, WUT,

TUD, CTI and IMAG). Together with TUCS Microelectronics laboratory we are actively building new partnerships towards China and central Europe in Nano systems design.

Activities in topics 1 and 2 are strategically headed towards current systems, standards and technologies while in topic 3 these issues are integrated when targeting future nano scale technologies. Research issues in topic 3 cover communication algorithms, system design methodology and implementation platforms needed when implementing digital communication and computation systems in nano or organic technologies. Topics 2 and 3 are covering in principle the same topic, but having different time-scales. Therefore main focus and research issues are also clearly different. In topic 3 the principal target is to develop algorithms, design methodologies and system platforms coherently towards future application needs and implementation technologies. The communication systems laboratory at the University of Turku is the only research unit in Finland, which is coherently approaching problems 2 and 3.

Ongoing projects:

- Communication Platform Architectures for Gigascale Integration (COMPLAIN) TEKES, 2001 – 2004
- System-on-Chip for Mobile Internet (SoC-Mobinet) IST, EU, 2001 – 2004
- Dynamic Parallel Radio Structures for Cell Array Platform (ArrayRadio) Academy of Finland, (TULE) Future electronics research programme, 2004 – 2006
- New Methods in Speech Technology (PUMS), TEKES, Fenix – Interactive computing programme, 2003 – 2007 (coordinator)
- Advanced Version of Embedded Core (AVEC), TEKES, 2004 – 2006

5.1.4.3 Future Goals

The current operative strategy is concentrated on balancing financial structure and establishing strategically important multidisciplinary research and educational cooperation needed for the critical mass. As the focus area two is currently on a nice growing phase, the key technical focus in the construction work is on building up overall competence needed for the focus areas one and three. The future goal is to be among world top laboratories in research and teaching in the all three focus areas presented.

5.1.4.4 Selected Publications

During 2004 the laboratory published 28 publications (one edited book, 6 articles in journals, 5 book-chapters, 8 articles in conference proceedings, and 8 technical reports or other publications).

Nurmi, J., Tenhunen, H., Isoaho, J. & Jantsch, A. (editors) 2004: Interconnect-Centric Design for Advanced SoC and NoC. 453 pages.

Avessta, N. & Aboulnasr, T. 2004: Combined regressor methods and adaptive IIR filtering. IEEE Transactions on Circuits and Systems, 51(11): 2222–2234.

- Avessta, N. & Aboulnasr, T. 2004: Maximum entropy Kalman filter for image reconstruction and compression. *Journal of Electronic Imaging*, 13(4): 738–755.
- Ipatov, V. 2004: On the Karystinos-Pados bounds and optimal binary DS-CDMA signature ensembles. *IEEE Communication Letters*, 8(2): 81–83.
- Liljeberg, P., Plosila, J. & Isoaho, J. 2004: Self-Timed Communication Platform for Implementing High-Performance Systems-on-Chip. *Elsevier VLSI Journal of Integration*, special issue on Networks on Chip and Reconfigurable Fabrics. 38(1): 43-67.
- Plosila, J., Sere, K. & Waldén, M. 2004: Asynchronous system synthesis. *Science of Computer Programming*.
- Alaranta, M., Valtonen, T. & Isoaho, J. 2004: Software for the Changing E-Business – Towards a More Rapid and Flexible Development Life Cycle, in *Digital Communities in a Networked Society: eCommerce, eGovernment and eBusiness* (M. Mendes, R. Suomi and C. Passos ed.) Chapter 9, pp 103-118.
- Plosila, J., Seceleanu, T. & Sere, K. 2004: Formal communication modeling and refinement. In Jouni Isoaho, Axel Jantsch, Jari Nurmi, Hannu Tenhunen, editor, *Interconnect-Centric Design for Advanced SoC and NoC*, chapter 12, pages 315–340.
- Liljeberg, P., Tuominen, J., Tuuna, S., Plosila, J. & Isoaho, J. 2004: Self-timed approach for noise reduction NoC. In *Interconnect-Centric Design for Advanced SOC and NOC*, chapter 11.
- Ahonen, T., Virtanen, S., Kylliäinen, J., Truscan, D., Sigüenza-Tortosa, D., Paakkulainen, J., Ristimäki, T., Kasanko, T., Nurmi, T., Isännäinen, H., Saastamoinen, I., Lilius, J., Nurmi, J. & Isoaho, J. 2004: A brunch from the coffee table - case study in NoC platform design. In J. Isoaho, J. Nurmi, H. Tenhunen and A. Jantsch, editors, *Interconnect-centric Design for Advanced SoC and NoC*, chapter 16, pp. 425-453.

5.1.5 Discrete Mathematics for Information Technology Laboratory

There are altogether 35 members of the Discrete Mathematics for Information Technology Laboratory: two emeritus professors, three professors, eight senior researchers, five younger researchers, and 17 doctoral students. The laboratory is part of the department of Mathematics. In 2004 the laboratory got external funding from the Academy of Finland for a total amount of 312.900 euros.

Laboratory Leader:

Professor Juhani Karhumäki

Emeritus Professors:

Academician Arto Salomaa

Aimo Tietäväinen

Professors:

Magnus Steinby

Jarkko Kari

5.1.5.1 Background and Mission

The laboratory continues the research traditions of the Department of Mathematics at the University of Turku. The two research groups are Automata Theory and Coding Theory groups. In addition a more applied group searching for connections to high tech industry works on cryptography and coding theory. Recently a clear emphasis has been on combinatorics on words. Our research is, and has always been, strongly internationally oriented.

5.1.5.2 Research

The research done by the automata theory group is basic research on automata theory, combinatorics on words and models of computing. More concretely, the actively studied problems are e.g. tilings of the plane, decidability questions in automata and words, combinatorial problems on words, such as periodicity and dimension properties, and quantum computing. Problems related to DNA, especially from the point of view of computing, are also topics of the group. The research topics in coding theory include space-time codes, sequences and identifying codes.

The research is mainly supported by the Academy of Finland. The group had three academy researchers and three post doc researchers in 2004. In addition, the research is supported by three projects: Words, Automata and Computing (1.1.2004-31.12.2007), Coding Theory and Combinatorics (1.8.2002-31.12.2005), and Finite Automata in Digital Image Processing (1.1.2003-31.12.2006). The group organized the prestigious ICALP04 (The 31st International Colloquium on Automata, Languages and Programming) as a part of ICALP-LICS event, which constituted besides these two conferences of eleven focused workshops, one dedicated to the 70th birthday of Academician Arto Salomaa. The event was an unbelievable success. The total number of participants was more than 430, and in ICALP alone there were 380 submissions – clearly the highest number ever. There will be two special issues of Theoretical Computer Science containing selected papers of ICALP. The Gödel Prize 2004 was delivered in the ICALP meeting.

In 2004 two Ph.D. theses were completed. The laboratory also received the best Ph.D. thesis awards both in Mathematics (Nevalinna Prize) and Computer Science in 2004.

5.1.5.3 Future Goal

The high level basic research will be the main goal also in the future. In 2005 we will have three foreign post doc researchers, one from Russia, one from China and one from Czech Republic, supported mainly by the Academy of Finland. The laboratory will be more structured and focused partially to new research directions like new models of computing and problems in self assembly.

5.1.5.4 Selected Publications

During 2004 the laboratory published 101 publications (three books, five edited books, 29 articles in journals, sixteen chapters in books, eleven articles in conference proceedings, two Ph.D. Thesis, and 27 technical reports).

- J. Berstel, J. Karhumäki and D. Perrin (guest editors), Special Issue on Combinatorics on Words with Applications, *International Journal of Foundations of Computer Science* 15, pp. 223-383, 2004.
- J. Berstel and J. Karhumäki, Combinatorics on Words - A tutorial, in: Current Trends in Theoretical Computer Science. The Challenge of the New Century, Gh. Paun, G. Rozenberg, A. Salomaa (Eds), *World Scientific, Singapore*, pp. 415-476, 2004.
- V. Blondel, J. Cassaigne and J. Karhumäki, Freeness of multiplicative matrix semi-groups, in V. Blondel and A. Megretski (Eds), Unsolved Problems in Mathematical System and Control Theory, *Princeton University Press* (Princeton, New Jersey), pp. 309-314, 2004.
- J. Diaz, J. Karhumäki, A. Lepistö and D. Sannella (Eds), Proceedings of the 31st International Colloquium on Automata, Languages and Programming, *Springer Lecture Notes in Computer Science* 3142, 1523 pp., 2004.
- J. Karhumäki, H. Maurer, Gh. Paun and G. Rozenberg (Eds), Theory is Forever, Essays Dedicated to Arto Salomaa on the Occasion of His 70th Birthday, *Springer Lecture Notes in Computer Science* 3113, 283 pp., 2004.
- J. Karhumäki and J. Shallit, Polynomial versus exponential growth in repetition free binary words, *Journal of Combinatorial Theory A* 105, pp. 335-347, 2004.
- A. Ehrenfeucht, T. Harju, I. Petre, D. M. Prescott and G. Rozenberg, Computation in Living Cells. Gene Assembly in Ciliates, *Springer-Verlag*, 201 pp., 2004.
- V. Halava and T. Harju, Undecidability in matrices over Laurent polynomials, *Adv. Applied Math.* 33, pp. 747-752, 2004.
- T. Harju and J. Karhumäki, Many aspects of the defect effect, *Theoretical Computer Science* 324 (1), pp. 35-54, 2004.
- T. Harju and D. Nowotka, Periodicity and unbordered words: A proof of Duval's Conjecture, (STACS'04) *Lecture Notes in Computer Science* 2996, pp. 294-304, 2004.
- T. Harju and D. Nowotka, Border correlation of binary words, *Journal of Combinatorial Theory A* 108, pp. 331-341, 2004.
- I. Honkala, An optimal robust identifying code in the triangular lattice, *Annals of Combinatorics* 8, pp. 303-323, 2004.
- I. Honkala and T. Laihonen, On identification in the triangular grid, *Journal of Combinatorial Theory B* 91, pp. 67-86, 2004.
- J. Honkala, Bounds for the D0L language equivalence problem, *Information and Computation* 190, pp. 70-80, 2004.

- J. Honkala, It is decidable whether the image of an N-rational sequence has a base, *Journal of Number Theory* 108, pp. 209-216, 2004.
- J. Kari (guest editor), Theoretical Aspects of Cellular Automata, *Special Issue of Theoretical Computer Science* 325, pp. 169-344, 2004.
- J. Kari, The tiling problem and undecidability in cellular automata, Proceedings of the International Workshop on Tilings and Cellular Automata, *CDMTCS Research Report Series* 253, 2004.
- D. Nowotka, Periodicity and Unbordered Factors of Words, *TUCS Dissertations No 50*, 2004.
- P. Rosendahl, Niho Type Cross-Correlation Functions and Related Equations, *TUCS Dissertations No 53*, 2004.

5.1.6 Health and Medical Informatics Institute

There are altogether ten members of the Health and Medical Informatics Institute: five professors and five doctoral students. The Laboratory is shared between the department of Information Technology (University of Turku) and the Institute of Information Systems Sciences (Turku School of Economics and Business Administration). In 2004 the laboratory got external funding from the health care industry and Tekes for a total amount of 17.750 euros

Laboratory Leader:

Professor Reima Suomi

Professors:

Timo Järvi
Eija Karsten
Olli Nevalainen
Markku Nurminen
Reima Suomi

5.1.5.1 Background and Mission

The Institute coordinates research and education in the areas of health and medical informatics. Involved are University of Turku and Turku School of Economics and Business Administration.

5.1.5.2 Research

Yearly some 15-20 projects are performed, most of them in co-operation with health care organizations active in the Turku area or nationally. For year 2004, assessing the national project on electronic prescriptions together with Stakes was an important project.

Eija Karsten and Reima Suomi have together with Jarmo Tähtkää run a minitrack on health care informatics issues in Hawaii International Conference on System Sciences 2004.

In autumn 2004 a master level course on health care information systems was kept, with some 25 participants.

5.1.5.3 Future Goals

The Institute will deepen its research and education activities. Especially large research projects, which would allow for multidisciplinary and timely extended work, are looked for. Active participation in the Tekes FinnWell program is looked forward.

5.1.5.4 Selected Publications

Marianne Maass and Reima Suomi. Adoption-related Aspects of an Information System in a Health Care Setting. In Proceedings of the 37th Hawaii International Conference on System Sciences (HICSS-37) 5-8.1.2004 Big Island, Hawaii, Jan 2004.

Riikka Vuokko. Constructing IT and Professional Identity: Introducing Mobile Informatics in Home Care. In Proceedings of AMCIS2004, New York, 2004.

Lauri Salmivalli and Jussi Nissilä. Curing Health Care Information Systems With Open Source Software. In Proceedings of the 12th European Conference on Information Systems ECIS 2004, 2004.

Riikka Vuokko. Effectiveness Trough Mobile Informatics: The Case of Social Home Care. In Proceedings of 4th European Conference on e-Government, Dublin, 2004.

Lauri Salmivalli and Reima Suomi. Electronic Data Flows in Health Care – Some Obstacles in the Implementation of EDI Systems. In In the proceedings of the 15th IRMA International Conference, 2004.

Riikka Vuokko. Experiences from an Implementation Project - Time Management and Control in Home Care. In Proceedings of the 37th Hawaii International Conference on System Sciences (HICSS-37) 5-8.1.2004 Big Island, Hawaii., Jan 2004.

Reima Suomi. Governance Structures for IT in the Health Care Industry. In Encyclopedia of Information Science and Technology. Khosrow-Pour, Mehdi, editors. Volume 1, pages 1305-1308. Idea Group Publishing, 2004.

Reetta Raitoharju. Job Satisfaction and Information Technology in Social and Health Care. In Proceedings of the 27th Information Systems Research Seminar in Scandinavia (IRIS27), Aug 2004.

Janne Lahtiranta and Kai Kimppa. Telemedicine and Responsibility: Why Anthropomorphism and Consent Issues Muddle the Picture. In 5th International WE-B (Working for e-Business) Conference, Nov 2004.

5.1.7 High Performance Computing and Communication Laboratory

There are presently 4 members of the High Performance Computing and Communication Laboratory: one professor, two senior researchers and one doctoral student. The laboratory is part of the department of Computer Science, Åbo Akademi University.

Laboratory Leader:

Professor Jan Westerholm

5.1.7.1 Background and Mission

The laboratory conducts research in both software and hardware related issues in high performance computing. One focus area is on writing parallel code that executes faster by taking the hardware architecture into account when writing software. Another focus area is on algorithms for computer graphics.

5.1.7.2 Research

Parallel cluster on a shoestring

The laboratory has designed and built a parallel workstation cluster of about 20 nodes. The design of the cluster is optimized for cost/performance ratio. It has been used for Monte Carlo simulations of a Heisenberg quantum spin model, flow simulations in porous media, etc.

Shadows in computer graphics

We investigate algorithms for shadows in dynamical environments.

Code optimization of a Lattice-Boltzmann fluid simulation code

This work is done in co-operation with the Department of Physics at the University of Jyväskylä and the Centre for Scientific Computing, CSC. The goal is to investigate the efficiency of a Lattice-Boltzmann code for fluid-dynamic simulations, and to improve the performance of the code.

Modelling of pore structures in paper

This work is done together with the Laboratory of Paper Coating and Converting at Åbo Akademi University. The project develops software for modeling the pore structures in paper.

5.1.7.3 Selected Publication

J. Arvo and J. Westerholm: "Hard-ware accelerated soft shadows using Penumbra Quads", Journal of WSCG 12(1), 11-18 (2004)

5.1.8 Laboris Information Systems Laboratory

There are altogether ten members of the Laboris Information Systems Laboratory. In 2004 the laboratory got external funding for a total amount of 16.000 euros.

Laboratory Leader:

Professor Markku Nurminen

5.1.8.1 Background and Mission

Laboris was established 1993 in order to promote research on organisational usability (exploitability) of information systems and other ICT artefacts. LABOR means work and IS stands for information systems. Both basic and applied research is conducted, they often take the form of contract research and product development.

5.1.8.2 Research

The usability laboratory financed by TUCS, Department of Information Technology, IAMSR and Laboris was used in student projects and research projects. Laboris submitted an offer on evaluation of the usability of e-Health Services piloted in the Wellcom project of Turku City and won one subproject that is aiming at a review of these services in present and future.

Laboris started the mobilisation of its competence to support the future Master's Programme on Work Informatics to be launched by the Information System discipline of the University of Turku. The concepts of usability and exploitability are operationalised and packaged for essential concepts of the Programme's competence.

5.1.8.3 Future Goals

The future goals are to improve the applicability and transferability for dissemination of research results on organisational exploitability, organisational implementation and usability of ICT artefacts in organisations and working life. The Work Informatics Programme will be a central vehicle for such dissemination.

5.1.8.4 Selected Publications

Jacques Berleur, Penny Duquenoy, Jan Holvast, Matt Jones, Kai Kimppa, Richard Sizer and Diane Whitehouse. Criteria and Procedures for Developing Codes of Ethics or of Conduct: To Promote Discussion Inside the IFIP National Societies, Sep 2004.

Erkki Innola and Antti Tuomisto. Knowledge Transfer and Initiation Process: About New Employee Becoming Old Reliable. In The Fifth European Conference on Organizational Knowledge, Learning and Capabilities, Apr 2004.

Petteri Kaitovaara: Packaging of IT Services: Conceptual and Empirical Studies. PhD Thesis. TUCS Dissertations No. 52.

- Petteri Kaitovaara. It Is Not Just IT – It Is IT Service That Matters. In Proceedings of Marketing, Strategy, Economics, Operations and Human Resources: Insights on Service Activities (La Londe 2004), Jun 2004.
- Ilkka Kempainen. Change Management Perspectives in an ERP Implementation. In Proceedings of the 12th European Conference on Information Systems, Turku Finland, June 14-16, 2004, Jun 2004.
- Janne Lahtiranta and Kai Kimppa. Telemedicine and Responsibility: Why Anthropomorphism and Consent Issues Muddle the Picture. In 5th International WE-B (Working for e-Business) Conference, Nov 2004.
- Kai Kristian Kimppa. Consequentialist Considerations of Intellectual Property Rights in Software and other Digitally Distributable Media. In Ethicomp 2004, Challenges for the Citizen of the Information Society, Apr 2004.
- Kai Kimppa. Intellectual Property Rights in Software—Justifiable from a Liberalist Position? The Free Software Foundations Position in Comparison to John Locke’s Concept of Property. In Intellectual Property Rights in a Networked World: Theory and Practice. Richard A. Spinello, Herman T. Tavani, editors, chapter 2, pages 67-82. Idea Group Publishing, Hershey, PA, USA, 2004.
- Kai Kristian Kimppa. Intellectual Property Rights – or Rights to the Immaterial – in Digitally Distributable Media Gone All Wrong?. In Information Ethics: Privacy and Intellectual Property. Lee Freeman & A. Graham Peace, editors, chapter 4, pages 53-67. Idea Group Inc., 2004.

5.1.9 Microelectronics Laboratory

There are altogether 18 members of the Microelectronics Laboratory: two professors, six senior researchers and ten doctoral students. The laboratory is part of the department of Information Technology. In 2004 the laboratory got external funding from the Academy of Finland for a total amount of 21.000 euros.

Laboratory Leader:

Professor Ari Paasio

Professor:

Aulis Tuominen

5.1.9.1 Background and Mission

Electronics and Information technology (started 1986) belonged up to 2001 to the department of Applied Physics and later to the new department of Information Technology. The microelectronics laboratory was established in 1990. The purpose of the laboratory is to teach and carry out scientific research mainly in the field of micro- and nano technology.

The laboratory extended its operation to the city of Salo during 2004 by the IT Department assigning a professor there. The discipline, “productisization” is totally

new in the universities and main task is to build up the training programme. The research in Salo is concentrating to productisization and electronics production and packaging technology.

5.1.9.2 Research

The laboratory has a semiconductor processing equipment (CDV, etching, sputtering and lithography) aimed for pilot projects in science and industry. One of the main interests is the development of (Si/SiO_x) structures on silicon wafer for light production by electroluminescence (EL) to achieve light emitting structures with normal IC technology. The laboratory's finding of the narrowed EL spectrum when the electric current density is increased was the first one in the world. Similar behaviour is found in lasers. So far the main emphasis is on enhancing of the EL intensity by structures with small surface area and higher current density and preparing a LED. We have cooperation with the University of Helsinki and Helsinki University of Technology. Applications in sensor technology (particle detectors) are other interests.

The laboratory is a world leader in the research field of electronic implementations of massively parallel mixed-mode array processors. The implementation theory is heavily modified from the original Cellular Nonlinear Network (CNN) concept in order to achieve large integration density. The research in the laboratory consists of all aspects of array processing ranging from small processing primitives in hardware through the whole system implementation and covers also algorithm development for image processing using these arrays. Also few patents have been applied from this research field. Close cooperation is done with the Electronic Circuit Design Laboratory (ECDL) at the Helsinki University of Technology (HUT) and international partners around the world. Dr. Victor Brea from the University of Santiago de Compostela, Spain, visited the laboratory for six months during 2004. The research is supported by the Academy of Finland. The group had one post doc researcher in the project: Parallel Processors for Power/Speed Critical Applications (1.8.2004-31.12.2007).

System on package design: Packaging technology and design is an emerging area in the laboratory. Since physical architecture of interconnects and integrated circuits is rapidly gaining significance, greater attention has to be directed to signal path optimization, crosstalk and interconnect design. Current research topics in high speed electronics within the laboratory are the design of a UWB transceiver using 0.18 μm CMOS mixed mode/RF technology and the development of an on-chip oscilloscope to be used as an analysing tools in high speed designs. The laboratory is collaborating with the Royal Institute of Technology (KTH – Stockholm).

In Salo, one of the research topics is lead free soldering which will be implemented by July 1 2006 according to the EU directive. Therefore the first wide study will concentrate in it. The aim is to use statistical mathematical methods to solve the long term reliability issues and characterize the production parameters. Due to the approaching dead line of lead free soldering, a complete conference on the topic was

arranged in Salo. This “NEXT” (New Exploratory Technologies) conference was very successful and total number of visitors was almost 250, even though the topic was limited to the lead free soldering only.

5.1.9.3 Future Goals

The construction of an electrically driven silicon solid state laser based on electroluminescent Si/SiO_x active layer and a proper resonator is the ultimate goal. At least a resonance LED from silicon/silicon oxide seems possible. The structures are suitable for small electrically driven light sources with low operation voltage (below 5 V). Integration on silicon makes these light sources ideal for demanding future purposes. The first real Si-based optoelectronics applications are just emerging on the markets.

There are three primary research goals of in the field of CNNs, or more generally in the field of massively parallel array processors. The first is a long range goal in designing processor arrays using nano technology (see ITRS roadmap). The second goal is to seek a large variety of application fields that can benefit from great processing power and generate processing algorithms for these fields. Such applications are sought from the field of medical, as well as from the consumer, automotive and security fields. The final goal is to continue the research in shrinking the processor size using conventional CMOS while still maintaining high performance also in analog or mixed-mode processing.

In Salo, NEXT conference will be arranged in October 2005 and it will deal also with microelectronics and manufacturing technology. First post graduate student in Salo is working for Nokia and his research will deal with failure analysis. The target to finalize his doctor thesis is in the end of 2006.

5.1.9.4 Selected Publications

Refereed journal: 6, international conference: 19, patent: 2, domestic conference: 4

Tanja Suominen, Petriina Paturi, Hannu Huhtinen, Lauri Heikkilä, Hannu-Pekka Hedman, Risto Punkkinen and Reino Laiho. Conductivity and Distribution of Charge on Electroluminescent Si/SiO₂ Structures Investigated by Electrostatic Force Microscopy. *Applied Surface Science*, 222(1-4):131-137, Jan 2004.

Miika Meretoja, Risto Punkkinen, Hannu-Pekka Hedman, Lauri Heikkilä, Mika Hirvonen, Tanja Suominen and Markku Heinonen. Electroluminescence in Si/SiO₂ Microstructures. *Physica Scripta*, T114:53-56, 2004.

Mika Laiho, Ari Paasio, Asko Kananen and Kari Halonen. A Mixed-Mode Polynomial Cellular Array Processor Hardware Realization. *IEEE Transactions on Circuits and Systems I: Regular Papers*, 51(2):286-297, Feb 2004.

Jonne Poikonen and Ari Paasio. A Ranked Order Filter Implementation for Parallel Analog Processing. *IEEE Transactions on Circuits and Systems - I*, 51(5):974-987, May 2004.

Victor M. Brea, David L. Vilarino, Ari Paasio and Diego Cabello. Design of the Processing Core of a Mixed-Signal CMOS DTCNN Chip for Pixel-Level Snakes. *Transactions on Circuits and Systems - I*, 51(5):997-1013, May 2004.

Sergei Vasilyev, Jarno Järvinen, Esa Tjukanoff, Alexander Kharitonov and Simo Jaakkola. Cryogenic 2 mm Wave Electron Spin Resonance Spectrometer with Application to Atomic Hydrogen Gas Below 100 mK. *Review of Scientific Instruments*, 75(1):94-98, Jan 2004.

5.1.10 Network Economics Institute

5.1.10.1 Background and Mission

The Network Economics Institute studies the utilisation of information and communication technology (ICT) in enterprises and organisations. Since 1980s the research has focused on the strategic management of information resources, with a special emphasis on the exploitation of digital networks in business. The institute has also long traditions in the area of decision and learning support systems and the management of end-user computing.

5.1.10.2 Research

Most studies conducted within the institute adopt action research as the primary research method. Following the established principles of action research, the researchers aim to contribute both to the practical concerns of organizations in planning and using information systems, and to the goals of information systems research by joint collaboration within a mutually acceptable ethical framework.

Hence, the researchers participate in the planning and development of information systems in organizations and bring their outsider's perspective and theoretical knowledge to facilitate the processes. At the same time they aim to create publicly usable methods for planning, developing and using information systems. In the year 2004, the institute carried out approximately ten action research projects. A typical industry project lasted from 6 to 12 months.

The institute organized the European Conference on Information Systems in 2004, which is one of the leading conferences in the information systems research field. The conference received close to 500 submissions, out of which 180 were selected. Approximately 350 IS researchers and professionals participated in the conference in June.

5.1.10.3 Future Goals

Our intention is to continue applied and practice oriented research also into the future. Particular emphasis will be placed on IS strategy formulation and implementation in networked organisations. The objective is also to strengthen the ties with the mobile commerce laboratory in the analysis of business uses of digital networks. The donation that the institute received from TeliaSonera enabled the establishment of a new professor chair from 2003 to 2005. This provides a good basis for increased research activity and cooperation in this field.

5.1.10.4 Personnel

Professors: Tapio Reponen, Reima Suomi, Hannu Salmela, Jussi Puhakainen, Seppo Sirkemaa (Pori unit).

Other Faculty: Lecturers (2), Senior research assistants (2), Research assistants (2), Staff (1)

5.1.10.5 Selected Publications

Alaranta, Maria – Viljanen, Maarit (2004) Integrating The IS Personnel After A Merger - Challenges And Opportunities. Proceedings of the 12th European Conference on Information Systems, Turku, Finland, June 14.-16.

Cantoni, Franca and Salmela, Hannu (2004) Proceedings of the Finnish-Italian Workshop on Information Systems, FIWIS 2004, Turku Centre for Computer Science, TUCS General Publication, No 36, June 2003.

Järveläinen, Jonna & Puhakainen, Jussi (2004) Distrust in One's Own Web Skills: A Reason for Offline Booking after Online Information Search. *Electronic Markets*. Vol. 14.

Koskivaara, Eija (2004) Artificial neural networks in analytical review procedures, *Managerial Auditing Journal*, Volume 19, Number 2, 2004, pp. 191-223.

Koskivaara, Eija, Artificial Neural Networks in Auditing: State of the Art. *The ICFAI Journal of Audit Practice*, Volume 1, Number 4, 2004, pp.12-33.

Lainema, Timo (2004). Redesigning the Traditional Business Gaming Process – Aiming to Capture Business Process Authenticity. *Journal of Information Technology Education*, Vol. 3, pp. 35-52.

Lainema, Timo (2004). Challenging the Dominant Paradigm: Evidence Supporting Time-Based Simulation Gaming. In Kriz & Eberle (Eds) *Bridging the Cap: Transforming Knowledge into Action through Gaming and Simulation*. ISBN: 3-00-013988-5. Ostler Druck, Passau, Germany, pp. 42-50.

Leino, Timo – Saarinen, Timo – Klein, Stefan (eds) (2004) *The Proceedings of the European Conference on Information Systems 2004*, Turku, Finland, June 2004.

Manuel De Jesus Mendes - Suomi, Reima – Carlos Alberto Dos Santos Passos (Eds) (2004). *Digital communities in a networked society*. Kluwer Academic Publishers.

Salmivalli, Lauri; Nissilä, Jussi (2004) Curing Health Care Information Systems with Open Source Software. In *Proceedings of European Conference on Information Systems 2004*, Turku, Finland, June 2004.

5.2 CREST

The Centre for Reliable Software (CREST) consists of four research laboratories/groups from the department of Computer Science: Distributed Systems Design, Embedded Systems, Mechanised Reasoning, and Software Construction. In 2003 CREST got external funding for the total amount of 848.400 euros: 480.600 euros from the Academy of Finland, 217.700 euros from industry and Tekes, 5.000 euros from EU, and 145.100 euros from other external parties.

5.2.1 Distributed Systems Design Laboratory

Laboratory Leader:

Professor Kaisa Sere (Department of Computer Science, Åbo Akademi University)

5.2.1.1 Background, Mission and Research

The Distributed Systems Laboratory, which is part of CREST and the national Centre of Excellence in Formal Methods in Programming, is formed by researchers from Åbo Akademi University, Department of Computer Science.

One of the main research directions within the laboratory is the construction and use of formal specifications, and for this reason, modelling and the analysis of models. The central techniques that we have developed and investigated within this context are model decomposition and feature introduction in layers mainly using the superposition principle. These techniques were formalised within the Action Systems/Refinement Calculus framework by Back and Sere in the early 1990s. The work on modelling has led to the study of software and systems construction processes with formal specification as a central artefact with very good results. The prime example of this is our work within the EU FP6 IST RODIN project, lead at our site by Elena Troubitsyna. The work within RODIN started September 2004 and is described elsewhere <http://rodin.cs.ncl.ac.uk/>. Moreover, Rimvydas Ruksenas finished his PhD thesis summer 2004 on compositional approaches to system specification and development.

Recently, the work on model decomposition has been applied within the field of computer networks. We are investigating the design of reliable peer-to-peer architectures and ad hoc networks as well as other network systems based on these ideas. A central topic here in 2004 was context-aware computing. Formal modelling of communication channels in digital circuits and modern system-on-chip designs is one of our central research issues at the laboratory currently.

In connection to modelling and constructing formal specifications, we have particularly been studying the integration of certain informal (or semi-formal) techniques within the construction process. The Unified Modelling Language, UML, has been central to this as well as the use of hazard and safety analysis techniques to reason about dependability issues. Moreover, within the RODIN project we investigate the

integration of two formal methods within the process, namely that of Action Systems and the B Method. The basic reason for this has been the door that has opened to using the quite excellent administration, analysis and proof tools supporting the method.

Component-based systems are becoming more important within our design machinery. We are studying the formal specification and refinement of components, their interfaces and communication protocols. In addition to refinement, software architectural issues are of importance when creating systems based on some library of components. We have been following the s.c. co-ordination ideas here, separating the correctness issues of components from the efficiency issues of their communication when studying systems and software architectures. These ideas have been particularly important when developing design abstractions for e.g. distributed and mobile components as well as digital circuits.

We have had financial support for our research via the Academy of Finland project FOSSE: Formal Systems and Software Engineering, 2001-04 as well as via EU financing (RODIN: Rigorous Open Development Environment for Complex Systems, 2004-07, ACiD-WG: Asynchronous Circuit Design Working Group, 2000-04) in addition to TUCS and the Centre of Excellence financing.

5.2.1.2 Future Goals

In the future we plan to continue our work on the above fields. Especially work on RODIN will take much of our attention the coming year. The work on computer networks will be strengthened, context-awareness will become more important as well as peer-to-peer computing. Related, but new direction is sensor networks where we are focusing on specifying and developing such systems as well as on applications.

We have a tradition of validating our methods and techniques with case studies of various sizes. These case studies also give us inspiration for future research. Especially within the RODIN project we carry out these studies with our industrial partners. Another important class of case studies comes from the area circuit design. This research is continued and heavily expanded. Here we have recently focused on tools and on modelling communication on circuit boards.

Finally, we have started to investigate different protocols for peer-to-peer networking as well as routing in ad hoc networks and architectural issues of the networks. Safety and reliability as well as QoS and fault tolerance issues in a broader scale will be stressed here as well as more generally.

5.2.1.3 Selected Publications

Pontus Boström and Marina Waldén. Implementation of control systems using B action systems: A case study. *Nordic Journal of Computing*, 11(2): 75–101, 2004.

- Juha Plosila, Kaisa Sere, and Marina Waldén. Asynchronous system synthesis. *Science of Computer Programming*, 2004.
- Lu Yan. MIN: Middleware for network-centric ubiquitous systems. *IEEE Pervasive Computing*, 3(3), Jul 2004.
- Dubravka Ilic and Elena Troubitsyna. A formal approach to model-driven engineering. In Paul Pettersson and Wang Yi, editors, *Proceedings of the 16th Nordic Workshop on Programming Theory*, pages 25–26. Uppsala University, Uppsala, Sweden, Oct 2004.
- Linus Laibinis and Elena Troubitsyna. Fault tolerance in a layered architecture: A general specification pattern in B. In Z.Liu J.R.Cuellar, editor, *Proceedings of the Second International Conference on Software Engineering and Formal Methods (SEFM 2004)*, Sep 2004.
- Linus Laibinis and Elena Troubitsyna. Refinement of fault tolerant control systems in B. In S.Wittmann M.Heisel, P.Liggesmeyer, editors, *Computer Safety, Reliability, and Security - Proceedings of SAFECOMP 2004*, number 3219 in Lecture Notes in Computer Science, pages 254–268. Springer, Sep 2004.
- Pontus Boström and Marina Waldén. Extensions of event based B for development of grid systems. In P. Pettersson and W. Yi, editors, *Proceedings of the 16th Nordic Workshop on Programming Theory*, pages 110–112. Uppsala University, Oct 2004. Technical report 2004-041.
- Lu Yan, Moises Ferrer Serra, Guangcheng Niu, Xinrong Zhou, and Kaisa Sere. SkyMin: A massive peer-to-peer storage system. In *Proceedings of Grid and Cooperative Computing - GCC 2004*, number 3251 in Lecture Notes in Computer Science. Springer, Oct 2004.
- Lu Yan and Jincheng Ni. Building a formal framework for mobile ad hoc computing. In *Proceedings of the International Conference on Computational Science (ICCS 2004)*, Lecture Notes in Computer Science (LNCS) 3036. Springer-Verlag, Jun 2004.
- Lu Yan and Kaisa Sere. A formalism for context-aware mobile computing. In *Proceedings of the ISPDC/HeteroPar 2004*. IEEE Computer Society Press, Jul 2004.

5.2.2 Embedded Systems Laboratory

There are altogether eight members of the Embedded Systems Laboratory: one professor, 2 senior researchers, and four doctoral students.

Laboratory Leader:

Professor Johan Lilius (Department of Computer Science, Åbo Akademi University)

5.2.2.1 Background and Mission

The Embedded Systems Laboratory was founded in 2001. It is an outgrowth of the informal embedded systems research group that existed at the Department of Com-

puter Science at Åbo Akademi since 1998. The laboratory's main mission is to improve the methods and techniques used to develop embedded systems.

5.2.2.2 Research

The laboratory is part of the Centre of Excellency for Formal Methods in Programming together with the Software Construction (SC) Laboratory and the Distributed Systems (DS) Laboratory. There are strong ties to the research of these laboratories.

The main research projects in the laboratory are:

Model-Driven-Engineering

In this project we co-operate with the SC laboratory to develop UML based tools and methods for the design of embedded systems. Our work is divided onto 2 strands: First we are looking for a design flow that uses UML and targets TTA (Transport Triggered Architecture) like processors. This flow consists of a high-level flow that uses UML as the main design language. We have developed different model transformations, that give different views into the system (e.g. UML-to-DFD transformations), but also transformations that allow the inclusion of Domain knowledge. To the high-level flow is then also attached a low-level flow that includes tools for the estimation of physical parameters like power consumption or silicon size of the final chip. This information can be fed back into the high-level flow at suitable points.

The second strand of this research is the development of a formal framework for models of computation. This research is made concrete in the Rialto language which is an intermediate language for heterogenous models of computation. We have developed mappings from different UML behavioural diagrams (Statecharts, Collaboration and Activity diagrams) into Rialto. The novelty of Rialto is that different models of computation are encoded into policies. These policies make it possible easily integrate new models of computations into the framework. We have also developed code-generation techniques for efficient code-generation of C from Railto.

Embedded Java

The focus of this project is to look at how to improve the performance of Java in the context of embedded systems. The focus has been on the development of a tool for static memory usage analysis and on the analysis of the power-consumption of Java programs. We have continued this work by doing a full analysis of the power-consumption of a Java virtual machine. We are also exploring different custom memory architectures in this context.

Digital-TV

The research on digital television will look on different aspects of media delivered over broadcast networks. This includes research on video coding and trans-coding, error coding, quality of service mechanism, file/object downloading services and software technologies related to interactive digital television. Four master's theses were performed in this area during the year. Together with Axel Technologies, the

Opensource Multimedia Home Platform environment OpenMHP was published in April 2004, where the lab is responsible of hosting the web-service www.openmhp.org. In autumn 2004, the laboratory co-authored a Guide to the OpenMHP environment, as a part of the ArviD cluster, by the Finish Ministry of Transport and Communications. Starting in April 2004, Radio- ja Televisiotekniikan Tutkimus RTT Oy financed a study on applying Forward Error Correction functionality on application level in IP data casting networks. During late 2004, the Wing-TV project was planned, in which 26 partners from the EU will cooperate in Eureka/Celtic project, with the objectives of validating the new standard DVB-H. The laboratory will during the period 2005-2006 actively participate in this project.

5.2.2.3 Future Goals

The laboratory will continue to work on the above 3 main topics. We do not plan to start any new research topics. Instead we plan to strengthen the laboratory by building co-operations with other universities, and by starting more industrial projects in these areas.

The laboratory will participate in the organisation of the 2nd International Workshop on Model-Based Methodologies for Pervasive and Embedded Software (MOMPES) in 2005. The laboratory will organise the joint conference Applications and Theory of Petri Nets (ATPN) and Applications of Concurrency to System Design (ACSD) in 2006.

5.2.2.4 Selected Publications

During 2004 the laboratory published 18 publications.

Marcus Alanen, Johan Lilius, Ivan Porres, and Dragos Truscan. MDE support in a protocol processing design method. In Uwe Aßmann, editor, *Proceedings of Model-Driven Architecture: Foundations and Applications 2004*, June 10-11, Linköping, Sweden, pages 234–247. Research Center for Intergrational Software Engineering, Jun 2004.

Dag Björklund. Efficient code synthesis from synchronous dataflow graphs. In *Second ACM & IEEE International Conference on Formal Methods and Models for Co-Design*, pages 83–92. IEEE Computer Society, Jun 2004.

Dag Björklund, Johan Lilius, and Ivan Porres. A unified approach to code generation from behavioral diagrams. In Cristoph Grimm, editor, *Languages for System Specification*, The ChDL series, chapter I, pages 21–34. Kluwer Academic Publishers, 2004.

Joao M. Fernandes and Johan Lilius. Functional and object-oriented views in embedded software modeling. In *11th IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2004)*, pages 378–387, Brno, Czech Republic, May 2004. IEEE Computer Society Press.

Joao M. Fernandes, Johan Lilius, Ricardo J. Machado, and Ivan Porres, editors. *Proceedings of the 1st International Workshop on Model-Based Methodologies for*

Pervasive and Embedded Software, number 29 in TUCS General Publications, Jun 2004.

Kai Koskimies, Ludwik Kuzniarz, Johan Lilius, and Ivan Porres, editors. Proceedings of the 2nd Nordic Workshop on the Unified Modeling Language NWUML'2004, number 35 in TUCS General Publications, Aug 2004.

Sébastien Lafond and Johan Lilius. An energy consumption model for Java virtual machine. Techreport 597, TUCS, Mar 2004.

Seppo Virtanen. A Framework for Rapid Design and Evaluation of Protocol Processors. PhD thesis, University of Turku, Sep 2004.

Dragos Truscan, Joao M. Fernandes, and Johan Lilius. Tool support for DFD-UML model-based transformations. In Miroslav Sveda Vaclav Dvorak, editor, 11th IEEE International Conference on the Engineering of Computer-Based Systems, Brno, Czech Republic, pages 388–397. IEEE Computer Society, May 2004.

5.2.3 Learning and Reasoning Laboratory

There are altogether nine members of the Learning and Reasoning Laboratory: two professors, one senior researcher and six doctoral students. The laboratory is shared between the department of Computer Science and the department of Information Technology.

Laboratory Leaders:

Professor Ralph-Johan Back and Professor Tapio Salakoski.

5.2.3.1 Background and mission

The TUCS Learning and Reasoning Laboratory co-ordinates research and development activities within formal reasoning, mechanised logic and with educational technology. This includes research in the use of formal reasoning in both computer science and in mathematics, but also the development of rigorous educational technology and the use of these technologies in courses within the departments at TUCS.

5.2.3.2 Research

- Formal and mechanised reasoning, with applications to programming logic
- High-school mathematics: use of structured derivations and logic in mathematics teaching
- Development and use of web-based and other educational technologies in computer science
- Algebraic structures for program refinement

5.2.3.3 Future Goals

- Further research into the use of formal reasoning methods in programming and mathematics
- Further research into teaching methods and educational technology in computer science and mathematics based on logic and rigorous reasoning

5.2.4 Software Construction Laboratory

During the year 2004 there were altogether nine members of the Software Construction Laboratory: one professor, two senior researchers and seven doctoral students. The laboratory is part of the department of Computer Science at Åbo Akademi University.

Laboratory Leaders:

Professor Ralph-Johan Back and Acting Professor Ivan Porres

5.2.4.1 Background and Mission

The research of the laboratory centres on the research of methods and tools for software construction. This includes software analysis and design methods, programming methods, languages and environments and the software construction process at large. Particular emphasis is put on the construction of highly reliable and functionally correct software systems.

- Programming logics (program correctness, semantics, program refinement)
- Different kinds of programming paradigms (concurrent systems, hybrid systems, interactive systems, etc.)
- Object-oriented programming (methods, theory, semantics, correctness)
- Software development processes and Software process improvement
- Software modelling and model driven engineering
- Software construction tools

5.2.4.2 Research Projects

Tools for Reliable Software Construction (TORES)

At the Centre of Excellence for Formal Methods in Programming Tekes, 2002-2004. The goal of TORES is to develop a large and well defined part of an advanced environment to model, verify, and implement reliable software-based systems. This project is carried out with the collaboration of the Distributed Systems Laboratory, the Embedded Systems Laboratory and the Mechanized Reasoning Laboratory.

Gaudi Software Factory

The Gaudi Software Factory is our experimental software laboratory. Here is where we put in practice the ideas that emerge from our other research projects. Gaudi is organized as a software production factory: its main and only objective is to build software products that satisfy the requirements specified by a customer.

5.2.4.3 Selected Publications

During 2004 the laboratory published 16 publications (two conference proceeding, one journal article, one book chapter, seven articles in conference proceedings, and five technical reports).

Cristina Cerschi Seceleanu and Tiberiu Seceleanu. Synchronization Can Improve Reactive Systems Control and Modularity. *Journal of Universal Computer Science (JUCS)*, 10(10):1429-1468, Oct 2004.

- Dag Björklund, Johan Lilius and Ivan Porres. A Unified Approach to Code Generation from Behavioral Diagrams. Chapter in Languages for System Specification. Cristoph Grimm, editors., The ChDL series, chapter I, pages 21-34. Kluwer Academic Publishers, 2004.
- Ralph-Johan Back and Cristina Cerschi Seceleanu. Contracts and Games in Controller Synthesis for Discrete Systems. In 11th IEEE International Conference on the Engineering of Computer-Based Systems, Brno, Czech Republic, May 2004.
- Marcus Alanen and Ivan Porres. Coral: A Metamodel Kernel for Transformation Engines. In Proceedings of the Second European Workshop on Model Driven Architecture (MDA), Sep 2004.
- Ralph-Johan Back, Piia Hirkman and Luka Milovanov. Evaluating the XP Customer Model and Design by Contract. In Proceedings of the 30th EUROMICRO Conference, Rennes, France, August 31-September 3, Aug 2004.
- Marcus Alanen, Johan Lilius, Ivan Porres and Dragos Truscan. MDE Support in a Protocol Processing Design Method. In Proceedings of Model-Driven Architecture: Foundations and Applications 2004, June 10-11, Linköping, Sweden, Jun 2004.
- Kai Koskimies, Ludwik Kuzniarz, Johan Lilius and Ivan Porres (Eds), Proceedings of the 2nd Nordic Workshop on the Unified Modeling Language NWUML'2004, number 35 in TUCS General Publications, Aug 2004.
- Kai Koskimies, Johan Lilius, Ivan Porres, Kasper Østerbye (Eds), Proceedings of the 11th Nordic Workshop on Programming and Software Development Tools and Techniques, NWPER'2004, number 36 in TUCS General Publications, Aug 2004.

5.3 IAMSR

The Institute for Advanced Management Systems Research (IAMSR) is a research centre within Åbo Akademi University and TUCS. IAMSR is carrying out theory-driven and applied research in approximate reasoning and fuzzy logic, real options, self-organizing maps and neural nets, interdependent multiple criteria optimization, software agents, mobile and electronic commerce methods and technology, industry foresight methods, scenario technologies, knowledge based support systems and hyper-knowledge.

There are two research laboratories and several small research groups at IAMSR. In 2004 IAMSR got external funding for the total amount of 2.014.000 euros: 1.642.000 euros from industry and Tekes, 36.000 euros from EU, 146.000 euros from Academy of Finland and 190.000 euros from other external parties.

5.3.1 Data Mining and Knowledge Management Laboratory

In 2004, there were 10 members of the Data Mining and Knowledge Management Laboratory: three professors, two post doctoral researchers and five doctoral students. The laboratory is shared between IAMSR, the Department of Computer Science, and the Department of Information Technology.

Laboratory Leader:

Professor Barbro Back

Professors:

Kaisa Sere (Department of Computer Science, Åbo Akademi University)

Eija Karsten (Department of Information Technology, University of Turku)

5.3.1.1 Background and Mission

At the Data Mining and Knowledge Management Laboratory we focus on research around developing, implementing and evaluating new methods for data mining and knowledge management. We also conduct practical studies in organizations. The laboratory is a joint effort between Åbo Akademi University, the University of Turku and the Turku School of Economics and Business Administration.

Information provided by different computer systems is growing at an increasing pace, day by day. In the last few years, the situation has radically changed for many actors in the business world. Scarcity of information has changed into an overload of information. Information in itself is, however, of no value, it becomes valuable only when it is turned into knowledge. It is obvious that company stakeholders, who can turn the huge amount of available quantitative and qualitative information into working knowledge, will gain a competitive advantage. Information technology has created a huge supply of information. Luckily the same technology also provides us with new tools to manage the information. Computational intelligence is a rather new research paradigm that aims at extracting knowledge from information. It refers to several computing paradigms within soft computing, in particular the use of expert systems, neural networks, and genetic algorithms. Intelligent agents, semantic web and XBRL have become important topics in this research area.

5.3.1.2 Research

The laboratory is participating in or running four large ongoing research projects; Maintenance and Management with Mobile Multimedia (4M, Tekes grant no. 40373/03), Offshore (Tekes grant no. 70009/04), Domino (Academy of Finland grant no. 104639), and Louhi.

4M is a joint project between five Finnish universities (Tampere University of Technology, Åbo Akademi University, University of Tampere, University of Vaasa, and University of Joensuu). The focus of the project is upon supporting maintenance management through the use of mobile multimedia devices and applications. The

project is led by Professor Hannu Vanharanta, Tampere University of Technology, Pori Unit.

The Offshore-project strives to support Finnish service providers to the oil and gas industry by developing new expert systems to support these companies in their efforts to develop new business opportunities, in particular in the former Soviet Union-area. The laboratory's primary effort has been in benchmarking the performance of Finnish companies against their closest competitors. The Offshore project is run together with Tampere University of Technology, with six companies involved, and is led by Professor Hannu Vanharanta.

The laboratory is also running a four year Academy of Finland project called DOMINO. Domino aims at 1) building advanced computational intelligence into computer-based decision support systems for complex decision situations and 2) taking part in the development of the taxonomy and specifications of XBRL for the Finnish accounting and financial environment. Part of the project has been carried out in co-operation with the Gaudi software laboratory within TUCS.

In addition, the laboratory is taking part in the Louhi project, a joint project with the University of Turku (Departments of Information Technology and Nursing Science), Åbo Akademi University (Department of Information Systems) and Turku University Hospital. Louhi explores the possibilities and limitations of natural language processing methods on the free form text part of nursing documentation of intensive care documentation, in order to build tools that can assist in finding relevant information in the documents, in ensuring that hospital standards are followed in the summaries, and perhaps even in selecting relevant data or text for consideration by the nurse.

5.3.1.3 Future Goals

The laboratory has initiated co-operation with the Bioinformatics Laboratory at TUCS, and the goal of the laboratory is to develop this co-operation in the field of qualitative data analysis. The laboratory will also further develop the co-operation within data and text mining with Tampere University of Technology, Pori unit, as well as the interdisciplinary research within qualitative data analysis done together with the Department of General Linguistics at the University of Helsinki. Finally, the laboratory will further pursue its research into using the self-organizing map as a support tool for business intelligence.

5.3.1.4 Doctoral Theses

Eija Koskivaara. *Artificial Neural Networks for Analytical Review in Auditing*. Doctoral thesis, May 2004. ISBN 951-564-185-3.

Tomas Eklund. *The Self-Organizing Map in Financial Benchmarking*. Doctoral Thesis, TUCS Dissertations No 56, November, 2004. ISBN 952-12-1436-8

5.3.1.5 Selected Publications

During 2004 the laboratory published 22 publications (two book chapters, five articles in journals, two doctoral theses, nine articles in conference proceedings, and four technical reports.)

Ralph-Johan Back, Piia Hirkman and Luka Milovanov. Evaluating the XP Customer Model and Design by Contract. In *Proceedings of the 30th EUROMICRO Conference*, Rennes, France, August 31-September 3, Aug 2004.

Adrian Costea and Tomas Eklund. Combining Clustering and Classification Techniques for Financial Performance Analysis. In *Proceedings of The 8th World Multi-Conference on Systemics, Cybernetics and Informatics (SCI2004)*, Orlando, Florida, July 18-21, 2004, Aug 2004.

Tomas Eklund, Barbro Back, Hannu Vanharanta and Ari Visa. *Financial Benchmarking Tools in Finnish Companies – A State of the Art Survey*. Technical Report 618, TUCS, Aug 2004.

Antonina Kloptchenko, Tomas Eklund, Barbro Back, Jonas Karlsson, Hannu Vanharanta and Ari Visa. Combining Data and Text Mining Techniques for Analyzing Financial Reports. *International Journal of Intelligent Systems in Accounting, Finance, and Management*, 12(1):29-41, 2004.

Eija Koskivaara. Artificial Neural Networks in Analytical Review Procedures. *Managerial Auditing Journal*, 19(1):191-223, 2004.

Aapo Lämsiluoto, Tomas Eklund, Barbro Back, Hannu Vanharanta and Ari Visa. Industry Specific Cycles and Companies' Financial Performance – Comparison with Self-Organizing Maps. *Benchmarking – An International Journal*, 11(4):267-286, Jul 2004.

Dorina Marghescu, Mikko Rajanen and Barbro Back. Evaluating the Quality of Use of Visual Data-Mining Tools. In *Proceedings of 11th European Conference on IT Evaluation*, 11-12 November, 2004, Amsterdam, Netherlands, Nov 2004.

5.3.2 Mobile Commerce Laboratory

There are altogether 15 members of the Mobile Commerce Laboratory: three professors, two senior researchers, eight doctoral students and two research assistants.

Laboratory Leader:

Professor Pirkko Walden

Professors:

Christer Carlsson (Institute for Advanced Management Systems Research, Åbo Akademi University)

Jussi Puhakainen (Department of Information Systems Science, Turku School of Economics and Business Administration)

5.3.2.1 Background and Mission

The Mobile Commerce laboratory was founded in 2001. The research program started with 3 separate projects on virtual mobile platforms, mobile commerce industry foresight and empirical market studies in Europe and Asia. The laboratory's mission is to find new, effective mobile products and services, which will offer everyday support for individuals in a way which will permanently change their everyday routines. As part of this process the mission is also to create a basis for building a growing and profitable service business on a global scale.

5.3.2.2 Research

The laboratory is working on both (i) theory-oriented research in user interfaces, software agents technology and support systems, and (ii) applied research, which is focused on planning and problem solving with mobile technology applications for and with corporate partners.

The following research objectives have been specified:

- Find, identify potential customer groups for fast-growing value added mobile technology applications
- Design, develop and implement mobile technology solutions for selected customer groups
- Test and evaluate systems solutions for an integrated production and distribution of products and services which are enabled by mobile technology. Find bottlenecks and modify and enhance service capacity with intelligent information systems and agent technology
- Design and test value added user interfaces and user support systems for mobile technology customers
- Find value added services for customer groups and evaluate them; test the service concepts in different potential markets; revise or design services

The main research projects in the laboratory are:

- Mobile Technology Applications and Mobile Technology Acceptance (Tekes)
- Mobile e-Health (Duodecim)
- Mobile Content Quality (Pär Landor)
- Intelligent Agents and Industry Foresight
- Mobile Solutions for Time Management in Knowledge Work (Anna Sell)
- Enhanced Mobile Solutions for Customer Care (Vaida Kadyte)
- Individual Adoption Processes and the Foresight Approach for Strategy Making (Shengnan Han)
- Mobility in Health Care (Ville Harkke)
- Mobile applications to support salespersons (Chihab BenMoussa)
- Mobile applications in tourism (Erkki Patokorpi)

5.3.2.3 Future Goals

The laboratory has built and will continue developing a network of research partners in Europe, Asia and North America. It will continue its work on both theory-

oriented research in user interfaces, software agent technology and support systems, and applied research, which is focused on planning and problem solving with mobile technology applications for and with corporate partners. There are a number of new research areas continuously being explored and prepared; mobile applications in tourism, mobile support for health care teams, mobile value services and knowledge mobilisation.

5.3.2.4 Selected Publications

During 2004 the laboratory published 29 publications (24 articles in conference proceedings, one book chapter and 4 technical reports).

Carlsson, C., Walden, P., Vogel, D., Yeh, C., Liao, S., mCommerce Trends in Hong Kong and Models, The Pacific Asia Conference on Information Systems (PACIS), Shanghai, China, July 7-12, 2004.

Carlsson, C., Hyvönen, K., Repo, P., Walden, P., It's all about my phone! Use of Mobile Services in Two Finnish Consumer Samples, in Yao-Hua Tan, Douglas R. Vogel, Joze Gricar and Gregor Lenart (Eds), Proceedings of the 17th Bled eCommerce Conference, eGlobal, Bled, Slovenia, June 21-23, 2004.

BenMoussa, C., A task base framework for mobile applications to support salespersons performance. IFIP conference on mobile support systems. Kluwer Academic publishers. Oslo, Norway, 2004.

BenMoussa, C., Supporting Sales persons through Location based Mobile Applications and Services. 18th IFIP world computer congress. Kluwer Academic publishers. Toulouse, France.

Han, S., Harkke, V., Mustonen, P., Seppänen, M., and Kallio, M. (2004): Mobilizing medical information and knowledge: some insights from a survey, in Proceedings of the 12th European Conference on Information Systems, Turku, Finland, 13-16 June, 2004.

Han, S., Harkke, V., Mustonen, P., Seppänen, M., and Kallio, M. (2004) Physicians' Behavior Intentions Regarding a Mobile Medical Information System: An Exploratory Study. In Proceedings of the 10th Annual Americas Conference for Information Systems, Aug 2004.

Han, S., Harkke, V., Mustonen, P., Seppänen, M., and Kallio, M. (2004) Professional Mobile Tool: A Survey of Physicians' Perceptions of and Attitude Towards a Mobile Information System. In Proceedings of 5th Annual GITM World Conference, Jun 2004

Kadyte, V. (2004), Introducing Mobile Technology into B2B Relationships: Experiences from the Paper-Manufacturing Industry. In proc. of the Fifth Annual Global Information Technology Management Association (GITMA) on June 13 - 15, 2004, San Diego, California, USA.

Kadyte, V. & Tétard, F., The Role of Usability Evaluation and Usability Testing Techniques in the Development of a Mobile System. In proc. of the NordiCHI workshop on improving the interplay between usability evaluation and software design, October 23-27, Tampere, ACM Press.

- Liu S., Defending against Business Crises with the Help of Intelligent Agent based Early Warning Solutions, in Proceedings of the 8th Pacific Asia Conference on Information Systems, Shanghai, China, 8-11 July, 2004.
- Sell A., Patokorpi, E., Anckar, B. and Walden P., 2004. "Adoption of Mobile Communication Technology: An Empirical Study on Females Working in Elderly Care." ECIS 2004
- Tétard, F. & Patokorpi, E., Kadyte, V. (2004), User-Centred Design of Mobile Services for Tourists: a Case Study on Student Work on Mobile Design. In proc. of the IFIP TC8 Working Conference on Mobile Information Systems (MOBIS), September 15 – 17, Oslo, Kluwer Academic Publishers.
- Tétard F. & Patokorpi E., 2004. "Cultural Heritage Tourism and Mobile ICT". Proceedings of the IADIS International Conference, 16-19 July 2004 – Avila, Spain.

5.3.3. Other selected publications from IAMSR

- Collan, M., 2004, Giga-Investments: Modelling the Valuation of Very Large Industrial Real Investments, TUCS Dissertations, No. 57, Turku Centre for Computer Science, Åbo Akademi University, Åbo, November 2004.
- Majlender, P., *A Normative Approach to Possibility Theory and Soft Decision Support*, University Doctorate Dissertation, TUCS Dissertations, No. 54, Turku Centre for Computer Science, Åbo Akademi University, Åbo, September 2004.
- Carlsson, C., Fullér, R. and Majlender, P., A normative view on possibility distributions, in: Masoud Nikraves, Lotfi A. Zadeh and Victor Korotkikh eds., *Fuzzy Partial Differential Equations and Relational Equations: Reservoir Characterization and Modeling*, Vol. 142, Springer Verlag, [ISBN 3-540-20322-2], 2004.
- Björk K-M., Nordberg R., 2004. Solving Large-scale Retrofit Heat Exchanger Network Synthesis Problems with Mathematical Optimization Methods. AIP in *Journal of Chemical Engineering and Processing*.
- Fullér, R. and Majlender, P., On interactive fuzzy numbers, *Fuzzy Sets and Systems*, 143(2004) 355-369.
- Georgescu, I., On the axioms of revealed preference in fuzzy consumers theory, *Journal of Systems Sciences and Systems Engineering*, 13(3), 279-296, 2004.
- Georgescu, I., Consistency conditions in fuzzy consumers theory, *Fundamenta Informaticae*, 61(1), 223-245, 2004.
- Kvassov, V., "The Effects of Time Personality on the Productivity of MIS", *Journal of Decision Systems*, Vol. 13, No. 1 pp. 9-25, Hermes-Science Publications, Lavoisier 2004.
- Carlsson, C., Fullér, R. and Majlender, P., Additions of Complete Correlated Fuzzy Numbers, in: *FUZZY IEEE 2004 CD-ROM Conference Proceedings*, Budapest, July 26-29, 2004, IEEE Catalog Number: 04CH37542C, [ISBN 0-7803-8354-0], 2004 (file name: 0091-1075.pdf, 5 pages).

6 Publications

6.1 TUCS Publication Series

TUCS has four publication series:

TUCS Dissertations

(ISSN 1239-1883) contains doctoral dissertations by researchers affiliated with TUCS.

TUCS Technical Reports

(ISSN 1239-1891) contains technical reports from TUCS.

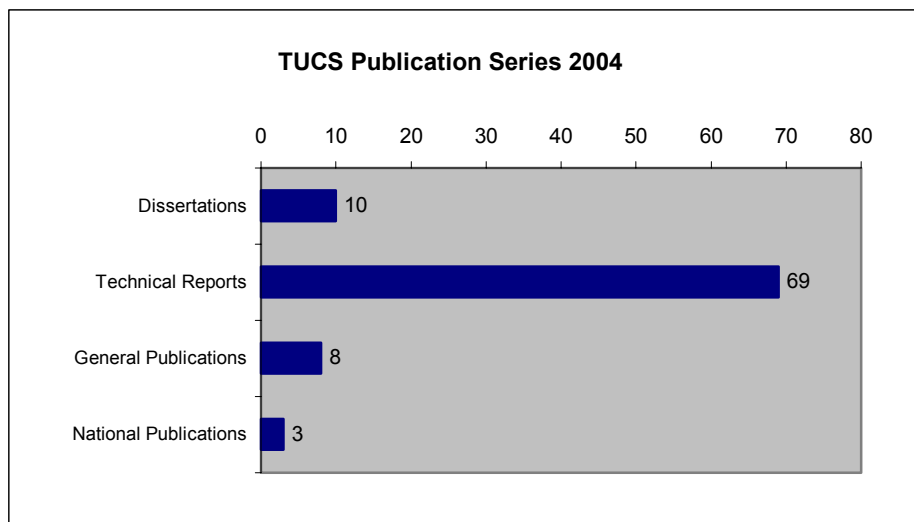
TUCS General Publications

(ISSN 1239-1905) contains all other publications from TUCS, like proceedings from conferences organized by TUCS, annual reports, etc.

TUCS National Publications

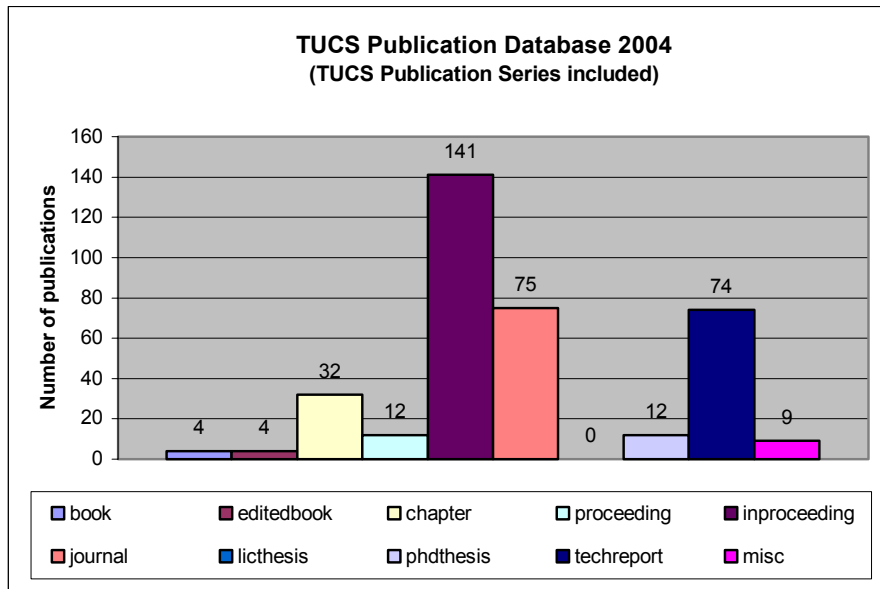
(ISSN 1457-8301) is intended for similar types of publications as the general publication series, but the publication language is either Finnish or Swedish.

During 2004, TUCS has published 10 Doctoral dissertations, 69 technical reports, 8 general publications and 3 national publications. Most of the TUCS publications are available online in electronic format from the TUCS World Wide Web pages.

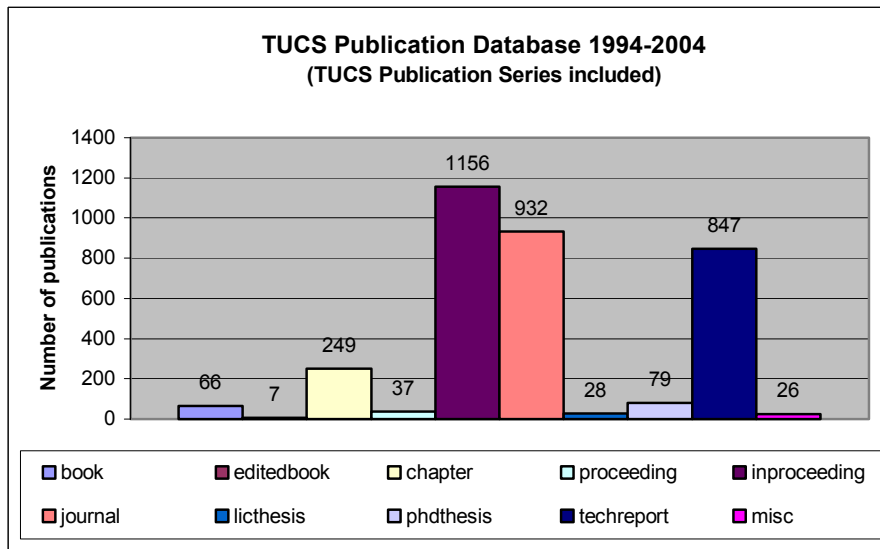


6.2 TUCS Publication Database

This section contains all publications from the researchers within TUCS during the year 2004, organized by type of the publication. The information is gathered from the TUCS bibliographical database.



The TUCS publication database has grown with 408 new publications during the year 2004. In total there are 3427 publications from the years 1994 to 2004.



7 Graduate School

TUCS Graduate School (TUCS GS) was the first Graduate School appropriated by the Ministry of Education in Finland. It offers a framework for studying for the Doctoral degree in Computer Science, Mathematics, Information Systems, Computer Engineering, Communication Systems, and Microelectronics. It is open for students from everywhere. Prerequisites are either a Master's or a Bachelor's degree in a relevant field. Study time is expected to be four years.

The Graduate School offers supervision of students within existing research projects: each student is assigned a personal supervisor from one of the five departments participating in TUCS. The students can attend all advanced level courses within the field of Information Technology offered by the participating departments. The language of instruction of the advanced level courses is English.

TUCS GS has traditionally had two application rounds per year. However, this year TUCS board decided to remove the autumn's application round due to the limited amount of student positions. Students applying to TUCS GS can apply for a student position with or without financing from TUCS. In 2004 the board accepted totally 14 new students (7 from Finland, 2 from China, and 1 from India, Pakistan, Iran, Ethiopia, and Georgia each). In the end of 2004 there were 97 students in the Graduate School.

Number of Graduate School Students 31.12.2004:

Åbo Akademi University	36
University of Turku	54
Turku School of Economics and Business Administration	7
TUCS Graduate students 31.12.2004	97

7.1 Curriculum Requirements

The curriculum for the Master's degrees and the Doctor's degrees follows the Finnish standard requirements. The Doctor's degree normally requires a Master's degree. The Master's degree requires 40 credits in addition to the Bachelor's exam. For the Doctor's degree, in addition to the Master's degree, the student must take 40 credits of courses and carry out research leading up to a doctoral thesis. The students within TUCS GS are expected to take courses from at least two of the research areas represented in TUCS.

7.2 New Students 2004

The following 19 doctoral students began their studies at TUCS Graduate School in 2004:

- *Dudkov, Alexey*, M.Sc. in Telecommunication with Distinction, Saint Petersburg Electrotechnical University, Russia
- *Ganesan, Sivakumar*, M.Sc. in Computational logic, Technical University Dresden, Germany
- *Grandell, Linda*, M.Sc. in Computer Science, Åbo Akademi University, Finland
- *Hakonen, Henri*, M.Sc. in Technology, University of Turku, Finland
- *Hollanti, Camilla*, M.Sc. in Mathematics, University of Turku, Finland
- *Lahdenoja, Olli*, M.Sc. in Electronics, University of Turku, Finland
- *Malik, Qaisar*, M.Sc. in Dependable Computer Systems, Chalmers University of Technology, Sweden
- *Nigussie, Ethiopia*, M.Sc. in Systems on Chip Design, Royal Institute of Technology, Sweden
- *Peltomäki, Mia*, M.Sc. in Mathematics, University of Turku, Finland
- *Pänkäälä, Mikko*, M.Sc. in Electronics, University of Turku, Finland
- *Qiu, Xuemei*, M.Sc. in Information Systems, Åbo Akademi University, Finland
- *Raitoharju, Reetta*, M.Sc. in Information Systems, Turku School of Economics and Business Administration, Finland
- *Suvitie, Eeva*, M.Sc. in Mathematics, University of Turku, Finland
- *Taati, Siamak*, M.Sc. in Computer Science, Sharif University of Technology, Iran
- *Tarkkanen, Kimmo*, M.Sc. in Computer Science, University of Turku, Finland
- *Torikka, Tommi*, M.Sc. in Electronics, University of Turku, Finland
- *Tsivtsivadze, Evgeni*, M.Sc. in Hydroinformatics, Institute for Infrastructural Engineering, The Netherlands
- *Tuominen, Johanna*, M.Sc. in Electronics, University of Turku, Finland
- *Vesalainen, Laura*, M.Sc. in Electronics, University of Turku, Finland

7.3 Dissertations 2004

In 2004 TUCS produced 12 Ph.D. theses:

- Mikael Collan. *Giga-Investments: Modelling the Valuation of Very Large Industrial Real Investments*. Åbo Akademi University, PhD thesis, Dec 2004.
- Tomas Eklund. *The Self-Organizing Map in Financial Benchmarking*. Åbo Akademi University, PhD thesis, Dec 2004.
- Attila Gyenesei. *Discovering Frequent Fuzzy Patterns in Relations of Quantitative Attributes*. University of Turku, PhD thesis, Jul 2004.
- Jonna Järveläinen. *Online or Offline: Motives behind the Purchasing Channel Choice of Online Information Seekers*. Turku School of Economics and Business Administration, PhD thesis, Nov 2004.
- Petteri Kaitovaara. *Packaging of IT Services – Conceptual and Empirical Studies*. University of Turku, PhD thesis, Aug 2004.
- Juha Kivijärvi. *Optimization Methods for Clustering*. University of Turku, PhD thesis, Feb 2004.
- Eija Koskivaara. *Artificial Neural Networks for Analytical Review in Auditing*. Turku School of Economics and Business Administration, PhD thesis, May 2004.
- Peter Majlender. *A Normative Approach to Possibility Theory and Soft Decision Support*. Åbo Akademi University, PhD thesis, Sep 2004.
- Dirk Nowotka. *Periodicity and Unbordered Factors of Words*. University of Turku, PhD thesis, Jun 2004.
- Petri Rosendahl. *Niho Type Cross-Correlation Functions and Related Equations*. University of Turku, PhD thesis, Aug 2004.
- Rimvydas Rukšėnas. *Formal Development of Concurrent Components*. Åbo Akademi University, PhD thesis, May 2004.
- Seppo Virtanen. *A Framework for Rapid Design and Evaluation of Protocol Processors*. University of Turku, PhD thesis, Sep 2004.

7.4 Conference Participation

During the year 2004, TUCS has financed conference participation and other travel expenses for a total of 79.390 EUR, of which 69.160 EUR has been used on journeys made by postgraduate students, 7.560 EUR by postdoctoral researchers and 2.670 EUR by others.

The following laboratories have received travel grants from TUCS during the year:

Postgraduate Students

(The total number of TUCS Postgraduate Students/Laboratory in brackets)

Laboratory	Trips	EUR
Algorithmics (7)	1	860
Bioinformatics (7)	4	2.800
Biomathematics (1)	1	30
Communication Systems (9)	3	2.870
Data Mining and Knowledge Management (5)	6	2.730
Discrete Mathematics for Information Technology (18)	9	6.390
Distributed Systems Design (6)	6	6.240
Embedded Systems (5)	6	6.170
Health and Medical Informatics Institute (4)	6	9.230
IAMSR (6)	9	6.170
Laboris Information Systems (2)	3	1.920
Learning and Reasoning (3)	4	1.820
Mobile Commerce (6)	11	9.610
Microelectronics (4)	3	1.720
Network Economics Institute (3)	8	6.880
Software Construction (6)	5	3.470
Telecommunication and Digital Systems (1)	1	250
Total	86	69.160

Postdoctoral Researchers

(The total number of TUCS Postdoctoral Researchers/Laboratory in brackets)

Laboratory	Trips	EUR
Algorithmics (2)	2	3.350
Discrete Mathematics for Information Technology (2)	2	910
Distributed Systems Design (1)	1	1.550
IAMSR (1)	2	1.650
Total	7	7.560

Travel destinations

Destination	Number
Finland	18
Europe	53
USA	12
Other	10
Total	93

8 Master's School

TUCS Master's School was established in the autumn of 2002 and presently consists of four master's programmes. These two-year master's programmes, which are taught in English, are awarded by a Finnish Master's degree from one of the participating universities. Prerequisites are a Bachelor's degree equivalent to a Finnish university Bachelor's degree in a relevant field and a certificate of knowledge of English. There are no tuition fees for the Master's School, but the Student Union membership is compulsory for Master's degree students. In 2004, 19 students started in the Master's School.

TUCS role within the Master's School project is to co-ordinate the planning of the project, provide information about the Master's School - mainly on the Internet and through e-mail - as well as to co-ordinate the application procedure.

8.1 Study Programmes

The master's programmes within the Master's School are:

- Master's Programme in Information Technology (University of Turku, Faculty of Mathematics and Natural Sciences, and Dept. of Information Technology)
 - Computing
 - Electronics and Communication Systems
- Master's Programme in Software Engineering (Åbo Akademi University, Faculty of Mathematics and Natural Sciences, Dept. of Computer Science)
- Master's Programme in Electronic and Mobile Commerce (Åbo Akademi University, Faculty of Economics and Social Sciences, Dept. of Information Systems)
- Master's Programme in Global IT Management (Turku School of Economics and Business Administration, Dept. of Management, Inst. of Information Systems Science)

9 Courses

The collection of advanced level and research courses given in English, forms a central part of the TUCS Graduate School. Approximately 30 courses on this level are given each year, mostly as part of the ordinary teaching duties of the TUCS faculty and researchers. The courses can be taken by all TUCS students (and also M.Sc. students at the departments), independently of which department or university they belong to.

The following courses have been given during the year. The courses are classified into the main research areas of TUCS which are *Algorithmics*, *Bioinformatics*, *Communication Systems*, *Discrete Mathematics*, *Embedded Systems*, *Information Systems*, *Microelectronics*, *Mathematical Modelling and Software Engineering*.

9.1 Regular Courses

Spring 2004

Algorithmics

1. Artificial Intelligence, 3 cu (38)¹
Timo Knuutila, University of Turku, Department of Information Technology
2. MPEG-4, 2 cu (62)
Jan Westerholm, Åbo Akademi University, Department of Computer Science
3. Neural Networks, 4-5 cu (24)
Timo Järvi, University of Turku, Department of Information Technology
4. Special Course on Networked Virtual Environments, 2 cu (47)
Jouni Smed, University of Turku, Department of Information Technology
5. Statistical Learning Theory, 2-3 cu (15)
Tapio Salakoski and Aleksandr Mylläri, University of Turku, Department of Information Technology

Bioinformatics

6. Bioinformatics Seminar, 2 cu (5)
Tapio Salakoski, University of Turku, Department of Information Technology
7. Introduction to Natural Language Processing, 3 cu (29)
Filip Ginter, University of Turku, Department of Information Technology
8. Methods in Functional Genomics (16)
Gordon Alford, University of Turku, Department of Information Technology

¹ Number of students marked in brackets

Communication Systems

9. High-Speed SoC/SoP Design, 3 cu (9)
Esa Tjukanoff and Imed Ben Dhaou, University of Turku, Department of Information Technology
10. Signal Processing Applications, 5 cu (11)
Jan Westerholm, Hannu Toivonen and Jerker Björkqvist, Åbo Akademi University, Department of Computer Science
11. Spread Spectrum and CDMA, 5 cu (17)
Valery Ipatov and Jarkko Paavola, University of Turku, Department of Information Technology

Discrete Mathematics

12. Boolean Algebra, 2.5 cu (26)
Magnus Steinby, University of Turku, Department of Mathematics
13. Combinatorics on Words, 5 cu (18)
Juhani Karhumäki, University of Turku, Department of Mathematics
14. Tilings and Patterns, 5 cu (19)
Jarkko Kari, University of Turku, Department of Mathematics

Embedded Systems

15. Hardware/Software Codesign, 3 cu (15)
Johan Lilius, Åbo Akademi University, Department of Computer Science
16. Simulation of Discrete Event Systems - Special Course in Embedded Systems, 3 cu (10)
Risto Lahdelma, University of Turku, Department of Information Technology
17. Special Course in Embedded Systems, 3 cu (7)
Xinrong Zhou and Jerker Björkqvist, Åbo Akademi University, Department of Computer Science

Information Systems

18. Advanced IT in Accounting / ERP and Internet Accounting, 5 cu (20)
Barbro Back, Åbo Akademi University, Department of Information Systems
19. Corporate Information Technology, 5 cu (24)
Vladimir Kvassov, Åbo Akademi University, Department of Information Systems
20. Evaluation of IS, 5 cu (21)
Markku Nurminen, Timo Kestilä and Jukka Heikkilä, Turku School of Economics and Business Administration, Institute of Information Systems Sciences and University of Turku, Department of Information Technology

21. Management of IS Projects, 5 cu (19)
Hannu Salmela, Turku School of Economics and Business Administration, Institute of Information Systems Sciences
22. Mobile Commerce, 5 cu (35)
Pirkko Walden and Christer Carlsson, Åbo Akademi University, Department of Information Systems
23. Theoretical Foundations of Information Systems, 3-5 cu (19)
Minna Koskinen, University of Turku, Department of Information Technology

Mathematical Modelling

24. Advanced Topics in Functional Analysis, 5 cu (5)
Mats Gyllenberg, University of Turku, Department of Mathematics
25. Mathematical Modelling, 5 cu (14)
Stefan Geritz, University of Turku, Department of Mathematics

Microelectronics

26. Formal System Specification and Modelling, 5 cu (9)
Juha Plosila and Tiberiu Seceleanu, University of Turku, Department of Information Technology
27. New Computation Platforms Towards Nano-Scale Systems, 5 cu (10)
Hannu Tenhunen and Jouni Isoaho, University of Turku, Department of Information Technology

Software Engineering

28. Development of Object-Oriented 3D and Media Applications, 3 cu (42)
Michael Samarin (Helsinki University of Technology), University of Turku, Department of Information Technology
29. Seminar on Issues in Design of Dependable Systems, 2 cu (1)
Elena Troubitsyna, Åbo Akademi University, Department of Computer Science
30. Seminar on Logic Programming, 2 cu (2)
Risto Lahdelma, University of Turku, Department of Information Technology
31. Software Agent Technology, 3 cu (25)
Roope Raisamo (University of Tampere) and Heimo Laamanen (University of Helsinki), University of Turku, Department of Information Technology
32. Software Architectures, 3 cu (54)
Kaisa Sere, Åbo Akademi University, Department of Computer Science
33. Special Course in Software Engineering, 3 cu (25)
Iván Porres, Åbo Akademi University, Department of Computer Science
34. Programming III, 3-4 cu (66)
Antero Järvi, University of Turku, Department of Information Technology

35. Programming Language Concepts, 3 cu (25)
Tatjana Petković, University of Turku, Department of Information Technology

General Courses

36. Ethical Decision Making And Information Technology, 2 cu (6)
Annamari Soini, Åbo Akademi University, Department of Computer Science

Fall 2004

Algorithmics

1. Advanced Course on Databases, 3 cu (33)
Jukka Teuhola, University of Turku, Department of Information Technology
2. Data Mining, 3 cu (30)
Timo Knuutila, University of Turku, Department of Information Technology
3. Design and Analysis of Algorithms, 3 cu (63)
Olli Nevalainen, University of Turku, Department of Information Technology
4. Statistical Learning Theory, 2 cu (10)
Tapio Salakoski, University of Turku, Department of Information Technology

Bioinformatics

5. Fractals, 2 cu (30)
Aleksandr Mylläri, University of Turku, Department of Information Technology

Communication Systems

6. Coding and Encryption in Telecommunication, 6 cu (22)
Valery Ipatov and Sami Nuuttila, University of Turku, Department of Information Technology
7. Self-Organizing Systems, 4 cu (20)
Juhani Peltonen, University of Turku, Department of Information Technology

Discrete Mathematics

8. Combinatorial Enumeration, 2.5 cu (14)
Tero Harju, University of Turku, Department of Mathematics
9. Finite Automata, 2.5 cu (12)
Tatjana Petković, University of Turku, Department of Mathematics
10. Introduction to Biocomputing, 3 cu (43)
Ion Petre, Åbo Akademi University, Department of Computer Science

11. Ramsey Theory and Related Topics, 2.5 cu (8)
Juhani Karhumäki, University of Turku, Department of Mathematics
12. Term Rewriting Systems, 2.5 cu (12)
Magnus Steinby, University of Turku, Department of Mathematics

Embedded Systems

13. Project Course, 5 cu (46)
Elena Troubitsyna, Åbo Akademi University, Department of Computer Science

Information Systems

14. Electronic Commerce in Global Economy, 5 cu (30)
Petra Schubert and Reima Suomi, Turku School of Economics and Business Administration, Institute of Information Systems Sciences
15. Electronic Commerce: Strategic Consulting in an Electronic Environment, 5 cu (15)
Pirkko Walden, Åbo Akademi University, Department of Information Systems
16. Group Work Technologies, 5 cu (31)
Markku Nurminen, University of Turku, Department of Information Technology
17. Information Systems in Health Care, 5 cu (15)
Eija Karsten and Reima Suomi, Turku School of Economics and Business Administration, Institute of Information Systems Sciences and University of Turku, Department of Information Technology
18. Usability Testing, 3+2 cu (20)
Franck Tétard, Åbo Akademi University, Department of Information Systems
19. User-Centred Design: Methods and Applications, 3 cu (16)
Sampsa Hyysalo, University of Turku, Department of Information Technology
20. XML Technologies and Applications, 3 cu (105)
Jukka Teuhola, University of Turku, Department of Information Technology

Mathematical Modelling

21. Introduction to Game Theory, 2.5 cu (12)
Stefan Geritz, University of Turku, Department of Mathematics

Microelectronics

22. Design of Analog Integrated Circuits, 5 cu (9)
Ari Paasio and Olli Lahdenoja, University of Turku, Department of Information Technology
23. Device Mismatch in IC, 2 cu (11)
Jonne Poikonen, University of Turku, Department of Information Technology

24. Microsensors, 5 cu (11)
Lauri Heikkilä, University of Turku, Department of Information Technology
25. Quantum Physics for Micro- and Nanoelectronics, 3 cu (3)
Esa Tjukanoff, University of Turku, Department of Information Technology
26. Seminar, 2 cu (3)
Risto Punkkinen, University of Turku, Department of Information Technology
27. SoP I, 2 cu (9)
Risto Punkkinen, University of Turku, Department of Information Technology
28. Supercomputing Structures, 3 cu (8)
Ari Paasio and Laura Vesalainen, University of Turku, Department of Information Technology
29. ULSI Design, 6 cu (13)
Juha Plosila and Pasi Liljeberg, University of Turku, Department of Information Technology

Software Engineering

30. Distributed Systems, 3 cu (91)
Ville Leppänen, University of Turku, Department of Information Technology
31. Parallel Programming, 3 cu (38)
Mats Aspnäs, Åbo Akademi University, Department of Computer Science
32. Software Quality, 5 cu (44)
Thorbjörn Andersson, Åbo Akademi University, Department of Computer Science

9.2 Short Courses

Spring 2004

1. Individual and Group Decision Making in Fuzzy Environments, 3 cu (10)
Mario Fedrizzi, University of Trento, Italy
2. IS in Media, 2, 3 or 5 cu (49)
Thomas Hess, Munich School of Management, Germany

Fall 2004

1. Foundations of Components and Software Composition, 2 cu (20)
Joost Kok, LIACS and Farhad Arbab, CWI, the Netherlands

10 Personnel

10.1 TUCS Staff

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17. **Christer Carlsson (Editor)**, Information Systems Day
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