Foreword ISLPED Proceedings

Future Perspectives

Charles F. Kettering, American Inventor

"My interest is in the future, because I am going to spend the rest of my life there"

After the well-known speed and area constraints, the ISLPED main focus on low power design, is certainly the new challenge in the design of integrated circuits. The design of nearly one billion transistor chips, down to 0.10 μm and below, supplied at less than 1 Volt but working at some GHz, is a very challenging task, certainly considered as an impossible task only some years ago. The design of such chips seem miraculous, but, as pointed out by:

Thomas Edison, LIFE, 1932

"Genius is one percent inspiration and ninety-nine percent perspiration"

The microelectronic revolution is fascinating; 55 years ago, in late 1947, the transistor was invented by William Shockley, John Bardeen and Walter H. Brattein, Bell Telephone Laboratories, which received the Nobel Prize in Physics in 1956. Everybody knows as the story continues: MOS technology, the first microprocessor in 1971, CISC machines, RISC microprocessors in 1981, superscalar and VLIW machines today, with a shift in CMOS technology in 1984-1985 with the 80386 and 68020.

Unknown engineer

"The best way to predict the future is to invent it"

The 2001 SIA Roadmap predicts in 2016 a 0.022 μm CMOS process (probably SOI) with 16 billions of transistors for high-performance chips, 0.4 Volt, 288 watts and 28 GHz as local frequency. As a result, there are today more transistors in the world (10^{17}) than ants (10^{16}).

William Bragg

"The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them"

However, what is the future of microelectronics? Are we close to the end of this marvellous story? Is the future belonging to nanotechnologies that could completely replace microelectronics (although 0.015 μm transistors have a 15 nanometers length)? Nano-devices have been constructed, capable of switching a current or single electrons with a ratio between the on/off current of 1 thousand to 1 million. Such elements could be promising as their sizes of some nanometers and extremely low or no power consumption are very attractive. Carbon nanotubes, quantum dots, single electron devices or molecular switches are the most promising nano-devices. For instance, a carbon nanotube has a diameter of 1 nanometer, and depending on its diameter, is a semiconductor device (otherwise, it is a conductor, not usable as a switch). However, if one over 10 nanotubes is semiconductor, how to select and interconnect the semiconductor ones to provide a useful logic function?

Quantum dots are based on the Coulomb blockade effect and electrons are moved one by one from dots to dots. They have been constructed atom by atom by atomic force microscopes. Due to noise, it is better to construct cellular automata with several dots, and to define a given state of the automat as the logic "0" and another state as "1". Majority gates have been demonstrated,

as well as AND/OR gates. The main problem is still how to interconnect these gates to provide useful functions. Furthermore, it is hard to construct atom by atom a complete chip with several billions of elements.

Design methods could be completely different from today, as nano-devices could be constructed randomly, without any predefined schematic or layout. However, a useful function could emerge from this huge number of nano-devices, or some auto-organization could occur. It is a little bit similar to natural selection for which only the useful functions will survive. But it will be hard to design a predefined and very complex function like a Pentium microprocessor.

Yogi Berra, American Baseball player

"It is very hard to make predictions, especially for the future"

The most probable future is that microelectronics will be used until perhaps 2020. Then it will be probably not replaced by nanoelectronics, but both technologies, i.e. microelectronics and nanoelectronics will co-exist with probably different applications.

Welcome

Welcome to the 2002 International symposium on Low Power Electronics and Design (ISLPED), also known in short as the "low power symposium". ISLPED is unique in the sense that it brings academic and industrial researchers, technology, circuit, architecture, systems and software people together: their common concern being design for low power.

A total of 162 contributed papers were received. Many thanks to all the authors who submitted their manuscripts. We return to the 2,5 days program to give us a little more room to switch between sessions and interact with other participants during the poster sessions. Even with two parallel sessions, we were able to accept only 24 long papers, 16 short papers and 21 poster papers. We will also have one keynote speech, two invited presentations and two embedded tutorials. These invited presentations are again from the wide span of topics in this symposium: a presentation on low voltage memories, one on nanotechnology and one on system integration for wireless communication. The winners of the student design contest have a special session on Tuesday afternoon. The goal of the design contest is to encourage innovation in low power design and to showcase original power-aware designs. An industry sponsored cash award will be presented to each selected design entry. This year, the symposium will once again feature a small exhibits area.

Many thanks to the technical program committee for all the hard work in the paper review, paper selection and session organization. Additional experts have also contributed to the review process and we acknowledge their contribution. The list of the technical program committee members and of the additional reviewers can be found in the following pages. Many thanks to Prof. G. De Micheli and Prof. L. Benini for hosting the technical program committee meeting at Stanford. Thanks also to the invited speakers for graciously donating their time. The symposium has received generous support from Intel, Motorola, ARM, Chipvision, Magma, Sequence Design and BullDast. ISLPED is sponsored by ACM Sigda and the IEEE Circuits and Systems society and receives technical co-sponsorship from the IEEE Electron Devices Society and the IEEE Solid State Circuits Society.

Finally, we would like to thank you, the audience and the reader, for your interest and support of this symposium. We hope that you will find the symposium both stimulating and helpful.

Vivek De and Mary Jane Irwin
General Co-Chairs

Christian Piguet and Ingrid Verbauwhede
Technical Program Co-chairs