

Porter and Chips

Swedish SSC/CAS Chapter Conference in Historic Beer Brewery

First held in 2001 and organized annually since 2006 by the Swedish Chapter of IEEE Solid-State Circuits Society (SSCS) [now the joint SSCS/IEEE Circuits and Systems (CAS) Chapter], the Swedish System-on-Chip Conference has become the venue where the majority of university researchers and Ph.D. students in analog/RF and digital circuit design in Sweden meet, enjoy, and network. Local arrangements rotate between four large universities in Sweden, and they were organized together this year with the Departments of Microtechnology and Nanoscience and Computer Science and Engineering at Chalmers University of Technology in Gothenburg.

The number of conference participants has fluctuated over the years, between more than 100 down to 30. This is probably a reflection of the current popularity of the research area and the related research funding situation. This year, around 50 participants enjoyed the presentations of four invited speakers from industry as well as 24 research presentations during the two conference days.

The conference was held in the old Carnegie Porter Brewery, now converted into a modern hotel, with a stunning view of the harbor of Gothenburg and the mighty Älvsborgsbron. The brewery and a sugar mill were built in the 19th century on the remains of the first Älvsborg fortress, dating back to the



Andreas Ehliar from Linkoping University presents the Best Digital Paper Award to Christoffer Fougstedt from Chalmers University of Technology.



Jonn Lantz from Volvo Car Group spoke about mechatronics and how to use modeling, agile methods, and gradual integration in the development of complex mechatronic systems in cars.



Torbjörn Hult, chief engineer at RUAG Space, was the keynote speaker at the conference.



Atila Alvandpour from Linkoping University presents Anders Nejdel from Lund University an award for his paper.

14th century. On two occasions, the Danes conquered the fortress, cutting off Sweden's connection to the sea in the west. Sweden had to pay dearly to recover it, and, in the history books, one can read about the Älvsborg's ransom. In addition, the Swedish East India Company had its home port in this district in the 1700s.

Invited Speakers

There are many electronics-related industries in the Gothenburg area, either whose products consist of

electronics and electronic systems or provide important components for suppliers of systems. Of the four invited speakers, three were representing renowned companies of different sizes and profiles of the region.

The keynote was given by Torbjörn Hult, chief engineer at RUAG Space. With almost 400 employees in Sweden, 300 of which are in Gothenburg, and around 1,000 employees in total, RUAG Space is a strong player in the European space industry, especially when it comes to the



Speaker Hans Thörnblom, director of ASIC development at Fingerprint Cards in Gothenburg, discusses fingerprint readers in semiconductor technology.

special computers, memory, and antennas that are needed for in-space crafts for the exploration of outer space. One such project is the comet explorer Rosetta, whose small lander Philae was observed in November 2014 when it landed on the comet Tjurjumov-Gerasimenko after more than ten years in space. The computer was designed and built in the 1990s in Gothenburg, with an 8-MHz clock frequency and a 3-GB solid-state memory (long before cheap flash drives).

Another project RUAG is involved in is the ExoMars rover, a European Mars landing vehicle, planned to be launched in 2018. Torbjörn Hult described the architecture of the system and its 70-MHz computers, with much redundancy to withstand hiccups from high-energetic particles, and the buses to control the vehicle, steering, sensors, and scientific instruments.

Electronic design for these extreme conditions is very challenging because the hardware has to be operated under harsh conditions for maybe 20 years, cannot be repaired or replaced, is manufactured in very small series, and has strict limitations in terms of weight and power consumption. RUAG designs its own aokuation-specified integrated circuits (ASICs), mostly processors and mixed-signal circuits for interfacing with other electronics, and 0.18 and 0.35 micron radiation hardened processes from European

manufacturers are used. To meet system requirements, few and complex chips are necessary, leading to complex system-on-chips. RUAG is also looking into techniques such as three-dimensional (3-D) stacking of chips, and they hope to apply field-programmable gate arrays in the system, which would lead to greater flexibility.

The next invited speaker, Jonn Lantz from Volvo Car Group, represented a completely different perspective on vehicles by speaking of mechatronics and how to use modeling, agile methods, and gradual integration in the development of complex mechatronic systems in cars or, simply put, software for the control of electronics. A premium car today may have more than 100 embedded computers in complex networks, a large number of sensors, mechatronic components, and interfaces to the outside world.

The ever-shorter development times for new car models are creating challenges where software development, to some extent, can be sped up but where new hardware still takes a long time to develop and test. By using model-driven developments, hardware models are created before the actual hardware is available to develop the software in parallel. The models go through several minor updates as system and hardware components are developed.

Another completely different perspective on electronics was given by the second day's first invited speaker, Hans Thörnblom, director of ASIC development at Fingerprint Cards in Gothenburg. The company has developed capacitive fingerprint readers in semiconductor technology for many years. The commercial breakthrough had been delayed until a few years ago when Apple bought Authentic, the largest company on the market. Now fingerprint readers are included in both the iPhone and iPad (those with a "gold ring" around the front button) as well as in other smartphones, especially from Asian manufacturers.

The technology is relatively simple, with a chip consisting mainly



Senior Principal Dr. Werner Weber from Infineon Technologies, Munich, Germany, and IEEE Distinguished Lecturer, gave a lecture on the last day of the conference.

of a matrix of capacitive elements that are read out in full rows to an A/D converter. The chip area is quite large, up to 100 mm² for the main sensor, which has 192x192 elements. Purely digital processes in 0.35-um and 0.18-um complementary metal-oxide semiconductors are used because of price. Fingerprint is probably the company that buys the most silicon area in Sweden, and several foundries are necessary to secure the supply. Interestingly, the size of the sensor (the number of pixels and, thus, also the area) has been shrunk significantly to just 30% of the original design (the chip area and the cost-per-sensor scale more or less by the same factor). This appears to be a limit in the number of elements and the area of the reader to operate reliably in a product.

The last invited speaker was Senior Principal Dr. Werner Weber from Infineon Technologies, Munich, Germany. Dr. Weber is the company's specialist in 3-D chip integration and an IEEE Distinguished Lecturer. Since 2005, he has been managing publicly funded research projects on 3-D integration and backend processing for automotive and energy saving applications. Ten years ago, Infineon (formerly Siemens Microelectronics) also included memories and circuits for wireless communications, particularly mobile phones, but today the company is mainly active in industrial electronics and

has a long history in electronics for the German car industry.

Today, the semiconductor industry is very large, and the annual growth has fallen to around 6% per year. The enormous cost of building new fabs and to develop new technology slows the growth and willingness to take large risks with new technologies. Since there are few products today that really can benefit from the increased performance given by Moore's law, it is instead other technology advancements (e.g., more than Moore) where the business opportunities may be found, according to Dr. Weber.

One such area is the 3-D chip integration that is already used in dynamic random-access memory modules and camera modules in mobile phones. To make the integration possible, through-wafer vias (TSV) are often crucial (several other presentations at the conference discussed the fabrication of TSV in detail). One issue with chip stacking is that, if the yield for each

chip is not extremely high, the cost of the product can be very high, since it is only possible to fully test the product after final assembly. Defective components at this stage will be very costly. Other challenges are related to thermal issues, such as high temperatures or mechanical stress (mismatch) at varying temperatures. The design tools must also be able to handle multichip design and microsystems.

Finally, it is the cost versus benefit that will decide if 3-D integration is the best method for a given product. By mounting chips close to each other on a substrate in a module, often called *2.5D integration*, the costs and risks are lower and may be a sufficient solution in many cases.

Best Student Paper Award

Each year, two prizes are awarded to the best student papers. The criteria for winning entries are good scientific results, a good oral presentation, and a well-written four-page paper for the

conference. The prize is divided into two parts, one for digital design and one for analog/RF.

Christoffer Fougstedt from Chalmers University of Technology won the award for best digital design paper with "Chromatic Dispersion Compensation Using Robust Low-Power Time-Domain Filters" (coauthors: Alireza Sheikh, Pontus Johannsson, Alexandre Graell i Amat, Magnus Karlsson, and Per Larsson-Edefors). Anders Nejdel from Lund University won the prize in the analog/RF category with the paper "Positive Feedback for Passive Mixer-First Receiver Front-Ends" (coauthors: Markus Törmänen and Henrik Sjöland).

Next year's conference will probably be held near Stockholm with local support from the Royal Institute of Technology.

—*Ted Johansson, Vice Chair,
IEEE Sweden SSCS/CAS Joint Chapter*

Emerging Systems for Big Data Management and Internet of Things Feature at 2015 Symposia on VLSI Technology and Circuits

The 2015 Symposium on Very Large-Scale Integration (VLSI) Circuits featured two focus sessions on systems for big data management and the Internet of Things (IoT). In addition to traditional IC-level developments, these sessions included innovations that extend well beyond a single IC, reflecting the growing importance of system-level developments to our community. The themes of big data, IoT, and smart sensing, however, could be felt well beyond these two focus sessions and extended throughout the four-day event.



Kazuo Yano receives a token of appreciation from Symposium Program Chair Masato Motomura following his plenary presentation.