Activity report on STRINGENT Research Center for 2004.

Christer Svensson, Director

1. General.

STRINGENT, Strategic Integrated Electronic Systems Research, was formed January 1st 2003 by joining 4 different groups (professor chairs) at Linköping University into a common research center. The four groups are Electronic Devices, Computer Engineering and Electronic Systems at Dept. of Electrical Engineering and Embedded Systems at Dept. of Computer Science.

1.1 Program description.

STRINGENT research program has formulated the vision:

*To make Circuit and System Sciences **lead** the development of future electronics.*

This vision will be accomplished by following goals:

New methods to convert complex ideas into silicon (*System Design)*
Improve efficiency of embedded systems (*Technology utilization*)
Reduce development times (*Design efficiency*)

The main goal during 2004 was to consolidate the research center and to build industrial relations. As the overall goal is to create a strong research center, we consider the SSF support for STRINGENT as a base funding for the center, on top of which there are also other funding. We consider all activities in the center as its results and do not distinguish between results obtained through different funding (except when directly asked for by SSF). During 2004 the center has developed well and we have initiated contact to many companies. Also, two spin-off companies was formed from the center. Our steering committee has met 3 times. The center is organized into 8 project groups across the original groups and departments, lead by 8 project group leaders. We are able to report a very successful second year of STRINGENT, with for example 4 dissertations, 3 licentiates, 2 books, 11 journal papers and 112 conference papers.

1.2 Project list.

The research program is organized in 8 project groups, lead by 8 project leaders. Each group is related to one of our overall goals, *System Design*, *Technology Utilization* and *Design Efficiency*. Ek, Da, Es and Em relates to the original research groups (professor chairs), Electronic devices, Computer Engineering , Electronic systems and Embedded systems. The structure has been slightly updated during 2004.

System design
Networks-on-chip (Christer Svensson)
Da1 SOCBUS
Em1 Optimization of real-time applications implemented on power constrained network-on-chip architectures
Em8 Heterogeneous networked embedded systems
Ek4 Global on-chip communication
Heterogeneous multiprocessor systems (Dake Liu)
Da2 Intra packet network processor
Da3 High end flexible DSP processor for future multimedia trans-coding
Da5 Low power base-band processor for SDR (Soft Defined Radio)
Em6 Design of heterogeneous multiprocessor systems for real-time applications
Signal processing algorithms (Lars Wanhammar)
Es4 Integrated active filters
Es5 Design and Implementation of Energy Efficient Digital Filters
Es6 Design and Implementation of Asymmetric Digital and Analog Filter Banks
Es7 Energy-efficient synchronization and equalization algorithms for multi-carrier systems
Es8 Low Power Algorithm Design and Implementation

Technology utilization
High speed interfaces (Jerzy Dabrowski)
Ek2 High speed off-chip communication
Ek5 Wide-band or tunable low noise amplifiers
AD and DA converters (Mark Vesterbacka)
Ek1 High performance AD conversion
Es1 CMOS digital-to-analog converters for communication
Es2 Algorithms and circuit techniques for increased performance of data
Converters
Es3 High performance ADCs implemented in SOI technology
High performance, low power circuit techniques (Atila Alvandpour)
Ek7 Low Power Multi-GHz Clocking
Ek8 Embedded memories
Ek9 System-on-chip synchronisation and communication techniques
Ek10 Low power, high performance processor building blocks

Efficient design
Verification (Petru Eles)
Ek3 Accurate models of AD-converters aimed for simulation
Em4 Formal verification of embedded systems in a reuse methodology
Em2 Modeling and verification of embedded systems
Testing (Zebo Peng)
Ek6 Testability-oriented design techniques for mixed-signal/RF integrated circuits
Em3 Hybrid BIST methodology for complex electronic systems
Em5 Testing system-on-chips using functional bus
Em7 Built-in self-test for ASICs and SoCs
Em9 SoC wrapper design, TAM configuration and test scheduling
Em10 Analysis and design of fault-tolerant heterogeneous embedded systems

2 Graduate education.

2.1 Graduate students

34 graduate students participate in STRINGENT, of which 16 are funded by the STRINGENT program (with an average funding of 73%). For a full list of students, see below. For a list of students financed through SSF, see form 3.

Ola Andersson	Anders Larsson
Stefan Andersson	Weidong Li
Alexandru Andrei	Behzad Mesgarzadeh
Erik Backenius	Sorin Manolache
Peter Caputa	Abdil Rashid Mohamed
L A Cortes	Sreedhar Natarajan
Anders Ehliar	Anders Nilsson
Johan Eilert	Henrik Olsson
Henrik Fredriksson	Mattias Olsson
Martin Hansson	Traian Pop
Zhiyham He	Rashad Ramzan
Emil Hjalmarsson	Francisco Rivas
Robert Hägglund	Linnea Rosenbaum
Gert Jervan	Erik Säll
Kenny Johansson	Erik Tell
Per Kalmström	Sriram Vangal
Daniel Karlsson	Daniel Wiklund

2.2 Graduate courses

9 Ph.D. courses was given during 2004. Additionally, Stringent arranged a summer school for all Swedish students in the field, see 4.5.

Introduction to digital ASIC backend design (Anders Edman)

Heuristic algorithms for combinatorial optimization problems (Zebo Peng)

Real-time and embedded systems (Zebo Peng)

Distributed systems (Petru Eles)

Formal modeling and verification for RT systems (Petru Eles)

Introduction to equalization techniques (Atila Alvandpour)

Timing issues in digital integrated systems (Christer Svensson)

Data representations for low power (Oscar Gustafsson)

Special topics in system level design: Networks on chip (Petru Eles)

2.3 Theses.

During 2004 we produced 4 doctors and 3 licentiates, see below.

Ulf Nordkvist, "Protocol processing in network terminals", Ph.D. April 2004 (Stringent funding of total education: 27%).

Darius Jakonis, "Direct RF sampling receivers for wireless systems in CMOS technology", Ph.D. June 2004 (Stringent funding of total education: 28%).

Håkan Bengtsson, "High speed CMOS optical receiver", Ph.D. Nov. 2004. (Stringent funding of total education: 40%).

Kalle Folkesson, "ADC modeling from a system perspective and design of RF-sampling radio receivers", Ph.D. Dec. 2004. (Stringent funding of total education: 20%).

Stefan Andersson, "New directions in RF LNA design", Licentiate, June 2004. (Stringent funding of total education: 0%).

Peter Caputa, "Design of efficient high-speed on-chip global interconnects", Licentiate, Dec. 2004. (Stringent funding of total education: 0%).

Mikael Olausson, "Hardware for speech and audio coding", Licentiate, June 2004. (Stringent funding of total education: 40%).

2.4 Present positions of graduated students.

Thomas Henriksson, Dr. May 2003, Philips research, Eindhoven, The Netherlands.
Annika Rantzner, Dr. March 2003, Integrated Vision Products, Linköping.
Ulf Nordkvist, Dr. April 2004, Infineon, Munich, Germany.
Darius Jakonis, Dr. June 2004, Acreo, Norrköping.
Håkan Bengtsson, Dr. Nov. 2004, Zarlink, Stockholm.
Mikael Olausson, Lic. June 2004, Sectra, Linköping.

3. Research

3.1 Participating researchers.

18 persons except students are engaged in STRINGENT, of whom 9 are partly funded by the program (with an average funding of 22%, see form 4). Participating researchers are:

Prof. Atila Alvandpour	Dr Aziz Ouacha
Docent Jerzy Dabrowski	Dr Kent Palmkvist
Dr. Anders Edman	Prof. Zebo Peng
Prof. Petru Eles	Dr. Paul Pop
Prof. Håkan Johansson	Prof. Christer Svensson
Dr. Erik Larsson	Dr. Ingemar Söderquist
Prof. Dake Liu	Prof. Mark Vesterbacka
Dr. Per Löwenborg	Prof. Lars Wanhammar

3.2 Publications.

The Research activity during 2004 has resulted in 2 books, 11 papers in scientific journals, 3 book chapters, and 112 papers in scientific conferences, of which 4 were invited. 8 silicon chips has been taped out and 5 have been evaluated. 5 patents or patent applications were reported. For a publication list, see Appendix 1.

4. External activities.

4.1 Cooperation with Swedish industry.

One of the groups participates with Volvo AB in an EU excellence center, ARTIST.
One research application was written with Switchcore, but rejected.
Master theses done with Saab Transpondertech and Hardi Electronics.
We have an ongoing cooperation with Acreo and the industrial demonstrator Soctrix developed within Acreo.
One of our researchers (C. Svensson) is a board member of Switchcore AB (publ.), Optillion AB and Wavebreaker AB.

4.2 Spinoff companies.

Two new companies were formed from STRINGENT research results during 2004.
Signal processing devices Sweden AB was formed during fall 2004 aiming at selling IP licenses for digital post-correction of high performance parallel AD-converters. The company won two grants in two Swedish programs for business development, *VINN NU* and *Venture Cup, Step 1.*
Coresonic AB was formed in December 2004 aiming at selling baseband signal processors in the form of silicon IP. The company attracted 800 ksek in seed money from Rendera AB and other local interests.

4.3 Cooperation with foreign industry.

We have 4 research grants from foreign industry, 50kUSD and 40kUSD from Intel (USA), 75kUSD from Intel (USA), Infineon (Germany) and Samsung (Korea), and 75 kUSD from Winbond (Taiwan). These external grants are thus about 17% of the SSF contribution. During 2004 we have had three interns (guest researchers) at Intel circuit research lab, during about 3 months each. Several master theses has been done at Philips, Eindhoven.

4.4 Additional research funding.

Several research applications were prepared during 2004, of which 4 were granted:
ARTIST2, EU network of excellence, 500ksek/yr.
3 project applications at Vetenskapsrådet was granted.
Furthermore two larger applications were prepared, one for an SSF center, NEST (Networked embedded system platforms), and one for a Vinn Excellence center. Both applications have applicants also outside the STRINGENT group.

4.5 Cooperation with other Swedish programs.

A national conference, SSoCC was arranged April 13-14 in Båstad in cooperation with Socware and FlexSoC.

A national summer school, Intelect, was arranged in Örebro in cooperation with Socware, August 23-25, 2004.

We have a close cooperation with the Socware program, including a funding of 2375 ksek (6750ksek promised).

One EU program with Infineon and CTH, Super-ADC, was funded by 100 keuro.

4.6 Webpage

The webpage is found at http://www.ida.liu.se/~eslab/stringent/. Responsible person is Erik Larsson (erila@ida.liu.se).

4.7 Information about the program.

In the beginning of 2004, we made a press release on STRINGENT yearly report and one selected result, programmable baseband chip for wireless systems. This press release resulted in several articles in Swedish and foreign technical journals and resulted in a few industrial contacts.

We arranged a number of presentations of STRINGENT to European industry, March 4 at Ericsson Mobile Platforms, Lund, April 27th at Philips research laboratories in Eindhoven, Oct 26th, a group from Ericsson (Basestations) visited us and Oct. 28th at Ericsson (UAB), Älvsjö. As a follow-up of previous year visit at Infineon, Munich, Dake Liu visited them in November.

5. Program administration.

The program has been managed by the program director, prof. Christer Svensson, with support from assistant Anna Folkesson

5.1 Steering committee.

The Steering committee has met 3 times during 2004. The members are:

Magnus Danestig, Wavebreaker, chairman (magnus.danestig@wavebreaker.se)
Jan Grahn, CTH (jan.grahn@mc2.chalmers.se)
Jonas Plantin, Ericsson (jonas.plantin@ericsson.com)
Mikael Rudberg, Infineon (mikael.rudberg@infineon.com)
Lars Svensson, CTH (larssv@ce.chalmers.se)

5.2 Advisory board.

The Advisory board has not met during 2004 but is called for a meeting in mars 2005. The members are:

Shekhar Borkar, Intel, USA (Shekhar.y.borkar@intel.com)
Manfred Glesner, T U Darmstadt, Germany (glesner@mes.tu-darmstadt.de)
Gunnar Björklund, Infineon, Sweden (gunnar.bjorklund@infineon.com)
Christain Piguet, CSEM, Switzerland (christian.piguet@csem.ch)
Tor Ramstad, NTNU, Norway (tor@tele.ntnu.no)

5.3 Monthly letter.

In order to keep all participants in Stringent aware of various events and news, the director writes a monthly letter (since August 2004) which is distributed to everyone and posted at the website.

Linköping, March 4, 2005,

Magnus Danestig   Christer Svensson
Chairman   Director