CHALMERS | GÖTEBORG UNIVERSITY

School of Computer Science and Engineering

Annual Report 2002

School of Computer Science and Engineering – CSE

Sektionen för Data- och informationsteknik – D&IT

D&IT

www.cse.chalmers.se

Cover picture: The soft shadows from the @ are generated from a new algorithm. Computer graphics p. 11.

A new School is formed...

The rapid development of computing technology is proceeding unabated: processing speeds double every 18 months, memory capacity is increasing dramatically, and prices are continuing to fall. We cannot know what applications are around the corner, but we can be sure that new areas will open up which will change our daily life. Therefore, high quality research and education in Information Technology is vital, both for industry and society.

Our Computing Science and Computer Engineering departments are among the strongest in Sweden. By joining them into a new School, Chalmers is focusing on the IT-area both in research and teaching. The School is further strengthened by being a part of Göteborg University as well.

We have an extensive undergraduate programme, both at Chalmers and Göteborg University, and the School is by far the largest actor in university IT-teaching in Western Sweden.

As you will see in this report of the first year of the School's existence, our research covers many areas, and some of our research groups are among the world leaders in their fields. The formation of the new School has stimulated new joint research initiatives across departmental boundaries; two examples of this are the groups working on security and on systems-on-a-chip, which are both presented in more detail below.

Jan Smith

Jan Smith, dean

Contents:

School of Computer Science and Engineering

Number of employees: **170**
Faculty members: **55**
PhD students: **70**

Full-time-students: **1100** (of which 200 at Göteborg University)

Revenue (SEK m): **153**

January 2002:

The School of Computer Science and Engineering is formed

Bo Samuelsson, Rector of Göteborg University, and Jan-Eric Sundgren, President of Chalmers, during the inauguration of the School of Computer Science and Engineering. 14th of March 2002.

Chalmers University of Technology and Göteborg University are taking a major joint initiative in the field of information technology by forming the IT-university in Göteborg. The IT-university has two denotations: (1) the activities at Lindholmen with a new faculty and educational programmes in applied information technology (2) an umbrella for all IT research and teaching within Göteborg University and Chalmers. The Göteborg University part of the Computing Science department belongs to the new faculty and the School as a whole is under the umbrella.

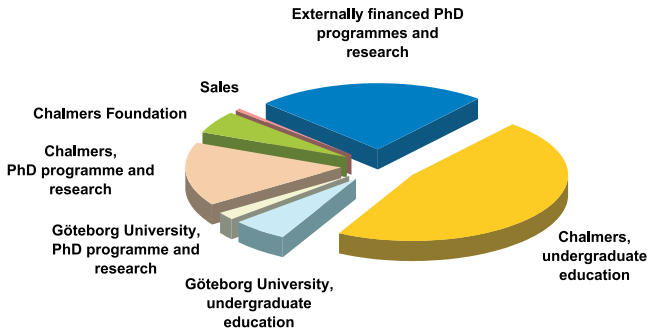
In teaching, we have introduced a new undergraduate degree programme in Information Systems Engineering (IT), and expanded the existing programme in Computer Science and Engineering. We have established new International Masters programmes in Dependable Computer Systems and Human-Computer interaction. We are also broadening our research profile.

Our research spans the whole spectrum, from theoretical underpinnings to applied systems development. The research atmosphere in the School is very exciting. The School has an extensive collaboration, both national and international, with universities and industry. We are attracting major grants from the

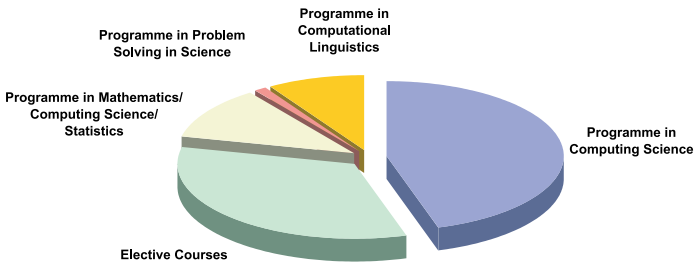
Swedish Strategic Research agency, the Swedish Research Council, the European Commission and other national and international research funding organizations. Several of these projects span many disciplines and levels of abstraction, and involve researchers from Computing Science and Computer Engineering as well as other engineering departments at Chalmers.

The strong expansion of the undergraduate teaching in recent years requires a corresponding increase in staff and during 2003 we expect to hire about 10 new associate professors. Chalmers Foundation's IT-initiative has been crucial when building up the new competence needed.

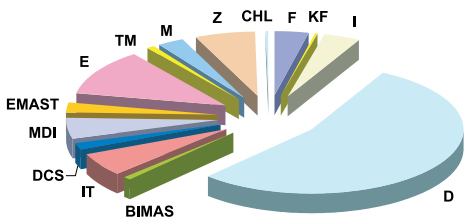
School of Computer Science and Engineering: Revenue 153 SEK m



Göteborg University: 200 full-time-students



Chalmers University of Technology: 900 full-time-students



F = Engineering Physics
KF = Chemical Engineering with Engineering Physics
I = Engineering Economics
D = Computer Science and Engineering
BIMAS = Bioinformatics
IT = Information Engineering
DCS = Dependable Computer Systems
MDI = Human-Computer Interaction
EMAST = Digital Communication Systems and Technology
E = Electrical Engineering
TM = Engineering Mathematics
M = Mechanical Engineering
Z = Automation Engineering
CHL = Chalmers Lindholmen

Erland Jonsson
David Sands

Providing in-depth security

In the last 50 years we have seen our dependence on computers and their services increase, giving us a clear trend: future information and communication systems will be ubiquitous and pervasive, i.e. fully distributed, networked and available everywhere and to everybody. They will provide flexible and tailored services of all kinds, including so-called critical infrastructure functions where life might be at stake. However, computer-related security incidents continue to grow in number and significance, implying that the state-of-the-art of today is not sufficient. Therefore, we must ameliorate our security practices to be able to embrace the vision of the future.

Illustrating this trend, an increasingly common feature of modern systems and devices is open-ended functionality, whereby new features and services can simply be downloaded and added on the fly, much in the way that, for example, web-browsers can be extended with plugins, mobile phones can receive new games and word-processing documents can contain macro commands.

Illustration: B. Sands

As computation becomes seamlessly woven into everyday life, such extensions are becoming more transparent and also more powerful. In the past, these extensions have reduced the overall security of the system, and attackers have used them to leapfrog into the system. The older coarse-grained “one-size fits all” security policy is no longer adequate in this domain, where we need to tackle the security challenges at the level of the applications themselves.

Professor David Sands

Operational security is sometimes classified as prevention, detection and recovery. We argue that security must be applied to all parts and at all levels of the system, as opposed to traditional security methodologies where focus has mainly been on boundary protection. Security considerations should also follow the system throughout its lifetime, starting from the specification phase, throughout construction, operation and maintenance. We call this approach in-depth security and our research span all phases.

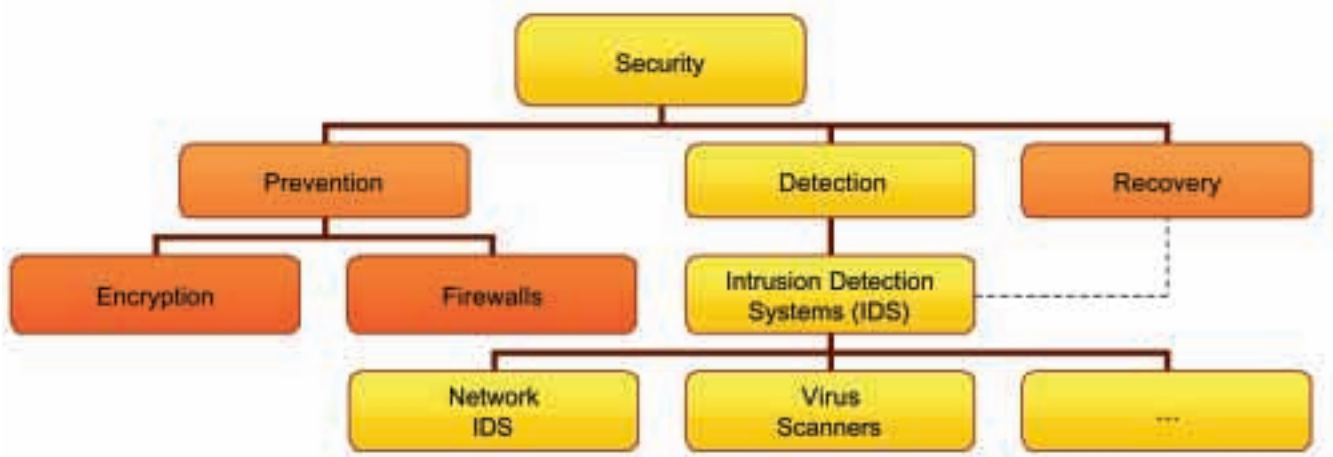
For example, we have begun looking into the problem of tackling security problems at the earliest stages in the design of systems,

e.g. before code is produced. Here the challenges are to find ways of expressing security architectures and policies using and extending standard design methods such as the Unified Modelling Language. In the next stage of development, we consider programming-language based security, where we investigate the application programming language technology (compilers, automatic program analysis, and code transformation) to ensure that only safe applications can be run. This is achieved through a combination of program analysis, transformation and certification, using technologies that have been developed in computing research for more than two decades. Research such as this may have a direct impact on the open-ended applications described in the example above.

But there are important issues at all levels in the lifetime of a system. Many security mechanisms fail or are circumvented by malicious attackers and detecting how and when this happens helps us understand and improve subsequent versions of the systems. Thus, another main branch of our current research is focused on the next generation of intrusion detection systems (IDS). Apart from countering the major problems of the commercial systems available today, such as network speed, encrypted traffic, and the high false-alarm rate, we investigate how an IDS can assist us in recovery after an intrusion. An important specialized area of IDS is virus detection, where commercial anti-virus systems have reached a certain maturity and are successfully deployed in millions of PC's around the world. Fraud detection, where the focus is economic crime, is a sub-area of intrusion detection where our latest research results have led to immediate improvements in commercial systems.

Professor Erland Jonsson

Computer security is a multidisciplinary research field and has drawn on many traditional areas, including statistics, artificial intelligence, programming languages and human-computer interaction, to name a few. As computers continue to decrease in size and cost, and as systems increase in connectivity, mobility and complexity, security research must rise to many new challenges. Whatever its direction, security is a fast-paced field that will play an increasingly central role in the design, construction and maintenance of future computer technology.



Kjell Jeppsson
John Hughes
Per Larsson-edefors
Mary Sheeran
Per Stenström
Lars Svensson

FlexSoC

A flexible system-on-chip platform for embedded systems

Computers are now being integrated into very many products that we rely on daily. While desktop computers are the most visible example of every-day computing, the majority of computers are embedded into a diverse set of products that we normally do not think of as computers. They are vital components in cars, dishwashers, and mobile phones, to name just a few examples. With the spread of the Internet, a new breed of products is underway that exploit the information exchange connectivity. It is becoming possible to integrate communication and processing support very cheaply in a wide range of small appliances – it will soon be feasible to locate your pair of glasses by having them tell you where they are! While the steadily shrinking circuitry and growing performance of silicon technology has brought us nearer such a vision, several challenges remain. To give concrete examples of these challenges, let us consider a familiar example of an embedded system: a mobile phone.

The FlexSoC group: Professor Per Larsson-Edefors, Dr. Lars Svensson, Professor Kjell Jeppsson (Microelectronics), Professor John Hughes and Professor Mary Sheeran.

A mobile phone uses hardware as well as software components to implement the desired functionality. Interaction with the user is implemented by software running on a quite general processor, whereas performance-critical functions are supported by tailor-made hardware blocks. Designing such Systems-on-a-chip, or SoCs, is challenging because of the heterogeneous abstraction that such a system exposes to the system designer. The goal of FlexSoC is to provide a uniform system abstraction, that will make it much easier to make hardware/software partitioning to meet challenging goals in the areas of functionality, performance, and low power consumption, within the limited resources of a SoC in an embedded system.

FlexSoC aims to combine the flexibility provided by programmable processors with the superior performance and resource-efficiency of hardware accelerators, by introducing a novel system abstraction. Conventional programmable processors use a single system abstraction, the instruction-set architecture (ISA), for all applications. For performance reasons, present-day SoCs do not provide a single abstraction, which makes it difficult to program them. In contrast, FlexSoC associates an application-specific ISA (AS-ISA) with a class of applications with similar functional requirements.

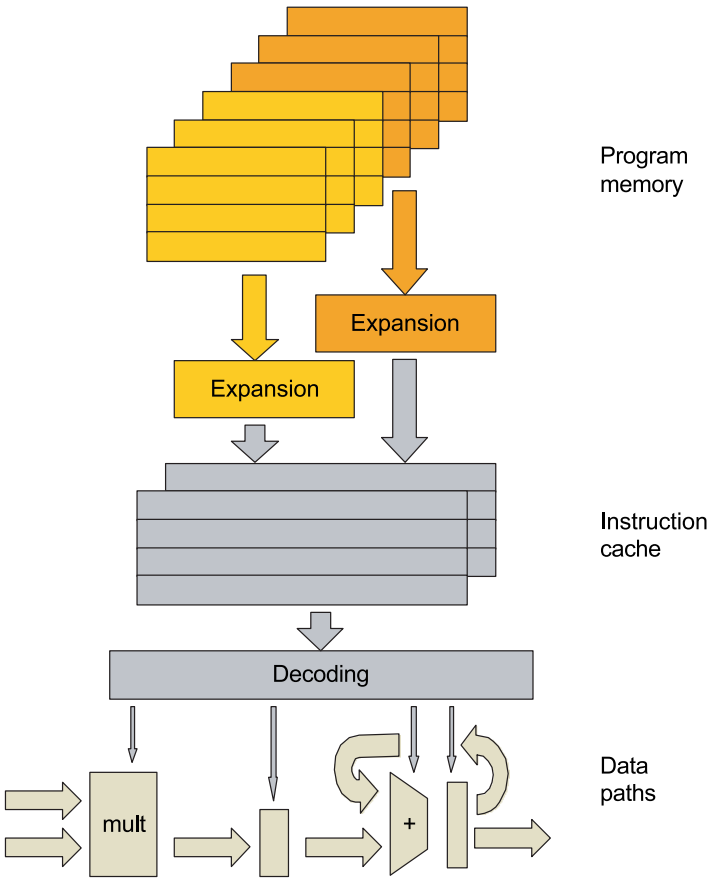
The AS-ISA will be synthesized by the software compiler, which will tailor it to represent the requirements of the application class in a compact and efficient manner. Thus, we expect a FlexSoC machine to approach the performance and low power consumption of a dedicated hardware accelerator without compromising flexibility.

The figure illustrates the use of AS-ISAs in a FlexSoC architecture. The application programs are stored in program memory in AS-ISA format. Different applications may use different AS-ISAs, represented by different colors in the figure. During program execution, the AS-ISA instructions are expanded into a native

instruction set, the N-ISA. Expansion happens when the instructions are loaded into the instruction cache. Since the AS-ISA is flexible, expansion must be carried out with reconfigurable logic circuits. Conventional instruction decoding is then applied on the cached instructions to produce the data path control word.

Professor Per Stenström, program leader. Picture taken at the inaguration of the School of Computer Science and Engineering, March 2002.

To reach its goals, FlexSoC engages experts not only in microelectronics but also in compiler design, hardware verification, and computer architecture. The project will span five years and is supported by the Swedish Foundation for Strategic Research.



The figure illustrates the use of AS-ISAs in a FlexSoC architecture.

The project involves the following senior researchers: Kjell Jeppsson (Microelectronics), John Hughes (Computing Science), Per Larsson-Edefors (Computer Engineering), Mary Sheeran (Computing Science), Per Stenström (Program Leader, Computer Engineering), and Lars Svensson (Computer Engineering).

Research groups

Algorithms

In machine learning, we investigate strategies for finding relevant attributes and hidden patterns in data in diverse settings such as (hyper)searching, clustering and collaborative filtering of information on the WWW, and for finding motifs in DNA. The methodology involves using fundamental techniques such as the Discrete Fourier Transform and the analysis of underlying stochastic processes such as random walks.

In distributed algorithms we have recently obtained several foundational results about the structure of autonomous computing or sensing mobile devices and network protocols for seamlessly connecting them such as the Smart Dust and Blue Tooth projects. Our results are already being incorporated into the EU funded EYES project for energy efficient sensor networks: http://eyes.eu.org/.

Research in on-line algorithms involves making decisions in real time and in spite of ignorance of the future and competitive analysis of the performance. Various results have been obtained for online scheduling, searching, backup and graph problems. Research in optimization attempts to incorporate and blend constraint programming methods with traditional optimization methods in solving aircraft scheduling problems. This work continues in association with the Gothenburg based company Carmen Systems, a world leader in this technology. We are currently working on a research monograph on analysis of stochastic algorithms, which has been accepted for publication in the prestigious Springer-Verlag series on Algorithms and Combinatorics. We are also involved in interdisciplinary research in Bioinformatics which is described in that section.

Peter Damaschke, Associate professor
Devdatt Dubhashi, , Associate professor
Birgit Grohe, PhD student
Mattias Grönkvist, PhD student
Thorvaldur Jochumssen, PhD student
Graham Kemp, Associate professor
Erik Kilborn, PhD student
Tuomo Takkula, PhD student
Tapani Utrianen, PhD student
Dag Wedelin, Associate professor

Bioinformatics

In systems biology we are devising mathematical models and software tools to model, simulate, visualise and analyse signalling pathways and other similar biological systems. By including models for the experimental environment we aim to create a complete simulated lab. In structural bioinformatics we model the 3D structures of proteins and their biologically important interactions. We are investigating probabilistic models and methods for phylogentic analysis, especially in the presence of horizontal gene transfer, in collaboration with the Cell and Molecular Biology group which has a unique collection of marine plasmid data where horizontal gene transfer plays a central role. We are using techniques from statistics and algorithmic learning to analyse the possibilities to detect loci of genes involved in complex diseases, to predict protein secondary structure elements from spectroscopic data, and to reconstruct DNA sequences. Bioinformatics is a multidisciplinary area and we collaborate closely with colleagues in the departments of Mathematical Statistics, Mathematics, Medical Biochemistry, Cell and Molecular Biology, Molecular Biotechnology and Clinical Genetics.

Peter Damaschke, Associate professor
Devdatt Dubhashi, Associate professor
Peter Gennemark, PhD student
Karin Hardell, PhD student
Merja Karjalainen, PhD student
Graham Kemp, Associate professor
Dag Wedelin, Associate professor

The Coding & Communications Networks (CCN) Group

www.ce.chalmers.se/CCN/

The continuing development of the Internet, wireless communications and wireless Internet is increasing the demands on enabling communication networks. The third generation mobile network is the next step towards bringing wireless Internet to the general consumer, providing data rates up to 2 Mbps. The need for increased capacity in wireless networks is already an urgent

issue, and likely to become more so in the near future. Bottlenecks are likely to occur in the wireless access links, which are notoriously slow and error prone.

Currently the research focus in the CCN is concentrated on iterative methods for detection and decoding, applied within the lower layers of a traditional network model. These methods have been shown to provide a new level of performance, moving the efficiency of communication systems closer to fundamental limits. We have several ongoing projects on joint iterative decoding in multiple access systems, efficient ARQ schemes based on iterative methods, and scheduling strategies for efficient iterative decoding of large concatenated systems, all projects leading to communications system design rules within an iterative processing paradigm.

Fredrik Brännström, PhD student
Lars K. Rasmussen, Associate professor
Peng Hui Tan, PhD student
Elisabeth Uhlemann, PhD student

Computer graphics

The computer graphics group has recently focused on two problems. In a computer-generated image, shadows are often missing, and one must put extra effort into getting correct shadows rendered. Furthermore, to simplify computations, point light sources are often used. This makes the edge of the shadow border consist of an immediate transition from “no shadow” to “full shadow”. However, light sources in the real world have an area of volume, which makes the shadow consist of a part where no light reach directly, and a smooth transition from “no shadow” to “full shadow”. Our project has developed a new ground-breaking algorithm that renders soft shadows. As the first group in the world, we can render soft shadows that are almost geometrically correct at over 70 images per second. The second project has developed an architecture for 3D graphics on mobile phones. The available resources for such a platform are drastically different than for common PCs, and therefore radical solutions are needed in order to efficiently render images of 3D scenes on mobile phones. For example, since they are powered by rechargeable batteries, the rendering must consume as little power as possible. This is what our new architecture focuses on.

Tomas Akenine-Möller, Assistant professor
Ulf Assarsson, PhD student

Computer Security

See “Providing in-depth security” pp. 6--7.

Magnus Almgren, PhD student
Dan Andersson, PhD student
Ulf Gustafson, Lecturer
Erland Jonsson, Professor
Håkan Kvarnström, PhD student
Stefan Lindskog, PhD student
Emilie Lundin, PhD student

Distributed Computing and Systems

www.cs.chalmers.se/~dcs

A distributed system is comprised by several computing devices connected via a network. Examples include: computing systems with several processors (multiprocessors), collaborative networked environments, the WWW, telecom systems, the electronic bond/stock market, the sensors-and-activators control in modern vehicles.

In such systems, *sharing* is the key-word: sharing information or cables, frequencies, expensive devices and more. Furthermore, users in distributed collaborative environments may wish to share -with colleagues/friends- views of “worlds”. The research challenges in all these are if/how it is possible to have consistent and well coordinated systems, which can be trusted in case of failure and which, at the same time, offer high performance guarantees.

This group studies efficient and reliable ways for concurrent computer-processes to share data and get coordinated (1) and to share network resources (2). We also research how to efficiently enable users to see good approximations of distributed “worlds” (3). Now, thinking how much digital information is generated in such complex systems, one gets convinced that visualization is the way to go to filter the interesting information (4).

Recent results of the group’s research in the above indicated problems:

1. Research in wait-free synchronization by the group has found ways to break synchronization bottlenecks in high performance applications.

2. Dynamic frequency allocation for cellular networks with best guarantees in fault-tolerance and call-satisfiability; probabilistic spreading of information with high reliability guarantees and low resource requirements.

3. An integrated model for collaborative environments; efficient synchronization for consistency in large systems.

4. The group is pursuing several research tracks in information visualization, with increasing acknowledgement by the respective academic communities. These include special environments for information visualization (3Dwm), scientific visualization of distributed systems (LYDIAN) and visualization techniques for concepts and methods for studying consistency.

Niklas Elmqvist, PhD student
Anders Gidenstam, PhD student
Boris Koldehofe, PhD student
Marina Papatriantafilou, Associate professor
Ha Hoai Phuong, PhD student
Håkan Sundell, PhD student
Philippas Tsigas, Associate professor
Yi Zhang, PhD student

Embedded and Networked Processors

www.ce.chalmers.se/staff/labe/embedded.html

Current Research Areas:

Architectural-level power estimation of parallel DSP architectures.
Non-standard number systems arithmetic units.
Grid Computing distribution using programmable network processors.

Projects:

The "DSP-PP" project: Aims at developing a software architecture-level power estimation tool for parallel DSP architectures capable of estimating the power (dynamic as well as static) consumption in the early stage of a parallel DSP architecture development.

The "RNS/SD units" project: Aims at developing new efficient arithmetic units based on non-standard number formats (RNS: Residue Number Systems and SD: Signed-Digit)

The "Wire Speed Grid Computing" project: Aims at developing and assessing the performance of a new distributed scheme where Grid tasks are distributed to computers on the (inter-)net by programmable network routers at "wire speed". The routing of these tasks (TM: Task Message) is performed truly distributed in that no central "server" is responsible for load allocation and balancing, but rather the network itself performs this with "no" additional delay. The TMs are routed to the node(s) on the (inter-) net, by the routers, to where they are "best served" according to criterias such as deadline for the expected result and possibly also the "budget" in terms of cost ($).

Lars-Olle Arnesson, Msc student
Lars Bengtsson, Associate professor
Do Quang Minh, PhD student
Björn Liljeqvist, MSc student
Anders Lindström, MSc student
Stefan Lund, PhD student
Michael Nordseth, MSc student

The FORCE group

We conduct research in design and validation of fault-tolerant embedded computer systems. Fault-tolerant computers can automatically mask or correct the effect of hardware or software faults that occur during execution of programs. Our research focus on cost-effective techniques for implementing fault tolerance in embedded control systems for automotive and aerospace applications. We also develop tools for fault injection based evaluation of fault-tolerance techniques.

In one project we are developing a real-time kernel (a small operating system) that uses time-redundant execution of programs for achieving fault-tolerance. We have evaluated the effectiveness of this technique through a series of fault injection experiments, in which we emulated the effects of heavy-ion and neutron induced faults in the central processing unit. During the experiments the computer was executing a safety-critical brake-by-wire application for a car. The results clearly demonstrated the effectiveness of our real-time kernel and help us identify several ways of improving the fault-tolerance.

In another project we investigate how low-cost software implemented error detection and error recovery mechanisms can make control applications inherently safe. The goal is to minimize the probability that the control system produces dangerous outputs. In an experiment with an electronic throttle control system for a car, we demonstrated that such mechanisms dramatically reduced the number of dangerous system failures, such as locking the throttle at full speed.

Joakim Aidemark, PhD student
Peter Folkesson, Assistant professor
Olof Hannius, PhD student
Johan Karlsson, Associate professor
Jonny Vinter, PhD student

The Formal Methods group

A bug in a chip or in a program to control a high speed train can have terrible consequences. By developing and using computer programs that do logical analysis, we can find bugs in both hardware and software. We can also prove conclusively that a piece of hardware or software does what it should. We are building these methods of bug-finding and proof into state of the art development environments.

On the software side, the KeY tool was released in prototype (http://i12www.ira.uka.de/~key/). It is a commercial Object Oriented design CASE tool with extra proof power, so that the user can develop guaranteed correct Java Card programs. New directions are the analysis of secure information flow in Java and using methods from testing to make program verification more efficient.

On the hardware side, we are the first group outside the US and Canada to receive funding from SRC, an alliance of major semiconductor companies. We work with Intel on methods of analysing circuits for non-functional properties like power consumption. We continue to devise new methods of describing, analysing and generating circuits, protocols and reconfigurable architectures (FlexSoC). See pp. 8--9.

Wolfgang Ahrendt, Associate professor
Reiner Hähnle, Professor
Magnus Björk, PhD student
Koen Claessen, Assistant professor
Niklas Eén, PhD student
Mia Indrika, PhD student
Wojciech Mostowski, PhD student
Jan-Willem Roorda, PhD student
Mary Sheeran, Professor
Niklas Sörensson, PhD student
Angela Wallenburg, PhD student

The High-Performance Computer Architecture Group

www.ce.chalmers.se/~pers

Ever since the beginning of the electronic computer era, new computer-based applications have been fueling the performance growth of computer technology – computers today are more than one million faster than they were 50 years ago. At the same time, computers are now embedded in virtually all technical systems and must also meet challenging demands on real-time responsiveness, low power consumption, and dependability attributes.

At Chalmers, Professor Per Stenström and his team research design principles to meet performance, real-time responsiveness, and energy efficiency issues in future high-end and embedded computers. One focus is on chip multiprocessors – an emerging architectural style – where they are addressing issues concerning execution models for on-the-fly exploitation of parallelism, resource adaptation to improve utilization of processing and memory resources, and principles for reduction of power consumption. The group is launching a project in embedded processor architecture (FlexSoC), which is described on pp. 8--9 in this issue. The team has also advanced state of the art in modelling methodologies for computer systems. Per Stenström was the general chair of the premiere international conference in computer architecture (ISCA) in 2001 and acts as its program chair 2004. This year, he gave a keynote address at IEEE IPDPS'2003 in France and will give another one at IEEE/ACM HiPC'2003.

Magnus Ekman, PhD student
Jochen Hollman, PhD student
Jonas Jalminger, PhD student
Jim Nilsson, PhD student
Per Stenström, Professor
Fredrik Warg, PhD student

interaction design group

www.cs.chalmers.se/idc

"Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them." (ACM SIGCHI definition of Human-Computer Interaction).

The benefits of Human-Computer Interaction (HCI) and Interaction Design ranges from competence in designing human-computer interfaces to ensure usability – be it a complex industrial processor control system, an interactive proof-editor or a mobile-phone – to designing new kinds of computational things that can become meaningful parts of people's everyday lives. The interaction design group works with education, research and experimental design in the field of HCI/Interaction Design. Our ambition is to build a strong group in this area at Chalmers as a basis for education and research with a solid foundation in both technology and design.

Staffan Björk, Lecturer/researcher
Lars Hallnäs, Associate professor
Peter Ljungstrand, Lecturer/researcher
Johan Redström, Lecturer/researcher
Olof Torgersson, Assistant professor

Language technology

One of the most challenging problems in language technology is automatic translation between natural languages. Already in the ’50s there were promises that this was a problem which was soon to be solved. The European union had a gigantic project trying to have automatic translation between the major European languages. The project was a big failure and ended up using technology from the ’60s.

An example of the state of the art is to take the following German sentence:

> Wer nichts weiß und weiß, dass er nichts weiß,
> weiß mehr als der, der nichts weiß und nicht weiß,
> dass er nichts weiß.

and feed it into Google’s automatic translator:

Who knows and knows nothing the fact that he does not know anything knows more than that, which knows and does not know nothing that he does not know anything.

It is rather impressive that we can get a feeling what the sentence is about, but it is certainly not a top quality translation. (A better translation would be: The person who knows nothing and knows that he knows nothing, knows more than the one who knows nothing and does not know that he knows nothing).

One project within the language technology group is multilingual authoring of documents. We want to make it possible to edit a document simultaneously in many languages. But instead of trying to solve the general translation problem, we restrict it to a small application domain. For instance, in a certain domain – like user manuals for electronic devices – there is only a small subset of the natural language being used. Our technical idea is to represent the document as a mathematical object expressed in a completely formal mathematical language (type theory). Then we can print this object in different ways, one for each natural language. So the document being edited is the mathematical object, but this is hidden to the user who only sees different representations of it having an impression that the document is edited in many different languages at the same time.

Robin Cooper, Professor
Markus Forsberg, PhD student
Thomas Hallgren, Assistant Professor
Kristofer Johannisson, PhD student
Janna Khegai, PhD student
Peter Ljunglöf, PhD student
Bengt Nordström, Professor
Aarne Ranta, Associate Professor

The “Multi” Group

Programming languages, such as Java or C, are the stuff of which software is made – the languages in which programmers express their intentions to the computer. Older languages are plodding: programmers must control the machine in every detail. Newer ones, such as Java, are more expressive, letting the programmer focus on the important points, with the machine filling in the details. We work with functional programming languages, which are even more powerful, and permit sweeping flights of fancy – which the computer must sometimes work hard to keep up with! In the last few years functional languages have helped Ericsson to build million line software systems on time and with excellent reliability.

Our work ranges from programming methods and applications, to compiler technology. Recent developments include two large projects starting with the support of the Strategic Research Foundation. One will develop programming methods for reconfigurable “system on a chip” architectures, while the other combines program testing with mathematical proofs to verify that software is error-free. The combination should enable us to improve the reliability of software at a reasonable cost.

Lennart Augustsson, Associate professor
Dennis Björklund, PhD student
Koen Claessen, Assistant professor
Jörgen Gustavsson, Dr
Thomas Hallgren, Assistant Professor
Rogardt Heldal, Dr
John Hughes, Professor
Mia Indrika, PhD student
Patrik Jansson, Assistant professor
Peter Ljunglöf, PhD student
David Sands, Professor
Mary Sheeran, Professor
Josef Svenningsson, PhD student

Programming Logic

The goal of the programming logic group is to construct computer systems which support the development of correct software. Several systems have been built based on Martin-Löf's constructive type theory, a foundational logical theory for constructive mathematics.

A key property of constructive mathematics is that computer programs can be extracted from mathematical proofs, the so called proofs-as-programs paradigm. However, this paradigm requires that all programs that can be written in Martin-Löf type theory terminate, that is, they cannot run forever. As a consequence programs in Martin-Löf type theory are more restricted than in ordinary programming languages. A recent Ph D thesis has however developed a new elegant method for translating the less restricted programs of a standard functional programming

language into the more restricted form of Martin-Löf type theory.

Another current interest is the development of a system which simultaneously support testing and proving of programs. Testing can be used both for debugging the program and its specification before a full proof of its correctness is attempted. Moreover, when a full correctness proof is unfeasible, testing some unproved properties will still increases the reliability of the program.

Other current interests are: generic programming – the idea of writing programs that can be reused in a large variety of situations; development of a standard library of proofs; and formal topology – developing a foundation for computing with real numbers in Martin-Löf type theory.

Marcin Benke, Assistant professor
Ana Bove, PhD student
Catarina Coquand, Assistant professor
Thierry Coquand, Professor
Peter Dybjer, Professor
Markus Forsberg, PhD student
Carlos Gonzalia, PhD student
Thomas Hallgren, Assistant Professor
Michael Hedberg, Dr
Qiao Haiyan, PhD student
Pierre Hyvernat, PhD student
Patrik Jansson, Assistant professor
Kristofer Johannisson, PhD student
Peter Ljunglöf, PhD student
Bengt Nordström, Professor
Aarne Ranta, Associate Professor
Jan Smith, Professor
Björn von Sydow, Associate professor
Makoto Takeyama, Assistant professor
David Wahlstedt, PhD student

ProSec – Programming Language Based Methods for Security

See "Providing in-depth security" pp. 6--7.

Stefan Axelsson, PhD student
Adam Darvas, Project assistant
Daniel Hedin, Project assistant
Rogardt Heldal, Dr
David Sands, Professor

Telecommunication Theory (TCT)

During the last couple of decades the area of digital communications has been one of the hottest (both in practise and theory) in technical research, especially for mobile applications. This is exactly the area for this research group and the Head has been active in this area since 1975, e.g. contributing to the modulation format (Continuous Phase Modulation, CPM) used in GSM systems all over the world. The scientific approach in the TCT group is of principal nature, i.e. problems of immediate technical interest are considered as well as more general areas are identified, problems formulated and solved. This generates knowledge of remaining rather than just temporary value.

The area in which most research is performed is within combined modulation and coding. This has lately been expanded into new multiple access techniques where in some cases CPM has been used. Another area of expansion is combined source and channel coding. Common to all these expansion is that a total view of the problem is taken and a joint treatment is taking place. Our work is of theoretical nature and recently iterative solutions are being used, emanating from the famous Turbo technique presented in 1993 by Berrou, Glavieux and Tihitimajshima. This allows extremely complex (and brilliant performance) systems to be implemented at a low cost using todays micro electronic technology. In the near future network aspects will also be considered. This will especially concern wireless (ad hoc) networks.

The group has an internationally leading role and is active in organizing and chairing top conferences in the area. We have also been rewarded with prestigious awards, both national and international.

Tor Aulin, Professor
Dhammika Bokolamulla, PhD student
Fredrik Brännström, PhD student
Jocelyn Chow, Assistant Professor
Anders Hansson, PhD student
Zihuai Lin, PhD student
Pär Moqvist, PhD student
Anders Nilsson, PhD student
Lars Rasmussen, Associate Professor
Peng Hui Tan, PhD student
Elisabeth Uhlemann, PhD student
Ming Xiao, PhD student


Professor Tor Aulin

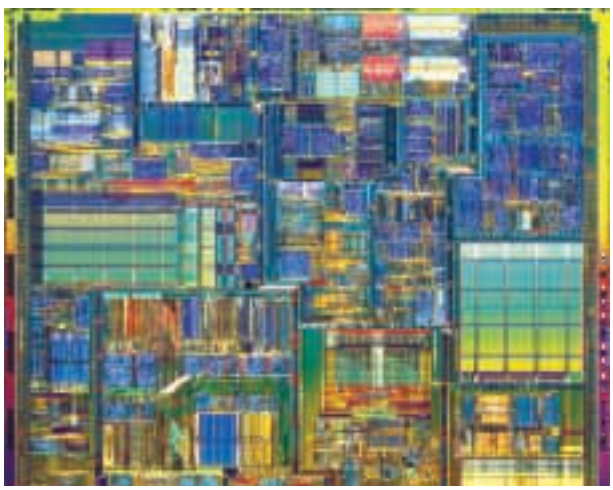
In 2002 the IEEE was celebrating its 50th anniversary and a total of 41 papers were selected from all papers (about 30 000) from the publications of IEEE as the Best-of-the-Best. Two of professor Tor Aulin's papers on continous phase modulation were among the selected 41!

VSLI Research Group

Following the recruitment of Prof. Larsson-Edefors to the chair in Computer engineering in July 2001, he initiated work to strengthen Chalmers research in System-on-Chip (SoC) design. The Swedish foundation for strategic research (SSF) approved a major research proposal of his, “Design of integrated electronic circuits and systems”, and launched, together with Chalmers, this 10 MSEK 3-year project in 2002. In January 2002 Dr. Lars Svensson, previously manager of a Switchcore laboratory, was recruited to be manager for the project.

Our work to strengthen Chalmers research in the area of integrated electronic systems has among other things led to the approval of a 10 MSEK SSF frame grant in microelectronics, in competition with well-established groups at KTH, LTH, and LiTH. This project, which also involves the Depts of Computer science and Microelectronic, provides a radically new vision on coordinated design of circuits, architectures and compilers for future System-on-Chip designs.

Daniel Andersson, PhD student
Dainius Ciuplys, PhD student
Mindaugas Drazdziulis, PhD student
Daniel Eckerbert, PhD student
Henrik Eriksson, PhD student
Per Larsson-Edefors, Professor
Magnus Själander, PhD student
Lars "J" Svensson, Dr



Intel Pentium Processor chip.

Undergraduate education

In response to the increased demand for information technology expertise in society our educational activities have grown steadily for many years.

By now the School runs three full length (4 - 4.5 year) programmmes:

- Computer Science and Engineering (Datateknik), Chalmers 160 students each year
- Information Engineering (Informationsteknik), Chalmers 80 students each year
- Computing Science (Datavetenskap), Göteborg University 50 students each year

We also give two new masters programmes (1.5 years on top of 3-year educations):

- Human Computer Interaction/Interaction Design 30 students each year
- Dependable Computer Systems (international programme) 30 students each year.

The School is also responsible for the computer science and engineering part of the curriculum for more than ten other programmes, for example the Electrical Engineering programme (Elektroteknik), the Engineering Physics programme (Teknisk Fysik) and the Computer Linguistics programme (Datalingvistik).

The three full length programmes are described briefly below and the two new masters programmes are described in more detail on the next spread.

In total the School gives more than 100 computer science and engineering courses on a wide range of different topics. This gives the students a broad selection and the opportunity to specialize within a number of areas where we offer advanced courses.

Our ability to provide a broad and deep curriculum relies crucially on our staff. Currently our teaching activities involves 55 faculty members, 70 PhD students, around 100 teaching assistants as well as administrative and technical support staff. We are currently in the process of recruiting 10 new faculty members. This will enable us to further broaden the curriculum to meet the future needs of industry, society and knowledge-seeking students in the Göteborg region and beyond.

Study activities in "Linsen".

Computer Science and Engineering

(Datateknikprogrammet)

The Computer Science and Engineering Programme ("D programme") is a 4.5 year programme leading to the degree of "civilingenjör". In the Swedish tradition, a civilingenjör degree is a natural starting point for a career towards leading roles in industry, in technical research and development as well as in management. The D programme at Chalmers aims to prepare the students to meet these challenges within its scientific area.

The curriculum is structured into three parts:

- The "basic knowledge part" covers the first two years and the beginning of year three. It consists of compulsory courses, in the core areas of computer science and engineering as well as in mathematics, physics and other engineering disciplines (electronics, signal processing, control theory, etc).

- The "project part" runs for most of the third year, consisting of an engineering project (done in groups of 5-8 students), supported by a number of elective courses.

• The “specialisation part” covers years four and five. Here the student chooses a specialisation, with a sequence of courses providing deeper knowledge and strengthening the student’s abilities to take part in development of new technology. Within this part is also the thesis project, often done in industry.

Currently we offer specialisations within:

- Algorithms
- Computer Languages
- Cognition Technology and Multimedia
- Communication systems
- Digital Systems Engineering
- Embedded Systems Engineering
- Engineering of Computer Based Systems

In the Amphi Theatre.

Information Engineering (Informationsteknik)

The Information Engineering Programme is a also a 4.5 year programme leading to a degree of “civilingenjör”. The focus is on software development, but the programme is also intended to give the students a broader perspective and an ability to work with people with different specialities. To get a degree the student has to study:

(40 credits = one academic year)
Information Technology equivalent of 60 credits
Projects 14 credits
Mathematics 30 credits
Broadening in Technology and Natural Science 15 credits
Social Sciences and Humanities 16 credits

The first three years contain compulsory courses, but there is also room for elective courses. Each year ends with a project where the students work together to solve a problem and to implement their solution in a structured way using Software Engineering methods.

The final 1.5 years are spent on specialisations. We are currently expanding our curriculum and we plan to provide specialisations within:

- Software Engineering and Development
- Interaction Design
- Games and Entertainment
- Bioinformatics
- Communication Systems
- Embedded Systems Engineering

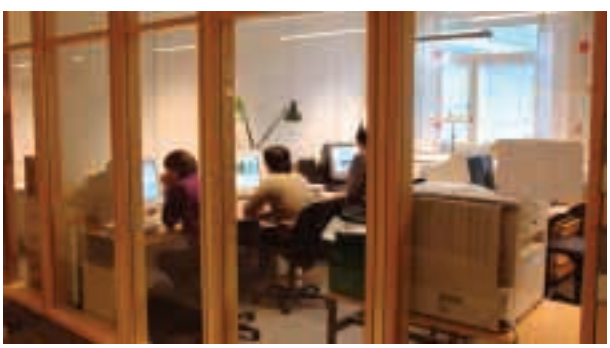
Computing Science (Datavetenskapligt program)

The Computing Science programme is given at Göteborg University and its main characteristic is that the programme, in the tradition of the University, provides a large degree of freedom of choice for the students. The programme provides a recommended curriculum of courses but the students have the possibility to design their education completely on their own.

Most students follow the recommendations closely which gives them a broad computing science education with foundations in core topics such as algorithms and the design and implementation of programming languages, as well as the possibility to focus on one or more of the specialisations available.

Other students follow the recommendations only loosely and choose to combine their computing science studies with one or several other subjects from the wide range of topics available at Göteborg University. Some examples are Biology, Economy and Linguistics.

Another small but ambitious group of students use the freedom to specialise deeply within a research area at the department of Computing Science. The School has recriuted many PhD students from this group.



Computer lab.

Masters programme in HCI/Interaction Design

Human-Computer Interaction (HCI) and Interaction Design concern the interaction between people and products in which computational technology is a central component. This can, for instance, be the design of the complex interface between the driver and the network of computers controlling a modern car, the next generation of mobile communication devices or the integration of computational technology into our everyday things, such as 'intelligent clothes'. Regardless of application area, a design perspective on the interaction between people and technology is central. This makes interaction design an increasingly important area in systems development, as well as in industrial and product design.

The Masters Program in HCI/Interaction Design at the IT-University is a one-and-a-half year program consisting of a series of courses on both user-centred development, analysis and evaluation, as well as experimental design. It aims at broadening the student's understanding of both the design issues central to interaction design and the design materials available for addressing them. The students come from a wide variety of backgrounds, including, computer science, electrical engineering, sociology, psychology, media and communication, and design. The courses are based on the student's own projects in a design studio.

The Iron Horse

The second semester, the students run a project focusing on the aesthetics of interaction design. The results of this project are then presented at an exhibition. Last year, the exhibition 'Interactive Futures' was held at Universeum. Exhibited projects included both more product-oriented work, such as the 'Wanted'-glove developed in co-operation with Hestra, as well as more experimental design, e.g., the Iron Horse. The 'Wanted'-glove: There are situations in which a mobile phone is hard to reach and the headset is difficult to use – situations in which it is important to be able to easily receive and make phone calls. Today it is possible to integrate technology into products that we already carry with us. 'Wanted' is designed to be a natural part of our immediate environment, and integrates communications techniques into a glove, thus making it easier to communicate in extreme situations. The Iron Horse combines modern technology with childhood dreams. It's a bike – but its sounds like a horse! By peddling at different speeds, you can walk, trot, or gallop. Sometimes it snorts and it greets you and other Iron Horses with a friendly neigh.

'Wanted' integrates communications techniques into a glove, thus making it easier to communicate in extreme situations.

The students have also presented their work at other events, both academic and commercial. Such venues include several exhibits at the NordiCHI conference in Aarhus, Denmark, at ACM's CHI conference in Florida, USA, and at the Nordic COMDEX fair in Göteborg.

The program is now in its second year running, and this year's students will present their projects at an exhibition in spring 2003.

More information: www.cs.chalmers.se/idc/ituniv

Photos: Johan Redström

Masters programme: Dependable Computer Systems

Much in our daily life rely on computers for their operations, e.g. when we fly, drive or ride the subway. As we depend on computer systems for our very lives, they must in turn be absolutely dependable. At the same time, computer systems are growing even more complex. Software size double every 18 months. Traditional design methods are breaking down, leading to appalling failures, such as the destruction of the Ariane 5 rocket on its maiden flight.

Several of the research groups, both at the Computing Science department and the Computer Engineering department, are working on dependability of software and hardware. Then, it was a very natural thing to start a masters programme in Dependable Computer Systems.

Ensuring dependability is a major challenge for the IT-industry. The international master's programme in Dependable Computer Systems give the students thorough grounding in many interrelated areas. Swedish industry expressed during the planning a strong interest for the programme. The planning and realisation of the programme has further increased the co-operation between the School's two departments.

The programme started 2001/02 with 11 students. The batch of 2002/03 consists of 25 students, of which 20 % are women. The number of first hand applicants has risen from 45 the first year to 228 in the second year.

All courses are assessed in "mid-term meeting", one each semester. The students there give their opinion of the courses they have taken to the programme management. Much as a result of the mid-term meetings, planning started during 2002 for a revision of the programme that will be implemented 2003/04. The order between some courses will be changed, to make the students better prepared for some courses that earlier have been experienced as difficult for many students. The number of compulsory courses will be increased to four; two from Computer Engineering and two from Computing Science.

To increase the affinity between the students as well as between students and teachers, social activities are organised, normally one each quarter.

The controls of a SAS Airbus 340 feed in to a "fly-by-wire" computer system, which is responsible for mechanically controlling the aircraft. A missed deadline or logical error could have disastrous consequences. Photo: SAS

Dissertations 2002

PhD seminars:

Public defense of PhD thesis by **Maarja Kruusmaa**, Computer Engineering, Chalmers University of Technology, February 14, 2002: **Repeated Path Planning for Mobile Robots in Dynamic Environments.**

Public defense of PhD thesis by **Thomas Lundqvist**, Computer Engineering, Chalmers University of Technology, June 14, 2002: **A WCET Analysis Method for Pipelined Microprocessors with Cache Memories.**

Public defense of PhD thesis by **Martin Hiller**, Computer Engineering, Chalmers University of Technology, October 18, 2002: **A Software Profiling Methodology for Design and Assessment of Dependable Software.**

Public defense of PhD thesis by **Ana Bove**, Computing Science, Chalmers University of Technology, November 8, 2002: **General Recursion in Type Theory.**

Public defense of PhD thesis by **Pär Moqvist**, Transmission Theory, Chalmers University of Technology, December 6 2002: **Multiuser Serially Concatenated Continuous Phase Modulation**.

Public defense of PhD thesis by **Vilgot Claesson**, Computer Engineering, Chalmers University of Technology, December 13, 2002: **Efficient and Reliable Communication in Distributed Embedded Systems.**

Public defense of PhD thesis by **Robert Feldt**, Computer Engineering, Chalmers University of Technology, December 18, 2002: **Biomimetic Software Engineering Techniques for Dependability.**

Licentiate seminars:

Licenciate seminar by **Jonas Jalminger**, Computer Engineering, Chalmers University of Technology, January 31, 2002: **On Improving Data Cache Space Utilization.**

Licenciate seminar by **Håkan Kvarnström**, Computer Engineering, Chalmers University of Technology, March 6, 2002: **Securing and Evaluating Fraud and Intrusion Detection Systems.**

Licenciate seminar by **Emilie Lundin**, Computer Engineering, Chalmers University of Technology, March 6, 2002: **Aspects of Employing Fraud and Intrusion Detection Systems**

Licenciate seminar by **Håkan Sundell**, Computing Science, Chalmers University of Technology, March 6, 2002: **Applications of Non-Blocking Data Structures to Real-Time Systems.**

Licenciate seminar by **Carlos Gonzalía**, Computing Science, Göteborg University, March 26, 2002: **Relation Calculus in Martin-Löf Type Theory.**

Licenciate seminar by **Peter Ljunglöf**, Computing Science, Göteborg University, April 16, 2002: **Pure Functional Parsing - an Advanced Tutorial.**

Licenciate seminar by **Daniel Eckerbert**, Computer Engineering, Chalmers University of Technology, April 26, 2002: **Deep Submicron Issues in RTL Power Estimation.**

Licenciate seminar by **Mathias Johansson**, Computer Engineering, Chalmers University of Technology, May 16, 2002: **Video Communication over the Internet.**

Licenciate seminar by **Martin Kämpe**, Computer Engineering, Chalmers University of Technology, May 21, 2002: **Prediction Methods for Branch and Cache Management in Computers.**

Licentiate seminar by **Josef Svenningsson**, Computing Science, Chalmers University of Technology, October 10, 2002: **Efficient and Accurate Constraint Based Program Analysis, and Aspects of Program Optimization.**

Licentiate seminar by **Peter Gennemark**, Computing Science, Chalmers University of Technology, October 21, 2002: **A model identification algorithm for cell signalling pathways.**

Licentiate seminar by **Peter Rundberg**, Computer Engineering, Chalmers University of Technology, November 8, 2002: **Data Dependence Speculation Methods to Expose Thread-Level Parallelism.**

Licentiate seminar by **Karol Ostrovsky**, Computing Science, Chalmers University of Technology, November 15, 2002: **Higher Order Broadcasting Systems.**

Licenciate seminar by **Vishaka Nanayakkara**, Computer Engineering, Chalmers University of Technology, December 18, 2002: **Analysis of Congestion in Computer Networks.**

Licenciate seminar by **Carl Bergenhem**, Computer Engineering, Chalmers University of Technology, December 19, 2002: **Protocols with Heterogeneous Real-Time Services for High-Performance Embedded Networks.**

Publications

Refereed conference articles:

Tarek Abdelzaher, **Björn Anderson**, **Jan Jonsson**, Vivek Sharma and Minh Nguyen: "The Aperiodic Multiprocessor Utilization Bound for Liquid Tasks". Real-Time Technology and Applications Symposium, San Jose, CA, September 2002.

Kristina Ahlström, **Jan Torin**, Krister Fersan, Per Nobrant: "Redundancy Management in Distributed Flight Control Systems; Experience & Simulations". In Proceedings of AIAA and IEEE 21th Digital Avionics Systems Conference, Irvine, CA. 27-31 October 2002.

Joakim Aidemark, **Jonny Vinter**, **Peter Folkesson**, and **Johan Karlsson**: "Experimental Evaluation of Time-redundant Execution for a Brake-by-wire Application". In Proceedings of International Conference on Dependable Systems and Networks (DSN-2002), Washington DC, USA, June 2002.

Tomas Akenine-Möller and **Ulf Assarsson**: "Approximate Soft Shadows on Arbitrary Surfaces using Penumbra Wedges". 13th Eurographics Workshop on Rendering 2002, pp. 309—318, June 2002. Pisa, Italy.

Björn Andersson and **Jan Jonsson**: "Preemptive Multiprocessor Scheduling Anomalies". International Parallel and Distributed Processing Symposium, Fort Lauderdale, Florida, April 15-19, 2002.

Dan Andersson, Martin Fong, **Erland Jonsson** and Alfonso Valdes: "Heterogeneous Sensor Correlation: A Case Study of Live Traffic Analysis". Presented at the 2002 IEEE Assurance and Security Workshop, United States Military Academy, West Point, NY June 2002.

Wolfgang Ahrendt: "Deductive Search for Errors in Free Data Type Specifications using Model Generation". In Automated Deduction — CADE-18, 18th International Conference on Automated Deduction, Copenhagen, Denmark, editor Andrei Voronkov, LNCS, volume 2392, Springer-Verlag 2002.

Wolfgang Ahrendt, Thomas Baar, Bernhard Beckert, **Martin Giese**, **Reiner Hähnle**, Wolfram Menzel, **Wojciech Mostowski** and Peter H. Schmitt: "The KeY System: Integrating Object-Oriented Design and Formal Methods". FASE 2002, Grenoble, France, 8-12 April 2002.

Örjan Askerdal, Magnus Gäfvert, **Martin Hiller**, **Neeraj Suri**: "A Control Theory Approach for Analyzing the Effects of Data Errors in Safety-Critical Control Systems". Proceedings of the Pacific Rim International Symposium on Dependable Computing (PRDC), pp. 105—114, Japan, 2002.

Ana Bove: "General Recursion in Type Theory".
In the proceedings of TYPES 2002. LNCS, Springer-Verlag 2002.

Koen Claessen and **John Hughes**: "Testing Monadic Code with QuickCheck". ACM SIGPLAN Haskell Workshop (part of ACM Principles, Logics, and Implementations of High-Level Programming Languages), ed. M. Chakravarty, Pittsburgh, 2002.

Peter Damaschke, Geir Agnarsson and Magnus Halldorsson: "Powers of geometric intersection graphs and dispersion algorithms". 8th Scandinavian Workshop on Algorithm Theory SWAT'2002 Turku, Finland, July 3-5, 2002. Lecture Notes in Computer Science 2368, pp. 140-149. Journal version accepted for Discrete Applied Mathematics, special issue: Stability in Graphs and Related Topics.

Peter Damaschke: "Scheduling search procedures 29th International Colloquium on Automata, Languages and Programming". ICALP'2002, Malaga, Spain, July 8-13, 2002 Lecture Notes in Computer Science 2380, pp. 281—292.

Peter Dybjer and A. Filinski: "Normalization and Partial Evaluation", in Applied Semantics, Advanced Lectures, LNCS 2395, Springer-Verlag 2002.

Cecilia Ekelin and **Jan Jonsson**: "A Lower-Bound Algorithm for Minimizing Network Communication in Real-Time Systems". Proceedings of the International Conference on Parallel Processing, Vancouver, Canada, August 2002.

Authors from the School in bold font.

Magnus Ekman, F. Dahlgren, and **Per Stenström**: "TLB and Snoop Energy-Reduction using Virtual Caches for Low-Power Chip-Multiprocessors". In Proceedings of ACM ISLPED-2002. August 2002.

Magnus Ekman, F. Dahlgren, and **Per Stenström**: "Evaluation of Snoop-Energy Reduction Techniques for Chip-Multiprocessors". In Proceedings of Workshop on Duplicating, Deconstructing, and Debunking (WDDD-1). May 2002.

Göran Falkman and **Olof Torgersson**: "MedView: A Declarative Approach to Evidence-Based Medicine". In: Surján, G., Engelbrecht, R. & McNair, P. (eds.): Health Data in the Information Society, vol. 90 of Studies in Health Technology and Informatics, pp. 577-581. IOS Press. Medical Informatics Europe, MIE'02, Hungary, Budapest, August 25-29, 2002.

Göran Falkman and **Olof Torgersson**: "Knowledge Acquisition and Modeling in Clinical Information Systems: A Case Study". In: Gómez-Pérez, A. & Benjamins, V.R. (eds.): Knowledge Engineering and Knowledge Management: Ontologies and the Semantic Web. Proceedings of the 13th International Conference, EKAW 2002, Sigüenza, Spain, October 1-4, 2002, vol. 2473 of Lecture Notes in Artificial Intelligence, pp. 96-101. Springer-Verlag.

Markus Forsberg and **Aarne Ranta**: "Labelled BNF: A High-Level Formalism for Defining Well-Behaved Programming Languages". In Nordic Workshop on Programming Theory (NWPT 2003), Tallinn, Estonia, November 2002. Extended abstract.

Carlos Gonzalia: "The Allegory of E-Relations in Constructive Type Theory". Conference: Fifth International Seminar on Relational Methods in Computer Science (RelMiCS 5) January 9-14, 2000, Québec, Canada. Published as: In 'Relational Methods in Computer Science: The Québec Seminar', pp.19-38. Edited by Jules Desharnais, Marc Frappier and Wendy MacCaull. Methodos Publishers, April 2002.

Anders Hansson and **Tor Aulin**: "On the discretization of unsupervised digital communication over time-dispersive channels" in Proc. IEEE International Symposium on Information Theory, Lausanne, Switzerland, June/July 2002, pp. 270.

Anders Hansson and **Tor Aulin**: "Unsupervised detection over time-dispersive vector channels" in Proc. Radio Science and Communication, Stockholm, Sweden, June 2002, pp. 338—341.

Martin Hiller, **Arshad Jhumka**, **Neeraj Suri**: "PROPANE: An Environment for Examining the Propagation of Errors in Software". Proceedings of the International Symposium on Software Testing and Analysis (ISSTA), ACM Press Software Engineering Notes, Vol. 27, No.4, pp. 81—85, Italy, 2002.

Martin Hiller, **Arshad Jhumka**, **Neeraj Suri**: "On the Placement of Software Mechanisms for Detection of Data Errors". Proceedings of the International Conference on Dependable Systems and Networks (DSN), pp. 135—144, USA, 2002.

Peter Holdfeldt, **Boris Koldehofe**, Carina Lindskog, Torbjörn Olsson, Wanja Petersson, Jonas Svensson , Linus Valtersson: "EnViDiA: an educational environment for visualization of distributed algorithms in virtual environments". In the Proceedings of the 7th Annual SIGCSE/SIGCUE Conference on Innovation and Technology in Computer Science Education (ITiCSE '02), pp. 226, 2002 ACM press.

Jochen Hollmann, Anders Ardö and **Per Stenström**: "Empirical Observations regarding Predictability in User Access-Behavior in a Distributed Digital Library System". Proceedings of the 16th International Parallel and Distributed Processing Symposium, pp. 221—228, IEEE, April 2002. Fort Lauderdale, FL, USA.

Jochen Hollmann, Anders Ardö, and **Per Stenström**: "Empirical Observations regarding Predictability in User Access Behavior in a Distributed Digital Library System", in Second International Workshop on Internet Computing and E-Commerce (ICEC'02), April 2002.

Reiner Hähnle, **Kristofer Johannisson**, and **Arne Ranta**: "An Authoring Tool for informal and Formal Requirements Specifications". In ETAPS/FASE-2002: Fundamental Approaches to Software Engineering, ed. by R. D. Kutsche and H. Weber, Springer LNCS, vol. 2306, pp. 233—248. Grenoble, France, April 2002.

Reiner Hähnle, Neil Murray and Erik Rosenthal: "Unit Preference for Ordered Resolution and for Connection Graph Resolution", Tableaux 2002, Copenhagen, Denmark, 1 August 2002.

Reiner Hähnle, **Koen Claessen** and Johan Mårtensson: "Verification of Hardware Systems with First-Order Logic". Workshop on Problems and Problem Sets, Copenhagen, Denmark, 1 August 2002.

Arshad Jhumka, **Martin Hiller**, **Neeraj Suri**: "An Approach to Specify and Test Component-Based Dependable Software". Proceedings of the International Symposium on High Assurance Systems Engineering (HASE), Japan, 2002 . (Arshad Jhumka: Winner of the Best Paper/Young Researcher Award)

Arshad Jhumka, **Martin Hiller**, **Neeraj Suri**: "Component-Based Synthesis of Dependable Embedded Software". Proceedings of the International Symposium on Formal Techniques in Real-Time and Fault Tolerant Systems (FTRTFT), pp. 111—128, Germany, 2002.

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Boris Koldehofe: "Simple gossiping with balls and bins". In the Proceedings of the 6th Annual 6th International Conference on Principles of Distributed Systems (OPODIS'02), pp. 109—118.

Martin Kämpe, **Per Stenström**, M. Dubois: "The FAB Predictor: Using Fourier Analysis to Predict the Outcome of a Conditional Branch". In Proceedings of 8th IEEE Int. Symp. on High-Performance Computer Architecture (HPCA-8), February 2002.

Martin Kämpe, **Per Stenström**, M. Dubois: "Self-Correcting LRU Replacement Policies". Tech. Report, Department of Computer Engineering, In Second Workshop on Caching, Coherence, and Consistency (WC3 '02) June 2002.

Björn Liljeqvist and **Lars Bengtsson**: "Grid Computing Distribution Using Network Processors". Proceedings of PDCS'02 (14th IASTED Parallel and Distributed Computing Conference 2002) conference, November 4-6, 2002, Cambridge (Boston), USA.

Zihuai Lin and **Tor Aulin**: "Lower symbol error probability bounds for CPM signalling over AWGN channels". In RadioVetenskap och Kommunikation 2002 (RVK 02), Stockholm, Sweden, June, 2002. pp. 606—610.

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Stefan Lindskog and **Erland Jonsson**: "Different Aspects of Security Problems in Network Operating Systems". In Proceedings of the Third Annual International Systems Security Engineering Association Conference (2002 ISSEA Conference), Orlando, Florida, USA, March 13-15, 2002.

Stefan Lindskog and **Erland Jonsson**: "Adding Security to Quality of Service Architectures". In Proceedings of the SSGRR 2002s Conference, L'Aquila, Italy, July 29 - August 4, 2002.

Pablo E. Martínez López and **John Hughes**: "Principal Type Specialisation". ACM SIGPLAN Asian Symposium on Partial Evaluation and Semantics-based Program Manipulation, Aizu, Japan, September 2002.

Emilie Lundin, **Håkan Kvarnström**, and **Erland Jonsson**: "A synthetic fraud data generation methodology". In Lecture Notes in Computer Science - Proceedings of the International Conference on Information and Communications Security (ICICS) 2002. Singapore, 9-12 December. Springer-Verlag 2002.

Bengt Nordström: "Constructivism. A Computing Science Perspective". Invited talk to the meeting on Foundations and the Ontological Quest in Pontificial Lateran University, Vatican City, January 2002.

Karol Ostrovsky, **K.V.S. Prasad** and Walid Taha: "Towards a Primitive Higher Order Calculus of Broadcasting Systems". In Proceedings of PPDP'02, International Conference on Principles and Practice of Declarative Programming, Pittsburgh, USA, 6-8 October 2002.

Minh Quang Do, **Lars Bengtsson**, and **Per Larsson-Edefors**: "DSP-PP: A Simulator/Estimator of Power consumption and Performance for Parallel Architectures". Proceedings of the PDCN'03 Symposium (Parallel and Distributed Computing and Networks), Innsbruck, Austria, February 10-13, 2002.

Jan-Willem Roorda, Wiebe van der Hoek, and John-Jules Meyer: "Iterated belief change in multi-agent systems". In Maria Gini, Toru Ishida, Cristiano Castelfranchi, and W. Lewis Johnson, editors, Proceedings of the First International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS'02), pp. 889—896. ACM Press, July 2002.

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Håkan Sivencrona et al: "A Novel Distributed Add-on Concept to Detect and Recover from Bus Failures in Controller Area Networks using REDCAN". Proc. 8th Int'l CAN Conf., CiA-Can in Automation Int'l Users and Manufacturers Group, Erlangen, Germany, 2002.

Håkan Sundell: "NOBLE: A Non-Blocking Inter-Process Communication Library", LCR 02, Washington DC, USA, 22-23 Mars 2002.

Håkan Sundell, **Philippas Tsigas**: "NOBLE: A Non-Blocking Inter-Process Communication Library". In the Proceedings of the 6th ACM SIGPLAN Workshop on Languages, Compilers, and Run-time Systems for Scalable Computers (LCR ´02), LNCS, Springer-Verlag.

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